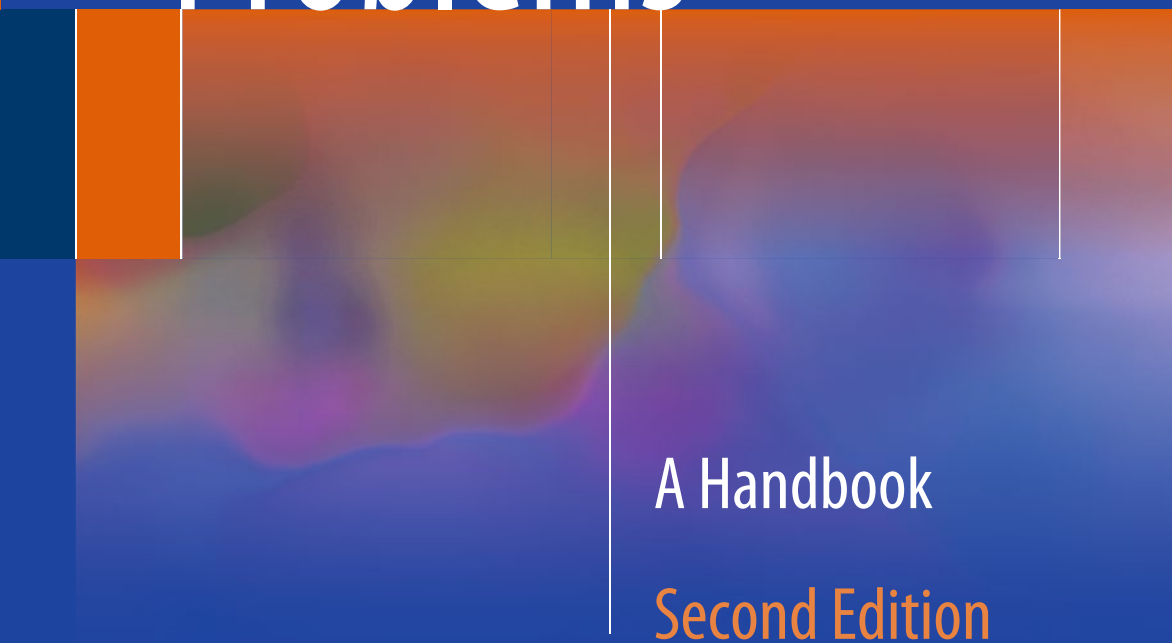
Common Musculoskeletal Problems



A Handbook

Second Edition

James M. Daniels
Editor

Springer

Common Musculoskeletal Problems

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We dedicate this book to all of our mentors. They teach us not just the science of medicine, but its practice…which is an art. Everyone has experienced that special mentor that did not just teach us how to analyze facts…They touched our hearts and made us better souls.
OURS has been Dr. Jerry Kruse. He has tirelessly worked at our University for thirty years plus in many roles – as a physician, scientist, educator, faculty, chair, CEO and Executive Dean, but most importantly as our friend, our role model and our mentor!
Thanks for all the help, Jerry!
JD and Crew

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Chapter 1
Introduction

James M. Daniels

This book was written to act as an off-the-shelf guide to assist healthcare providers evaluating patients with common musculoskeletal complaints in a primary care setting. The second edition is the result of recommendations given to us by the medical students, residents, and fellows that have used this guide for the past 5 years. It has been used as a 3-year curriculum in a primary care residency and in an intensive fourth-year medical student elective on musculoskeletal conditions. This edition also used many of the 54 references out of the JAMA series, *The Rational Clinical Examination: Evidence-Based Clinical Diagnosis.* We also updated the tear sheets to comply with new meaningful use recommendations.

This book results from a $750,000 research grant that studied how comfortable primary care providers comfort level when treating musculoskeletal conditions. We found that resident and attending family physicians reported feeling unprepared and uncomfortable diagnosing and treating musculoskeletal conditions. This text has been created with these busy primary care providers in mind. The content was created to train primary care residents but has also been used to help educate hundreds of medical students, athletic training students, physician assistant students, student nurses, and attending physicians in a variety of clinical specialties who have interest in the subject matter.

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The Approach to the Patient

Primary care providers work in a much different environment than orthopedic surgeons; therefore, their approach to the patient presenting in clinic must also differ from a specialist's approach.

In a busy primary care setting, a patient with a musculoskeletal problem may include in a full agenda conditions that they want to review with their provider that day. A 42-year-old female complaining of monthly episodes of back pain, menorrhagia, and desiring contraception may be dealing with a gynecologic issue that is causing her pain. A 60-year-old man complaining of nighttime back pain and increased urinary frequency may have prostate cancer. A 20-year-old female complaining of marriage problems, crying spells, and back pain might not only be dealing with depression but with a facet syndrome. A 47-year-old male presenting for a routine physical who admits on review of systems to back and outer leg pain and numbness when he coughs or jogs may, in fact, have nerve root impingement. These patients all have very different reasons for their symptoms, some of which might not be musculoskeletal in nature. Finding time to properly address all these issues becomes challenging. Many healthcare providers must find a way to recognize and deal with these challenges.

The approach to the patient by a physician who has a referral practice is very different, largely because the patient population they serve is different. This changes not only the initial approach to the patient but also what types of investigations and testing should be done. Certain examination techniques may be highly important for an orthopedic surgeon but might not be as useful for primary care provider. Similarly, one can expect that a spine MRI is going to have a higher false-positive rate in a primary care population than in that of the spine surgeon simply because of the population they treat. The way that students are taught about musculoskeletal medicine can also vary greatly, depending on their mentors' training and the population of patients they see.

How detailed does the healthcare provider's knowledge base need to be? For a specialist, we expect great depth of knowledge with relatively narrow breadth. For the primary care physician, we expect a much broader knowledge base with less depth. If we graphed depth vs. breadth of knowledge, we would see very different graphs (see Fig. 1.1). These graphs may have the same overall area, but the distribution

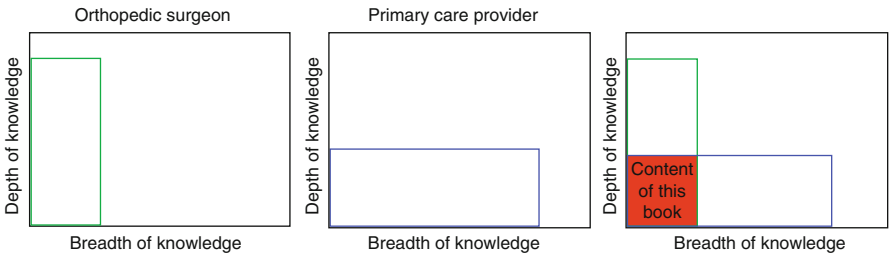

Fig. 1.1 Knowledge base in musculoskeletal medicine

varies depending on the training the physician has had and the population the physician has been trained to serve. With this book, we attempt to provide information that is relevant to and directly applicable to patient care in the primary care setting. Our focus is to concentrate on the area in which these practices overlap.

Layout

This book is divided into reference chapters, each of which focuses on a specific joint or region of the body. Each chapter is laid out in the following basic format:

1. Treatment sheet—Will include a tear or treatment sheet that can either be copied, used on paper, or easily downloaded into an electronic medical record. It includes chief complaint, history of present illness, past medical history, summary of the pertinent physical examination, and points that need to be evaluated in a visit to a primary care healthcare provider's office. This would include red flags, three pertinent questions that should be considered for every patient, common and "don't miss" conditions, and a diagnostic category guide in the form of a small table. This table is meant to help the healthcare provider place each patient in one treatment scenario. This may include an actual treatment of the problem, treatment with follow-up, consultation with co-management of the patient with a musculoskeletal specialist, or referral to another healthcare provider for more specialized treatment. This table is followed by a plan and disposition.
2. Anatomy—Basic anatomy is presented in written and/or diagrammatic form; in some cases, more detailed anatomy is discussed as it relates to common conditions. Surgical anatomy is not included, as it is not necessary for the outpatient evaluation and management of most common musculoskeletal conditions.
3. Red flags—Certain conditions require either immediate treatment or referral or may represent a condition that, if not diagnosed or treated, may result in serious sequelae for the patient. Red flags are history points, exam findings, or diagnoses that the healthcare provider needs to recognize as potentially serious.
4. Approach to the patient—Important portions of clinical history and physical exam findings are reviewed. Whenever possible, these are based on evidence-based materials. The clinical evaluation component of the text is presented as a "tear sheet" format, which can act as a guide or "memory jogger" for the encounter, or when filled out completely, can serve as a component of the medical record.
5. Common clinical presentations and management—Evaluation and management of the most common conditions that present in the outpatient setting are discussed.
6. Flow diagram—Many times, a specific diagnosis, while desirable, is not essential for the management of common musculoskeletal complaints. The more important issues are recognition of the potential "red flag" problems and appropriate plans for initial management, follow-up, and reevaluation. The disposition flow sheet helps direct the clinician in management and follow-up of the patient's

problem. In the appendix, a detailed tear sheet is included that was available in the first edition. It also includes updated flow diagrams and a meaningful use of template. This form, divided into sections, is meant to be filled out by each participant of the healthcare team, including the receptionist, nurse, and provider. This form can be given to the patient at the end of the visit and will fulfill all of the guideline recommendations for meaningful use.

The second edition of this book demonstrates an evolution of our process of producing curriculum for musculoskeletal medicine in a user friendly, practical format. Though we use this curriculum for fourth-year medical students and primary care residents, it also serves nicely for any healthcare provider as a practical way to improve the quality of their practice by using the treatment sheets and meaningful use form. It may also act as a way to improve the consistency of treatment plans and hopefully decrease the ever-increasing burden of documentation requirements.

All of the authors and contributors of this book are in some way connected to Southern Illinois University School of Medicine as a graduate, student, resident, fellow, faculty, or consulting physician. Notice that each chapter has a number of authors and may have a number of contributors. We tried to balance both a primary care approach along with a subspecialty knowledge base to complete this edition. We strongly believe that in today's society more healthcare providers need to be involved in not just the "care of the patient" but need to "care about the patient." This type of collaboration is not only good for the patient but good for the healthcare provider.

I hope that you enjoy this updated version of our book.

Chapter 2
The Cervical Spine

Wayne A. Mathews and Cesar S. Arguelles

Functional Anatomy

Figure 2.1 illustrates the surface anatomy of the cervical spine (C-spine). The C-spine consists of seven vertebrae (C1–C7) and supports the weight of the head (approximately 14 lb). The first two vertebrae are called the axis and atlas, respectively, and do not have a disc between them but are closely bound together by a complex of ligaments. The C1 (atlas) "ring" rotates around the odontoid or "peg" of C2 (axis), allowing for almost 50 % of total cervical rotation. The spinal canal is housed within the cervical vertebrae and is widest between the C1 and C3 levels (A-P diameter 16–30 mm) and narrows as it progresses caudally (14–23 mm). When the neck is fully extended, this canal can narrow an additional 2–3 mm.

Cervical spine vertebrae differ from lumbosacral vertebrae in several ways. First, there are foramina on each side which allow passage of the vertebral arteries. Additionally, the facet joints in the C-spine have steeper angles which allow for more rotation between vertebrae without subluxation. The most important difference, however, is the nonsynovial joint, known as the uncovertebral joint or "joint of Luschka." During midlife, this joint prevents a disc rupture from directly pressing onto the nerve root. This means that most disc herniations in the neck occur posteriorly (unlike the LS spine, in which most herniations occur laterally). As we age,

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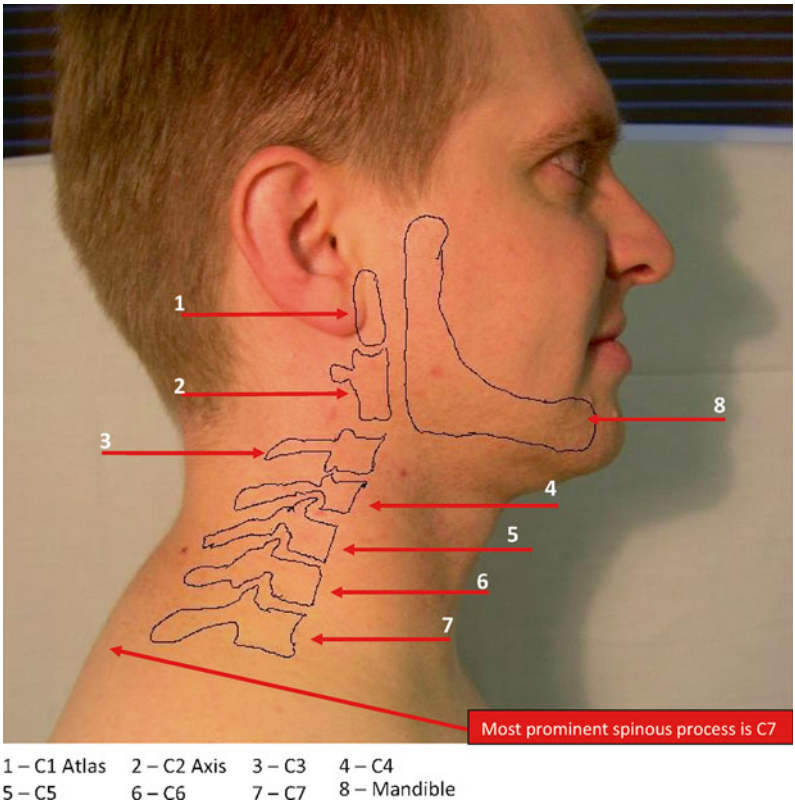

Fig. 2.1 Surface anatomy of cervical spine

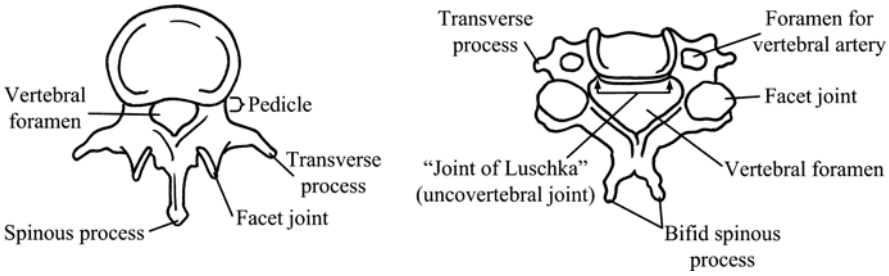

Fig. 2.2 Comparison of lumbosacral (*left*) and cervical (*right*) vertebrae

these joints can form osteophytes that can impinge upon the nerve root or compress the cervical cord directly causing cervical myelopathy. Figure 2.2 shows the major differences between lumbar and cervical vertebrae.

Red Flags

Some serious conditions can present as neck pain, and the following are considered "red flag" conditions which should spur further evaluation.

1. *Trauma*: Neck pain in the setting of trauma should receive emergent evaluation and is best managed in an emergency department. If there is any fear of spine instability, the patient should be immobilized with an appropriate cervical collar and transferred by emergency medical personnel.
2. *History of neck surgery*: New neck pain in a patient who has had prior neck surgical intervention must be approached with caution. Strong consideration to immediate referral should be given in all but the most clear-cut cases.
3. *Rapidly progressing neurological deficit*: Patients who present with rapid, progressive neurologic deficits should be suspected of having CNS involvement and should be urgently referred.
4. *Neck and/ or jaw pain associated with cardiac risk factors and exertion:* Referred pain with cardiac ischemic pattern or associated with diaphoresis should be urgently referred.

Epidemiology of Cervical Spine Pathology

Neck pain is common, occurring half as often as low-back pain; almost 70 % of the population experiences neck pain at some time. Women are affected more than men. Other risk factors are cigarette smoking, advancing age, and certain occupations. The prevalence of neck pain at any given time is 15 %.

The most common post-traumatic cause of neck pain is a whiplash injury, typically following an automobile accident. The mechanism of injury is a hyperextension motion followed by deceleration and may damage anterior muscles, ligaments, and discs. A number of high-quality studies have shown that a certain percentage of patients, on average 33 %, reported chronic symptoms after sustaining this type of injury. The Quebec task force recommends that only patients with peripheral neurological findings and those with fracture dislocation require surgical intervention. These types of injuries often involve litigation and, under our current tort system, encourage expensive imaging, most of which have no proven value in improving the course of clinical improvement.

Patients who work in occupations which involve repetitive use of the upper extremities, such as machine operators, office workers, and carpenters, are also prone to neck pain. These types of disorders often involve nerve entrapment, and nerve conduction studies may be useful to localize the origin of entrapment neuropathies.

A careful history is the most useful tool in differentiating C-spine pathologies. Important questions include the nature, duration, and location of the pain, associated numbness or tingling in either or both upper extremities, other musculoskeletal symptoms, and any history of trauma.

In patients presenting with neck pain, the physical exam must include a neurologic evaluation. The necessary exam will differ depending on patient presentation (evaluation is described in detail below). Most patients with neck pain and an absence of neurologic findings will have benign neck pain and require no further workup. Two different sets of rules have been created to assist healthcare providers in determining when imaging is appropriate (the Canadian Task Force (CTF) X-ray Rules and the Nexus Rules). It has been suggested that the CTF rules are more relevant in the primary care setting. These rules are shown in Table 2.1.

Common Clinical Presentations

Myofascial (Mechanical) Neck Pain

This is by far the most common neck condition the primary care provider will encounter. Mechanical neck pain is typically reported as diffuse and nonspecific and made worse with neck movement. Two-thirds of these patients have pain in their shoulders and upper arms in a nonradicular pain pattern. The other one-third of these patients will present with headaches sometimes radiating to the front of the head. Upon examination, there may be localized "trigger" points in the cervical and

Table 2.1 Canadian C-spine task force rules

Condition 1: perform radiography in patients with any of the following:
Age 65 years or older
Dangerous mechanism of injury
Fall from 3 ft (1 m) or 5 stairs
Axial load to the head, such as diving accident
Motor vehicle crash at high speed (>62 mph)
Motorized recreational vehicle accident
Ejection from a vehicle
Bicycle collision with an immovable object
Paresthesias in the extremities
Condition 2: in patients with none of the above characteristics, assess for any low-risk factor that allows safe assessment of neck range of motion. Perform radiographs to assess patients WITHOUT any of the low-risk factors listed here. Perform the range of motion examination described in condition 3 to assess patients WITH any of the low-risk factors listed
Simple rear-end motor vehicle accident
Sitting position in emergency department
Ambulatory at anytime
Delayed onset of neck pain
Absence of midline cervical spine tenderness
Condition 3: test active range of motion in patients with ANY of the low-risk factors listed in condition 2. Perform radiography in patients who are unable to actively rotate the neck 45° both left and right. Patients able to rotate their neck, regardless of pain, do not require imaging

peri-scapular musculature. Injection of 2 cc 0.5 % bupivacaine or 1 % lidocaine into the trigger point can be both diagnostic and therapeutic.

The primary goal in evaluation of patients with myofascial neck pain is to exclude worse pathology. In the absence of neurologic symptoms or neurologic findings, these patients can be managed conservatively. Management strategies include use of NSAIDs, activity and postural modification, physical therapy (PT), muscle relaxants, and, occasionally, limited use of opioids.

Cervical Spondylosis

Cervical spondylosis is a general and nonspecific term that encompasses a broad spectrum of afflictions but, for purposes of clarity, can be organized into three clinical syndromes: spondylosis with joint pain, spondylosis with cervical radiculopathy, and spondylosis with cervical myelopathy. It is important to remember that shoulder problems can masquerade as neck pain, such as in the case of shoulder impingement or rotator cuff disorders.

Spondylosis with Joint Pain

Degenerative arthritic changes, such as foraminal narrowing or spurring of vertebral bodies, will often be seen on radiographic imaging. This condition of cervical joint pain is often chronic, increases with advancing age, and may respond to NSAIDs, gentle range of motion exercises, and physical therapy.

Whiplash-Associated Disorder

Whiplash-associated disorder (WAD) commonly occurs in "rear-end" motor vehicle crashes. There are many theories as to why patients have so much discomfort after sustaining this type of injury. Facet joints may be the primary generators.

These patients will generally complain of symptoms similar to those associated with mechanical neck pain. Headaches are common, but physical examination will reveal no evidence of neurologic compromise. Treatment of WAD generally mimics that for mechanical neck pain.

Cervical Spondylosis with Radiculopathy

Cervical radiculopathy is the result of nerve root irritation or ischemia and can occur at multiple levels. This most commonly occurs at the interval foramina. It usually presents with nonspecific neck pain, but the most prominent symptom is

that of weakness, numbness, and tingling in one of the upper extremities. Patients with these symptoms that occur before the age of 35 should be suspected of having congenital abnormalities. The pain pattern may help make the diagnosis of cervical radiculopathy (see Fig. 2.3).

At times it is difficult to determine if a patient's pain is coming from the C-spine, the shoulder, or both. Patients complaining of pain in the posterior part of their shoulder or who have symptoms below their elbow often have a cervical pathology as the source of their pain. In addition to this, patients with C-spine pathology will complain of increased symptoms doing overhead work and will sometimes have their symptoms relieved by abducting their shoulder and resting their hand on the top of their head. Figure 2.4 describes the common motor and sensory evaluation of nerve roots C5–T1.

There have been a large number of studies to identify clinical signs or symptoms best associated with the diagnosis of nerve root impingement. Perhaps the most clinically useful set was described by Dr. Weiner et al., who identified a test item cluster. In this study, the authors found that there were four predictable variables that most likely identified patients with cervical radiculopathy:

1. Cervical rotation of less than 60° to the ipsilateral side.
2. *A positive Spurling's test.* This test is performed with the patient in a seated position. The patient laterally flexes the neck to the ipsilateral side, and the examiner

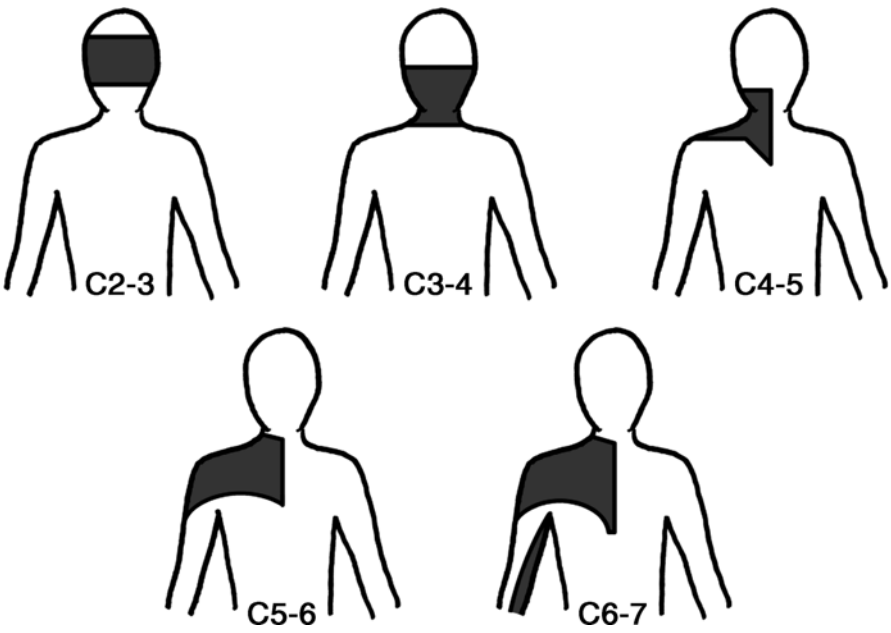

Fig. 2.3 Pain patterns at each cervical level (Adapted from Grubb SA, Kelly CK, Bgoduk N. Cervical discography: clinical implications from 12 years of experience. Spine. 2000; 25:1382–9)

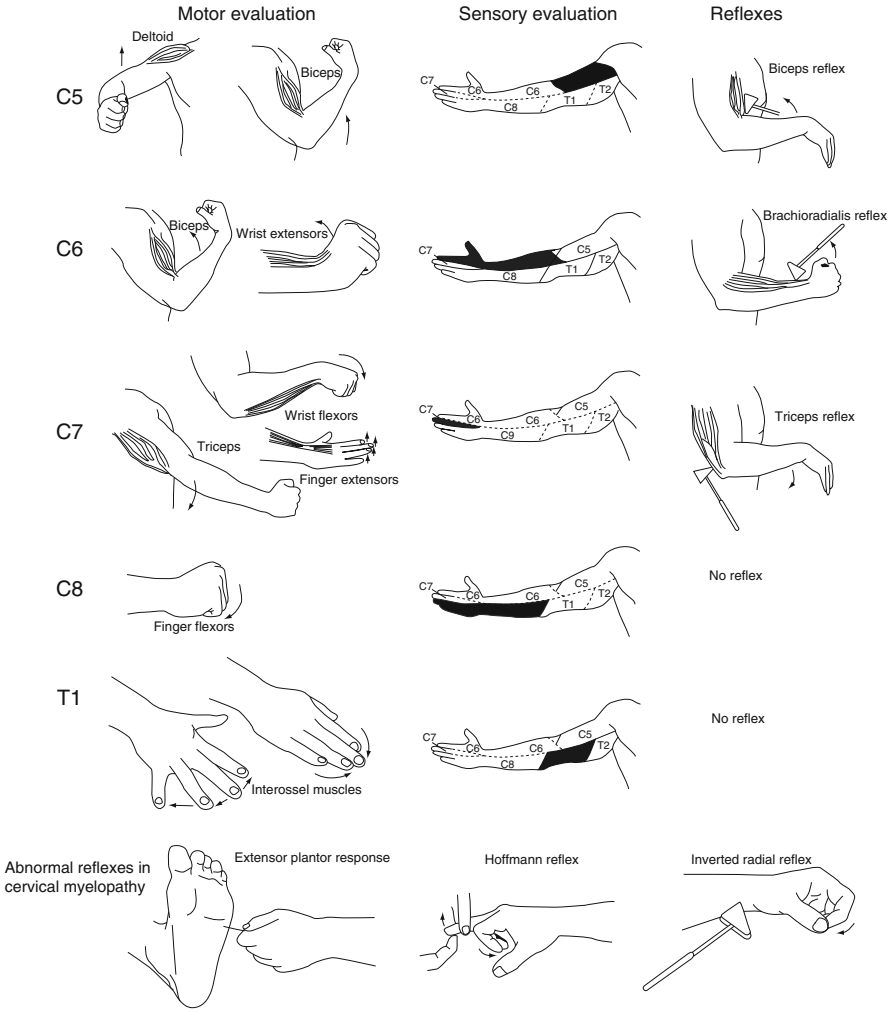

Fig. 2.4 Motor, sensory, reflex evaluation of cervical spine nerve roots

places pressure on the top of the patient's head. If the pressure on the patient's head reproduces the patient's symptoms into the arm, then the test is positive (see Fig. 2.5).

3. *A positive distraction test.* This test is performed with the patient in a supine position. The examiner cradles the patient's neck on the occiput and exerts traction. If this relieves some of the patient's symptoms, it is positive.
4. *A positive upper limb test.* This test is performed with the patient in a seated position. The patient abducts the arm to 90°, and with the elbow completely extended, the examiner dorsiflexes the wrist. This maneuver can reproduce patient's symptoms if the cause is cervical nerve related.

Fig. 2.5 Spurling's maneuver

These four tests combined are useful for the evaluation of radiculopathy: if three of the signs are present, the LR+ for radiculopathy is 6.1; if all four are present, the LR+ is 30.3; fewer than three of the signs are less helpful for predicting radiculopathy.

In most cases, physical therapy and pain control are reasonable treatment modalities for radiculopathy. An MRI should be ordered to confirm the diagnosis and to identify any other anomalies; if this is negative, the patient generally does not need orthopedic referral. If the MRI shows significant findings, or if the patient does not respond to PT, referral should be considered. Steroid injections have sometimes been used but are somewhat technically difficult, and there are concerns about potential complications.

The Stinger Injury

The stinger or burner is an injury associated with contact sports, especially football. The primary symptom is burning pain radiating down one upper extremity. Most cases involve the brachial plexus and may also involve cervical nerve roots. The usual mechanism of injury is traction with the shoulder depressed and the neck forced into lateral flexion. Treatment consists of restoring range of motion and improving neck and shoulder strength. Return to sports participation is dependent upon restoring pain-free range of motion and full recovery of strength and function. Protective devices, such as cowboy collars, may be useful to prevent these types of injuries.

Cervical Myelopathy

Cervical myelopathy occurs when the spinal cord is either directly compressed or rendered ischemic by compression. This can be caused by a congenitally small spinal canal or the normal "degeneration" of structures of the cervical spine. The most common culprits include thickening of the ligamentum flavum and spurring of the uncovertebral joint. The uncovertebral joint "protects" the cord from lateral disc herniation in midlife, but as a patient ages and osteophytes start to form in this joint, they can exert direct pressure on the spinal cord. This is most commonly seen in the sixth decade of life and may present acutely as a result of a minor fall or injury. There are a number of other entities that can also masquerade as cervical myelopathy. These include peripheral neuropathy, upper motor neuron disease, multiple sclerosis, cerebra vascular disease, and syringomyelia.

Cervical myelopathy may present with neck pain and bilateral upper extremity symptoms (pain, numbness, or tingling as in radiculopathy), along with report of loss of balance or lack of coordination. Most commonly, patients with cervical myelopathy present with clumsiness or lack of fine motor skills in the hands or an increasingly awkward gait and difficulty in maintaining balance. Patients may also complain of urinary urgency and hesitation but rarely of incontinence.

Physical exam findings include abnormal reflexes often found in patients with cervical radiculopathy. These patients are often hyperreflexic and may have upgoing Babinski reflexes, inverted radial reflex (flexor tendons of the wrist are struck on the radial aspect of the forearm with a reflex hammer, and the index finger will flex), and Hoffman's reflex (flexion of the index finger and thumb when the examiner "flicks" the patient's middle finger nail) (Fig. 2.4).

Occasionally, these patients may present acutely after falling or may present when ischemic insult occurs in the cord such as a thrombosis of the posterior inferior cerebral artery. Patients with these symptoms should be evaluated and referred on for further evaluation.

Patients with suspected or confirmed cervical myelopathy should be referred to an orthopedic or spinal surgeon. MRI can confirm the diagnosis, but if clinical symptoms are suggestive without imaging, referral should be made at that time.

Conclusion

Most patients with neck pain have benign myofascial neck pain. The primary goal in evaluation of these patients is to rule out more serious pathology. Those with serious pathology require more intense workup and management, while those with mechanical symptoms can be reassured and managed conservatively. Careful history and physical exam can easily distinguish between potentially serious and benign causes of pain.

Please refer to Fig. 2.6 for the C-spine meaningful use form.

CC: Radicular symptoms ☐ Positive ☐ Negative

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____

Occupation/Sport/Position: _____
Handedness: ☐ Right ☐ Left ☐ Both

Red Flags:
1. Trauma
2. History of neck surgery
3. Rapidly progressing neurological symptoms

Q1. Is the pain coming from the neck? (See Table 2.1)
Radicular symptoms?
Spurlings?
Fever?
Trauma?

Q2. Is the neurological examination normal? (See Figure 2.4)
Spurlings?

Q3. Is this an emergency?
a) Unstable fracture
b) Meningitis
c) Progressive neurological deficits

Common and Don't Miss Conditions:
- Mechanical neck pain
- Cervical radiculopathy
- Cervical myelopathy]
- Whiplash Associated Disorder (WAD)
- Lower extremity symptoms

TREAT APPROPRIATELY	Cervical Myelopathy .....721.1 Degenerative Disc Disease.....722.4 Mechanical Pain/Benign Neck Pain .....723.1 Mild Radicular Symptoms .....723.4 Whiplash Associated Disorder 847.0

Fig. 2.6 The C-spine meaningful use form

TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Severe pain Narcotics prescribed
CALL CONSULTANT THAT DAY	Fracture X-ray negative, but tender bony prominence or neurologic signs Meningitis
CONSULT OR REFER	Suspect myelopathy Other positive X-ray findings History of C-spine surgery with recurrent symptoms

Plan:
- ☐ Xray / imaging What: _____
- ☐ Laboratory eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / work up initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 2.6 (continued)

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Chapter 3
The Shoulder

James M. Daniels

Functional Anatomy

Figures 3.1 and 3.2 illustrate the surface anatomy of the glenohumeral joint of the shoulder. The shoulder is a ball-and-socket joint whose structure allows for an impressive range of motion (ROM) but at a cost. Unlike the very stable hip joint, which has a deep socket, the glenoid fossa is relatively shallow, and the humeral head is oversized with respect to the fossa. The labrum, a rim of cartilage around the glenoid fossa, helps increase the depth and stability of the shoulder joint, but the other soft tissues of the shoulder provide most of the joint's stability. In order for proper functioning to occur, all these tissues (muscles, tendons, ligaments, and the labrum) must be functioning at proper tension. Disruption in any one of these can lead to dysfunctional shoulder motion and subsequent problems [1, 2].

The shoulder is actually composed of four joints: the sternoclavicular (SC) joint, the acromioclavicular (AC) joint, the glenohumeral (GH) joint, and the sternothoracic (ST) joint (see Fig. 3.3). Pathology can occur at any one of these joints, but pathology is most common in the AC and GH joints. The labrum provides some static stability to the GH joint, as does the joint capsule, which is composed of three main ligaments: the anterior, inferior, and posterior glenohumeral ligaments. Injury to these ligaments can allow the humerus to slide out of the glenoid fossa. When this occurs to a minor degree and spontaneously relocates, this is called subluxation; if the humeral head completely leaves the socket, it is true dislocation. Many children and adults have some degree of physiologic subluxation due to natural laxity of these ligaments and do not necessarily have underlying pathology [3].

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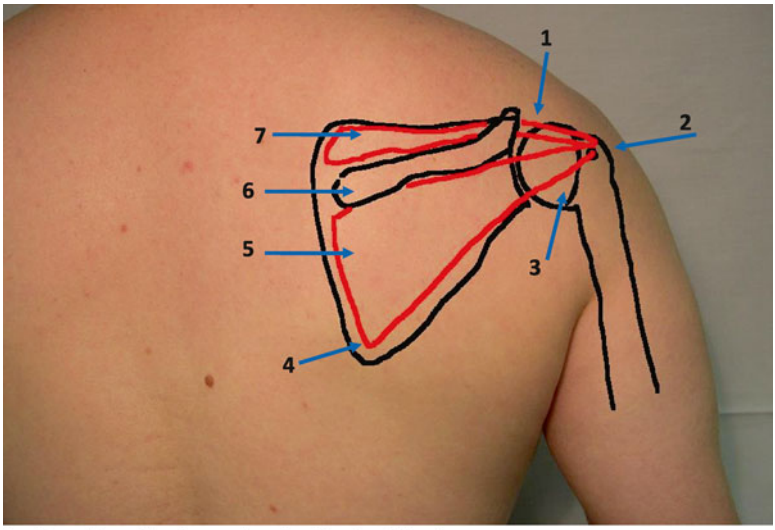


Fig. 3.1 Surface anatomy of the shoulder – posterior view

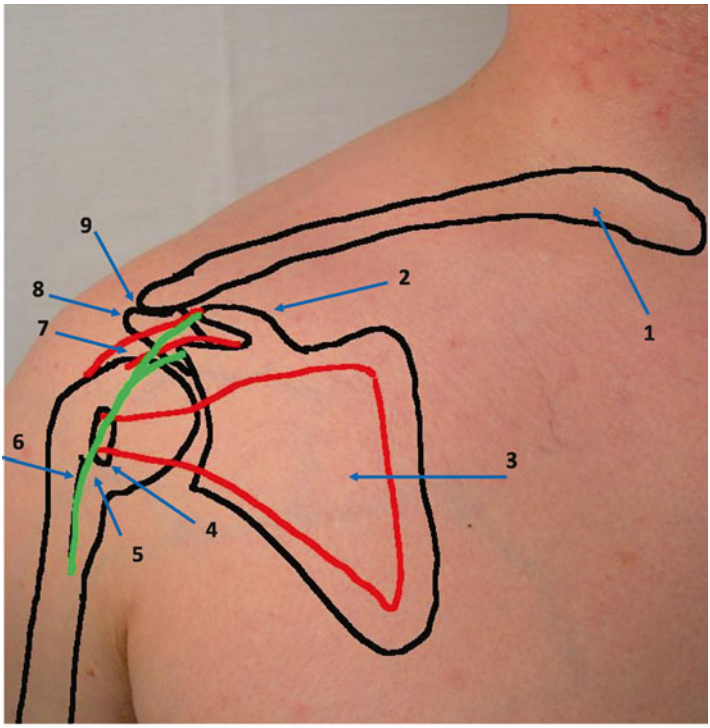
The muscles provide dynamic support to the shoulder joint. The biceps tendon crosses this joint and provides additional dynamic support, but the majority of stability is due to the deltoid muscle, which applies constant upward force on the shoulder, and the muscles of the rotator cuff (supraspinatus, infraspinatus, teres minor, and subscapularis), pulling the "ball into the socket," opposing the deltoid's anterior pull. Due to their location, the supraspinatus and infraspinatus tendons are the most common muscles injured in the rotator cuff [4].

Red Flags

Age of Patient. A very elderly or very young patient complaining of shoulder pain may represent a more serious type of condition. This would include pathological fracture, growth plate injury, and malignancy.

Nonmusculoskeletal Causes of Pain. Symptoms such as shortness of breath, GI upset, cough, rash, weight loss, fever, multiple joint involvement, or morning stiffness should prompt the investigation of metabolic causes of shoulder pain.

Trauma. Patient's trauma to the shoulder should receive a radiographical evaluation to rule out fracture. Additionally, those with major trauma can have visceral pain that is referred to the shoulder (such as lung or chest wall injury or ruptured spleen) and should be carefully evaluated.



1 – Clavicle
2 – Coracoid process of scapula
3 – Subscapularis muscle
4 – Lesser tubercle (insertion of subscapularis)
5 – Bicipital tendon
6 – Bicipitol groove
7 – Supraspinatus
8 – "AC" joint
9 – Acromion process of scapula

Fig. 3.2 Surface anatomy of the shoulder – anterior view

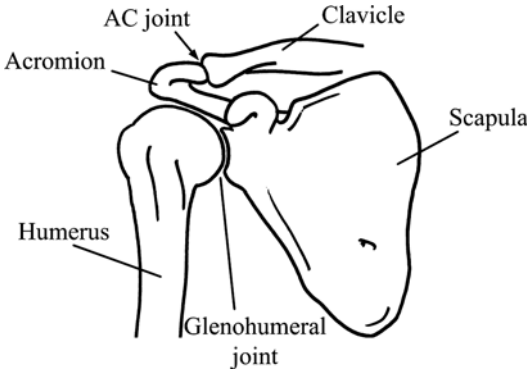


Fig. 3.3 Skeletal anatomy of the shoulder – anterior view

Suspected or Known Dislocation. These patients should have an X-ray to rule out fracture. Posterior shoulder dislocation can be difficult to identify. In patients with a history of seizure disorder or electrocution, consideration for posterior dislocation should be entertained.

General Approach to the Patient

There has been a great deal written about the physical examination of the shoulder. Many physical examination techniques have been described to detect various pathologies of the shoulder. The accuracy of these examination techniques has been called into question. Recent meta-analysis of the available medical literature has not shown a high correlation between physical exam findings and final diagnoses discovered either on MRI or in surgery [5–8]. Shoulder complaints are common, comprising up to 16 % of all musculoskeletal visits to any healthcare provider [9, 10].

The clinician should approach all shoulder complaints with a history and physical examination. Detailed testing can be performed depending on suspected conditions described below.

A basic history should include duration, nature, and location of pain as well as inquiring about any radicular symptoms. Risk factors for nonmusculoskeletal conditions that can present with shoulder pain (such as lung disease, MI, etc.) should be assessed. Patients who appear unstable after trauma or who are suspected to have life-threatening nonmusculoskeletal pathology (such as MI or concern for ruptured viscus) should not be assessed in the primary care outpatient setting and should be transported to an emergency department.

Examination should start with complete exposure of the shoulder, with either the shirt removed or the patient wearing a sleeveless shirt or sports bra. A gown can be tied around the trunk under the arm, if needed for modesty. The skin should be evaluated for any rashes or lesions that might suggest other causes of pain, such as shingles [9].

A brief neurovascular exam is important for ALL patients who present with shoulder pain. The Spurling's maneuver (described in Chap. 2) can be quickly performed and if negative rules down radiculopathy. Hoffman's test (flicking middle finger with resulting flexion of index finger and thumb) may point to an upper motor lesion causing the patient's discomfort. Evaluation of the radial pulse and capillary refill is reassuring for adequate distal circulation.

Palpate the SC and AC Joints. Tenderness over the SC joint usually occurs only after significant direct trauma to the anterior chest and is a cause for concern, as trauma this severe can sometimes be associated with traumatic shoulder dislocations. Palpate the AC joint for tenderness.

Next, have the patient abduct the arm from the side to the overhead position, noting pain or limitations of ROM. From behind the patient, evaluate the scapula for

winging or abnormal movements with shoulder abduction, which may indicate damage to the long thoracic nerve [10].

Common Clinical Presentations

Rotator Cuff Pathology

With age, most patients get some degree of external impingement of the tendons of the rotator cuffs, causing rotator cuff tendinopathy. These patients will complain of generalized anterolateral shoulder pain that may radiate toward the deltoid. Examination of these patients involves impingement testing, which can be accomplished with Hawkins and Neer testing (shown in Fig. 3.4). Negative findings on *both* these tests have an LR− of 0.1 for impingement, nearly ruling out this pathology [5].

Continued impingement or a traumatic event can lead to rotator cuff injury, in which the tendon is completely torn. In addition to the impingement testing, the supraspinatus and infraspinatus strength should be tested. Supraspinatus weakness is tested by having the patient extend the elbows, abduct the arms to 90°, and forward flex about 45°. The patient then makes a fist with "thumbs down" and then resists the examiner putting downward pressure on the arms. Infraspinatus weakness is tested by having the patient keep the elbows at the sides with the elbow flexed 90°. The patient then pushes out (externally rotating) against resistance from the examiner. The supra- and infraspinatus tests are depicted in Fig. 3.5. It is important to understand that an abnormal test result is one that demonstrates true *weakness* of the movement, not just lack of effort due to pain [4]. These three tests together (impingement testing, supraspinatus weakness, and infraspinatus weakness) can be very useful in predicting rotator cuff tears. If no abnormal results are present, a tear is basically ruled out. Presence of only one is not predictive, but the presence of two of these has an LR+ of 5 for tear, and the presence of all three has an LR+ of 48 for rotator cuff tear [5, 6].

Patients with suspected impingement or tendinopathy without tear can be safely referred to PT for a month and reassessed. Older adults with continued symptoms after a month of PT whose exam is unchanged are still likely to benefit from conservative therapy and can be treated with another month of PT and/or can be offered a steroid injection. If their pain persists beyond 2–3 months, referral and/or MRI evaluation should be considered for possible missed rotator cuff tear [8, 11]. Younger patients with continued symptoms after a month of PT, however, should be referred to a specialist or have an MR arthrogram performed, which can demonstrate a labral tear.

All patients with suspected or diagnosed complete rotator cuff tear should be referred, although many times, these patients can be managed with PT and do not require surgery [9, 11].

Fig. 3.4 Hawkins (**a**) and Neer (**b**) testing

AC Joint Pathology

The AC joint can be injured during trauma or a fall directly, or it can be chronically injured by repetitive overloading activities such as weight lifting. If pain complaints localize to the AC joint area and primary exam revealed tenderness to palpation,

Fig. 3.5 Supraspinatus (**a**) and infraspinatus (**b**)

further testing of the AC joint can be done with the squeeze test (Fig. 3.6). This stresses the AC joint and will reproduce pain but can also be confused with a distal clavicular fracture, so any patient with trauma and AC pain should have X-rays performed [6, 7].

Once fracture is ruled out, most patients with AC joint pathology can be managed conservatively with the use of ice and NSAIDs or other pain control. In

Fig. 3.6 Squeeze test

noncomplex cases, a sling may be used for patient comfort but should be limited to 1–2 weeks at most. In patients with osteoarthritis of the AC joint, it can be injected with steroid. Sometimes this may be technically difficult as the joint space is very small. Usually no more than 0.5 ml can be injected into the joint. If the bones of the AC joint are displaced enough to override each other on X-ray or if distal clavicle fracture is suspected, the patient should be referred. Persistent AC joint pain can indicate underlying rotator cuff pathology that can be managed through physical therapy [11].

Shoulder Instability

Patients with shoulder instability (laxity of one or more of the three glenohumeral ligaments) tend to be younger and more active than those with impingement. Although young patients with instability of the shoulder may have impingement symptoms and findings, they often have underlying instability that needs to be addressed. In these patients, it is important to evaluate the integrity of the shoulder capsular ligaments and the labrum [6, 11].

On the other hand elderly patients usually have more pathology-related to impingement than instability.

The internal rotation resistance strength test (IRRST) has been advocated as a way to differentiate intraarticular (OA labral pathology, capsular tears) and extraarticular issues such as rotator cuff pathology with impingement. In the literature, the IRRST demonstrated that it has both a high and negative predictive value along with high sensitivity and accuracy up to 94.5 % [11, 12]. To perform this test, have the patient hold their effected shoulder at 90° of abduction with approximately 80° of external rotation. The patient then resists internal rotation. If there is weakness with internal rotation, it indicates intraarticular pathology. Weakness with external rotation indicates extraarticular pathology. This test can also be helpful in elderly patients who are being treated for presumed rotator cuff tendinopathy. If resisted internal rotation consistently reproduces some of their symptoms, consideration for the diagnosis of osteoarthritis of the glenohumeral joint may be considered. Younger, more active patients with shoulder symptoms should be evaluated for instability (capsular pathology).

Instability can be divided into two categories. The first consists of patients with generally lax joints. The ligaments in these patients allow for some subluxation of the humeral head from the glenoid fossa. This can be demonstrated using the sulcus sign (see Fig. 3.7). Patients who have multidirectional instability have a positive sulcus sign and may have capsular laxity of the glenohumeral joint in all directions (inferior, anterior, posterior). These patients may present with pain caused by repetitive activity without any history of trauma. They often are unlikely to have significant pathology that needs surgical intervention. These patients are said to have AMBRI lesions (*A*traumatic, *M*ultidirectional, *B*ilateral, *R*ehabilitation is helpful, surgery *I*nfrequently needed). Patients with AMBRI lesions can be managed with physical therapy and activity modification [3, 13].

Fig. 3.7 Sulcus sign

The second kind of instability involves unidirectional instability (the patient has a negative sulcus sign indicative of stiffer ligaments) that is often traumatic, such as overthrowing or wrenching of the arm. A significant anterior force on the humerus can cause stretching of the anterior glenohumeral ligament, which can tear off a piece of the labrum, referred to as a "Bankart lesion." These patients are said to have TUBS lesions (*T*raumatic, *U*nidirectional, *B*ankart, require *S*urgery).

Additional testing of the capsule and labrum can be performed using the apprehension and posterior capsule tests. The apprehension test is used to assess the anterior ligament; this is depicted in Fig. 3.8. Pain with this test is not necessarily an abnormal finding, but if it reproduces the feeling that brought the patient in or makes the patient feel as if the shoulder is going to "pop out," it is a positive (abnormal) result. Evaluation of the posterior capsular ligament is similar but is performed having the patient lie prone, with the shoulder hanging over the edge of the table. The examiner grasps the humerus near the head while stabilizing the posterior scapula and then puts posterior force on the humerus. As with the apprehension test, a positive finding is one that reproduces the feeling of "popping out."

If all other testing is negative, integrity of the labrum can be tested by having the patient abduct the affected shoulder completely (180°) and then, as rapidly as possible, circumduct the shoulder (performing a "cranking" type of motion). Pain and clicking indicate pathology. Patients with isolated positive findings on labral or capsular testing should be referred for evaluation. If the capsular and labral tests are negative, a trial of physical therapy is reasonable, but if the patient does not improve, referral should be made [13].

In summary, most patients with shoulder pain can be managed conservatively. Those with fractures, suspected labral tears, or complete rotator cuff tears need

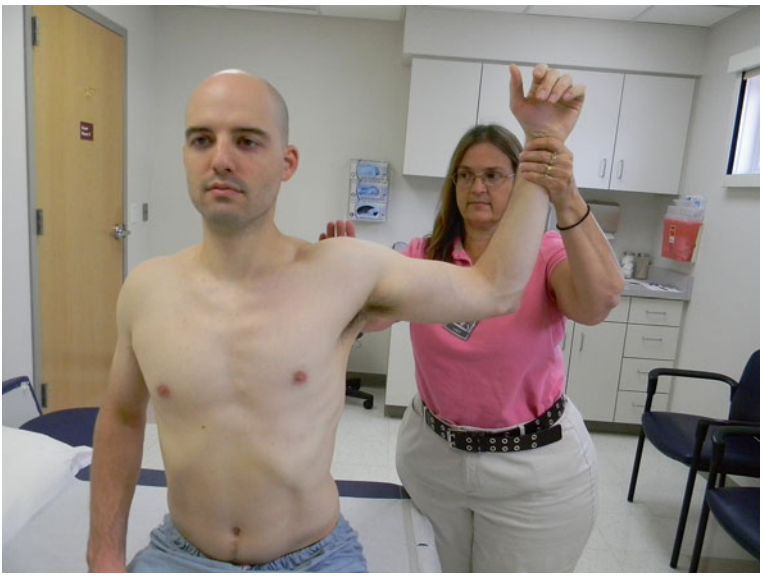


Fig. 3.8 Apprehension test

early referral; others can be treated with the RICE (Rest, Ice, Compression, Elevation) protocol and physical therapy for a month and reassessed. Younger or very active older patients should be more thoroughly evaluated for the possibility of shoulder instability, while older and less physically active patients more commonly deal with impingement, which is less likely to require intervention. Patients with persistent pain or for whom the diagnosis remains obscure should be referred. The flow diagram in the appendix can help the provider work through the appropriate triage and management of common shoulder complaints.

Please refer to Fig. 3.9 for the Shoulder Meaningful Use Form.

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____

Occupation/Sport/Position: _____
Handedness: ☐ Right ☐ Left ☐ Both

Red Flags:
1. Radicular symptoms
2. Trauma
3. Suspected or known dislocation
4. History of malignancy or systemic symptoms

Q1. Is the problem the shoulder?
Radicular symptoms
Spurlings
Symptoms below elbow or posterior aspect of shoulder (may be C-spine)

Q2. Which joint is involved?
Acromioclavicular tender: Squeeze test
Sternoclavicular joint: Palpate
Scapula-Thorax joint: ABduct arms 5 times - observe
Glenohumeral joint: Check cuff, capsule and labrum

Q3. If it is glenohumeral, what is the diagnosis and treatment?
a) Dislocation
b) TUBS lesion
c) AMBRI lesion

Common and Don't Miss Conditions:
- Rotator Cuff Injury
- Shoulder Instability
- A-C Joint Pathology
- Fractured Clavicle
- Labral Tear
- Osteoarthritis

Fig. 3.9 The Shoulder Meaningful Use Form

TREAT APPROPRIATELY	Shoulder Instability (AMBRI) ..... 718.81 Impingement ..... 726.2 Osteoarthritis ..... 715.91 Rotator Cuff Tear ..... 840.4 Dislocation/Subluxation ..... 831.00 AC Joint Separation ..... 831.04 Rotator Cuff Tendinitis (supraspinatus) ..... 726.10 Rotator Cuff Tendinitis (infraspinatus) ..... 726.19 Shoulder pain, nonspecific with negative exam 719.41
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Status Post dislocation
CALL CONSULTANT THAT DAY	Dislocation Fracture Major Trauma
CONSULT OR REFER	Suspected or Confirmed rotator cuff tear with no response to PT Recurrent dislocations Suspected labral tear Radiculopathy Young/Active patient with no response to 4 wks of PT or treatment TUBS instability

Plan:
- ☐ Xray / Imaging What: _____
- ☐ Laboratory Eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 3.9 (continued)

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Chapter 4
The Elbow

Becky J. Hanna and Tamara Pylawka

Functional Anatomy

Figures 4.1 and 4.2 illustrate the surface anatomy of the elbow. The elbow functions as a hinged joint which allows for flexion, extension, supination, and pronation of the upper extremity. The joint is made up of articulations of the distal humerus with the ulnar notch and radial head (Fig. 4.3).

Normal range of motion of the elbow is 0° (full extension) to 135° (full flexion). Flexion and extension are controlled by the biceps and triceps muscles, respectively. The elbow also rotates 0–180° with supination and pronation. Supination (palm up position) occurs with activation of the biceps muscle. The pronator teres powers pronation of the elbow (palm down position).

Three major nerves traverse the elbow: (1) the median nerve crosses medially and can be entrapped in muscle; (2) the ulnar nerve passes medially and posteriorly to the medial epicondyle through the cubital tunnel, another site of entrapment; and (3) the radial nerve descends laterally with a superficial branch that is also prone to injury. The paths of these nerves are shown in Fig. 4.4.

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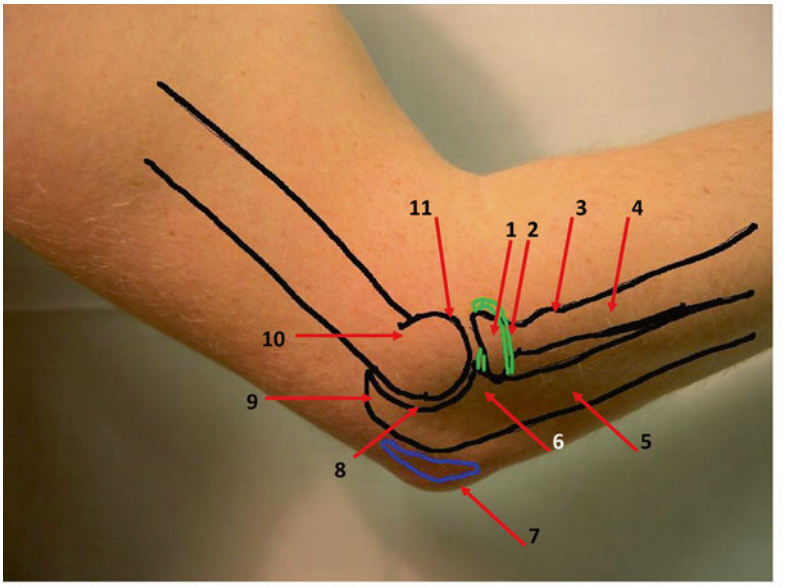

Fig. 4.1 Surface anatomy of the elbow – lateral view

Red Flags

1. Decreased range of motion (ROM). Inability to flex or extend the elbow can be indicative of underlying fracture, dislocation, or joint effusion, all of which may be or indicate potentially severe conditions. All patients with true decreased ROM should be thoroughly evaluated, and in most cases, imaging is warranted.
2. Joint effusion and redness. Swelling of the elbow must be carefully evaluated. Olecranon bursa swelling, located posteriorly over the olecranon, must be distinguished from a true joint effusion, which is intra-articular. Patients with a true joint effusion will often have more diffuse swelling and will also have reduced ROM or significant pain with ROM. While isolated olecranon bursa swelling can be managed by the primary care provider, joint effusions must be further evaluated, particularly for the concern of a septic joint.
3. Feeling a "pop"/weakness during activity. This can be a sign of biceps tendon rupture. Patients will be tender over the insertion of the biceps. Although ROM may be normal, weakness of the forearm will be evident on exam with flexion and supination. Immediate referral is required for effective treatment; any delay can result in a poor outcome.

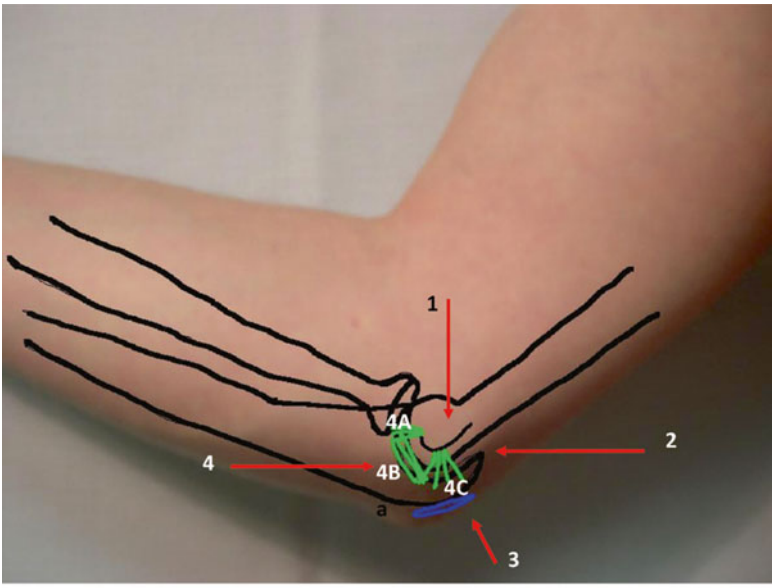

Fig. 4.2 Surface anatomy of the elbow – medial view

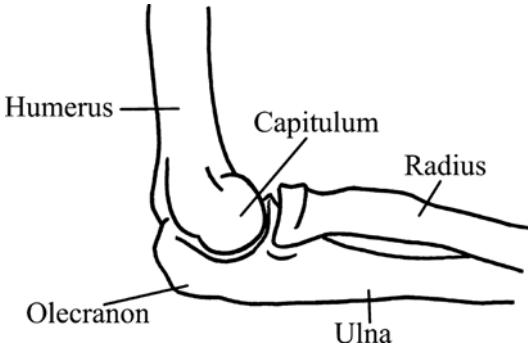

Fig. 4.3 Skeletal anatomy of the elbow – lateral view

General Approach to the Patient with Elbow Pain

When evaluating the patient who presents with elbow pain, it is important to obtain an accurate history. Gathering information about occupational, hand dominance and recreational activity, as well as any recent injury or trauma, is helpful to pinpoint the offending cause of elbow pain and develop a diagnosis. Knowing the onset of pain helps to differentiate a chronic overuse injury from something more acute.

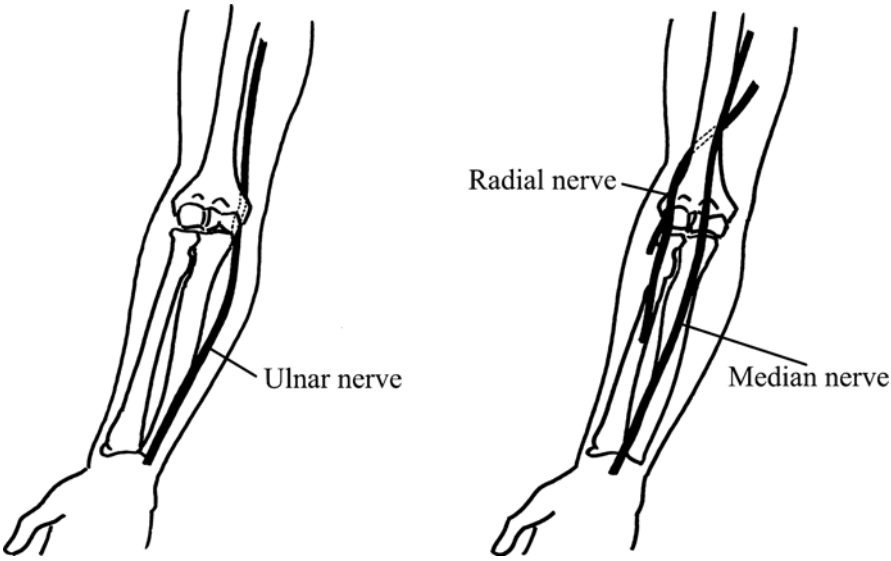

Fig. 4.4 Anatomy of the major nerves crossing the elbow

Have the patient pinpoint the area of their pain. This is helpful in narrowing your diagnosis: lateral vs medial pain vs pain over the olecranon bursa. Aggravating and alleviating factors are helpful to know. If the patient has weakness, numbness, or paresthesias, these may be clues to nerve entrapment syndromes or cervical radiculopathies.

The physical exam of the elbow should include inspection, ROM testing, strength, palpation, neurovascular exam, and any special testing. The elbow should be inspected for swelling, deformity, and redness. Evaluate ROM for both flexion/extension and supination/pronation, both passive and against resistance. ROM and strength should be compared to unaffected side. Also evaluate flexion and extension of the wrist as the proximal attachment of these tendons is located on the medial and lateral epicondyles, respectively. If the patient has pain at the elbow with wrist movement against resistance, this can indicate a tendinopathy of the flexor tendons if the pain is on the medial epicondyle or of the extensor tendons if the pain is on the lateral epicondyle. Also, palpate the insertion of the biceps muscle, olecranon, and olecranon bursa for tenderness.

Special testing for elbow pain may include Tinel's test (gently tap over the nerve with your index finger) at the cubital tunnel if having paresthesia into 4th and 5th digits. A positive Tinel's at the cubital tunnel may be indicative of ulnar nerve entrapment. Radial nerve compression/entrapment should be considered in patients diagnosed with lateral epicondylitis which is resistant to treatment and also if pain is more distal to the lateral epicondyle than expected in lateral epicondylitis. If the radial nerve is affected, pain and weakness may be provoked by resisted extension of the middle finger. A positive test may indicate a radial nerve compression.

Even in the absence of obvious radicular symptoms, a brief neurovascular examination should be performed by assessing at least the radial pulse, skin color, and capillary refill, as well as distal sensation. If radiculopathy is suspected, examination of the neck, shoulder, and wrist should be performed to identify the source of pain (see other sections of the text).

Common Clinical Presentations

A brief summary of common clinical presentations of elbow pain in the primary care setting is reviewed in Table 4.1. These are characterized by location on the elbow and include pertinent history, exam findings, and treatment.

Table 4.1 Common clinical presentations

Location of pain	Condition	History	Exam findings	Treatment
Lateral elbow	Lateral epicondylitis	History of activities with rapid or repetitive wrist extension	Pain over the lateral epicondyle or within 2 cm of the lateral epicondyle; extending the wrist against resistance reproduces pain in lateral elbow	Avoidance of the offending activity NSAIDs short term Limited evidence to support corticosteroid injection – may give short-term improvement but no better than other treatments at a year
Medial elbow	Medial epicondylitis	History of repetitive wrist flexion	Pain over medial epicondyle or just distal Pain is reproduced with resisted flexion of the wrist	Avoidance of the offending activity
	Ulnar nerve entrapment (cubital tunnel)	Sustained elbow flexion, leaning on elbow or repetitive gripping Numbness in fourth and fifth digits, night pain	Tenderness along cubital tunnel/ ulnar nerve	Avoid leaning on elbows, prolonged flexion. Symptoms of weakness and numbness that persist >6 months may warrant surgical referral

(continued)

Table 4.1 (continued)

Location of pain	Condition	History	Exam findings	Treatment
Posterior elbow (olecranon)	Olecranon bursitis Noninfectious Infectious (septic bursitis)	Leaning on elbow repetitively, repetitive trauma to elbow	Noninfectious – painless nontender swelling over bursa Infectious – painful, erythematous swelling over bursa In both of these situations, ROM should be preserved	Painless bursitis managed conservatively; aspiration can introduce infection; in recurrent cases, a corticosteroid injection can be considered; avoid offending activity; use soft elbow pads for protection Septic bursitis should be aspirated and cultured, antibiotics started, close follow-up

Less Common Presentations

While the majority of elbow disorders seen in the primary care setting will fall into those included in Table 4.1, the clinician must be aware of other conditions that may be encountered. Typically, the clinician will be alerted to more serious pathologies by the presence of one or more "red flags" above, and further imaging or diagnostic workup will be performed. A few of the more common of these "less common presentations" can be seen in Table 4.2. Management of these problems is outside of the scope of this text but can be found in many orthopedic and primary care references.

In summary, most elbow conditions encountered in primary care will be typical presentations of common conditions that can be managed by the primary care provider. Any uncertainty in diagnosis or suspicion of serious pathology should lead to early referral to a specialist.

Please refer to Fig. 4.5 for the Elbow Meaningful Use Form.

Table 4.2 Less common elbow pathologies

Condition	Typical presentation	Clinical pearls
Posterolateral instability	Clicking/snapping/locking and lateral elbow pain proximal to posterior to lateral epicondyle	Can progress to full dislocation
Radial head fracture	History of FOOSH injury, tender distal to lateral epicondyle, limited ROM	May be difficult to see on X-ray; look for fat pad signs
Radial nerve compression	Lateral elbow pain, more distal than lateral epicondylitis; weak supination and middle finger extension	EMG, MRI, or referral reasonable [7]
Ulnar nerve compression/ entrapment (cubital tunnel syndrome)	Paresthesias of the ring and small fingers, pain along medial elbow along the ulnar nerve ("funny bone")	Be sure to rule out cervical nerve pathology
Elbow dislocation	Common in younger patients, hx of trauma, or hyperextension injury. May see obvious dislocation or have decreased ROM	X-ray before attempting relocation
Loose body in joint space	Sensation of something moving, locking, or pain	May be able to see on US or MRI
Supracondylar fracture	Hx of FOOSH injury, anterior elbow pain	May be difficult to see on X-ray
Pronator syndrome (median nerve compression)	Anterior elbow pain and distal paresthesias in median nerve distribution	Can be compressed in multiple locations of the arm and elbow. Rule out cervical pathology

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____
_____
Occupation/Sport /Position: _____
Handedness: ☐ Right ☐ Left ☐ Both

Red Flags:
1. Loss of range of motion
2. Joint effusion / redness
3. Bicep tendon rupture

Q1. Is the problem the elbow?
Radicular symptoms
Spurlings

Q2. Any neurological involvement?
Cubital Tunnel?

Q3. How to treat?
a) Bicep tear
b) Dislocation
c) Pediatric fracture: consult that day

Q4. What are the patient's expectations? If diagnosis is not clear, consult early.

Common and Don't Miss Conditions:
- Tendinopathy extensor tendons (Lateral)
- Tendinopathy flexor tendons (Medial)
- Olecronon bursitis
- Fracture
- Cubital Tunnel Syndrome
- Ruptured distal bicep
- Elbow Dislocation

TREAT APPROPRIATELY	Olecranon Bursitis.....726.33 Lateral Epicondylitis.....726.32 Medical Epicondylitis.....726.31 Pain in Elbow.....719.42 Osteoarthritis.....715.92 Contusion.....923.11 Cubital Tunnel Syndrome.....354.2

Fig. 4.5 The Elbow Meaningful Use Form

TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Cellulitis Patients with decreased ROM Patients with Normal X-ray
CALL CONSULTANT THAT DAY	Distal biceps rupture Suspected septic arthritis
CONSULT OR REFER	Fracture Limited ROM with no improvement over 1 week Undiagnosed pain

Plan:
☐ Xray / Imaging What: _____
☐ Laboratory Eval What: _____
☐ NSAIDs _____
☐ Acetaminophen _____
☐ Other _____
☐ PRICE Protocol
☐ Physical Therapy

Disposition:
☐ Treatment initiated: Follow-up _____ weeks
☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
☐ Immediate call to Dr._____
☐ Consultation initiated with Dr._____
☐ Referral to Dr._____

Fig. 4.5 (continued)

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Chapter 5
The Hand and Wrist

James M. Daniels, Michael W. Neumeister, Janet Albers, and Thomas H. Miller

Anatomy and Function

Figures 5.1, 5.2, and 5.3 illustrate the surface anatomy of the proximal wrist. The wrist is composed of the distal radius and ulna, which articulate with each other to form the radioulnar joint. The distal radius also articulates with the scaphoid and lunate bones [1]. The distal ulna articulates with the triangular fibrocartilage complex (TFCC), which functions much like the meniscus of the knee. The TFCC also has ligamentous attachments to the lunate, capitate, and triquetrum [1]. The distal wrist is composed of the eight carpal bones arranged in two rows. The proximal carpals (scaphoid, lunate, triquetrum, and pisiform) are closely approximated to the radius, while the distal carpals (trapezium, trapezoid, capitate, and hamate) are closely associated with the metacarpal bones. When the wrist deviates radially or

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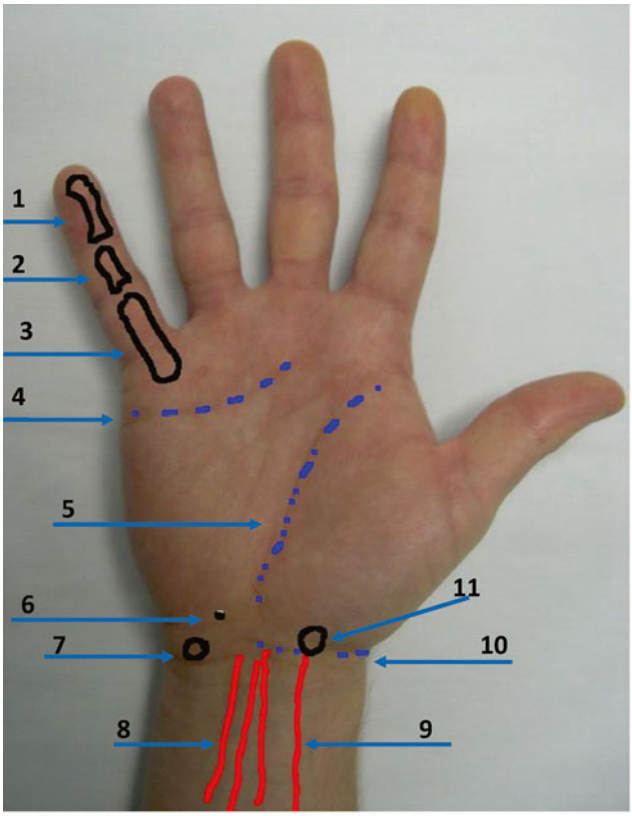
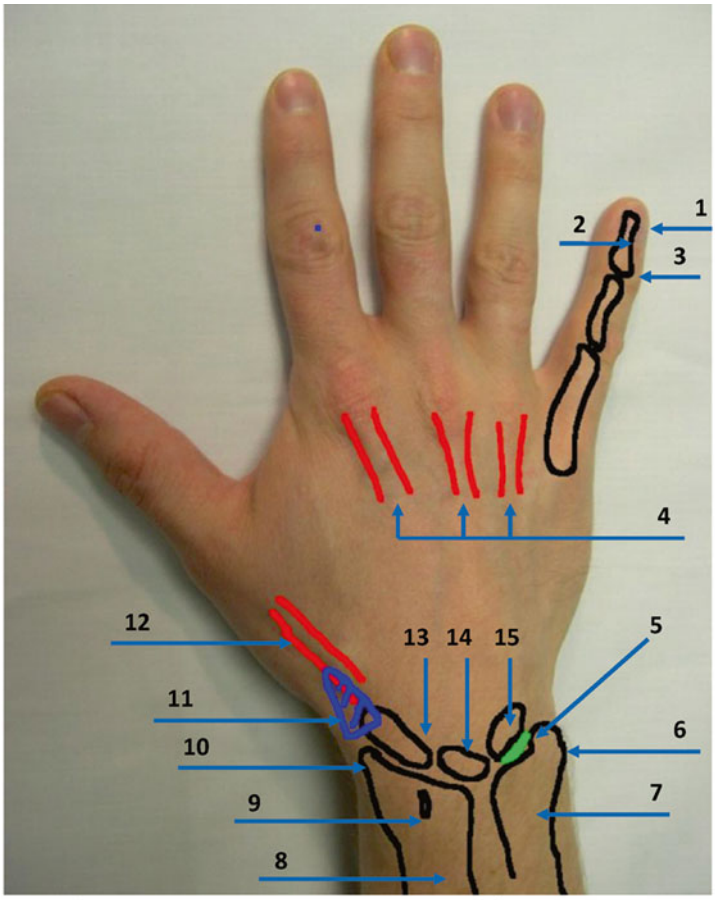


1 – Distal Phalange
2 – Middle Phalange
3 – Proximal Phalange
4 – Distal Transverse Palmar Crease
5 – Radial Longitudinal Crease
6 – Hook of Hamate
7 – Pisiform
8 – Palmaris Longus
9 – Flexor Carpi Radialis
10 – Distal Wrist Crease
11 – Scaphoid

Fig. 5.1 Surface anatomy of the hand – palmar aspect

dorsiflexes, the scaphoid flexes palmarly, which puts it in a precarious position to be injured when a patient falls, particularly when the patient falls on an outstretched hand [2]. Figure 5.4 shows the basic anatomy of the wrist.

Each of the digits has two neurovascular bundles, one on the radial side and the other on the ulnar side, which contain an artery, vein, and nerve [3]. The extensor tendons, which originate on the lateral dorsal forearm, insert on the dorsal hand. The flexor tendons from the medial forearm insert on the palm of the wrist and hand [4]. The superficial flexor tendon on each phalynx inserts at the base of the middle phalynx, while the deep flexor tendon inserts on the base of the distal phalynx. Figure 5.5 and Table 5.1 demonstrate the extensor and flexor tendons of the fingers.



1 – Head
2 – Shaft
3 – Base
4 – Common Extensor Tendons
5 – Triagnular Fibrocartilage Complex (TFCC)
6 - Ulnar Styloid
7 – Distal Ulna
8 – Distal Radius
9 – Lister's Tubercle
10 – Radial Styloid
11 – Anatomical Snuffbox
12 – Extensor Pollicis Brevis Tendon
13 – Scaphoid
14 – Lunate
15 - Triquetrum

Fig. 5.2 Surface anatomy of the hand – dorsal aspect

The metacarpal–phalangeal (MCP) joint of the thumb differs from the usual "ball and socket" joints of the other digits. Instead, it is a "saddle" joint, which allows for the pincer grip. This joint is largely supported by soft tissue and is therefore easily injured.

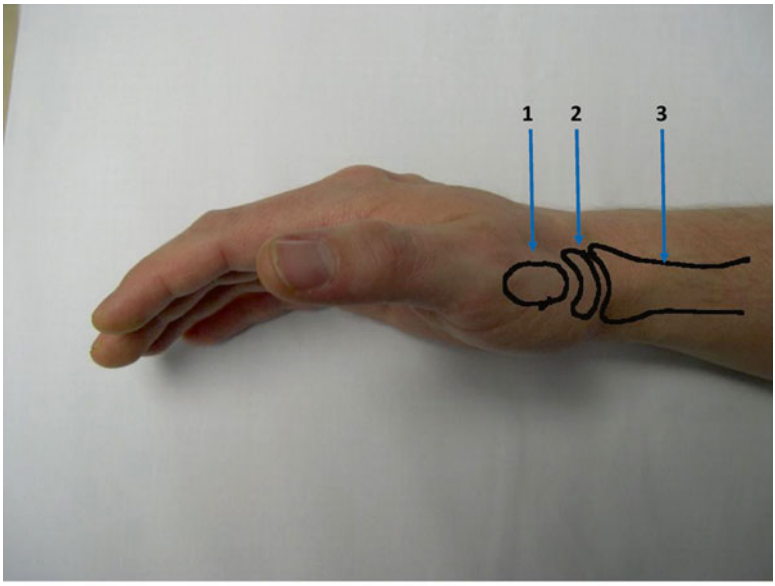


Fig. 5.3 Surface anatomy of the wrist– lateral view

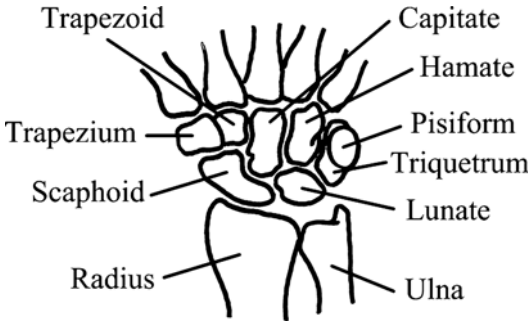


Fig. 5.4 Skeletal anatomy of the wrist – palmar aspect

Red Flags

Several hand and wrist conditions should be urgently investigated or referred due to potential serious sequelae.

Compound fracture. Any compound fracture should be urgently referred to a specialist. Active or profuse bleeding should be controlled with pressure; no attempts at exploration should be made.

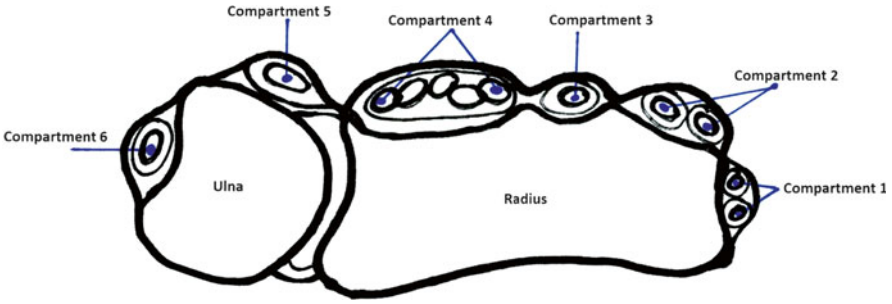


Fig. 5.5 Flexor and extensor tendons

Table 5.1 Flexor and extensor tendons

Compartment	Structure in compartment	Common pathologies	Clinical findings
1	Extensor pollicis brevis	DeQuervain's tenosynovitis	Fibrosis of the synovium around the first dorsal compartment; pain, crepitus radial aspect of the wrist
	Abductor pollicis longus		
2	Extensor carpi radialis brevis	Intersection syndrome	Fibrosis of intersection between the first and second dorsal compartment, approximately 4 cm proximal from Lister's tubercle on the radial aspect of the wrist
	Extensor carpi radialis longus		
3	Extensor pollicis longus	Rupture with distal radius fracture	Degenerative tear of the extensor pollicis longus tendon
		Drummer boy palsy	Patient cannot extend the thumb
4	Extensor digitorum communis	Tendinopathy	Tendinopathy and pain on dorsal aspect of the wrist with wrist extensor
	Extensor indicis proprius		
	Posterior interosseous nerve		
5	Extensor digitorum minimi	Vaughn–Jackson syndrome	Rupture of the extensor digitorum minimus and sometimes the extensor carpi ulnar. Patient has weakness extending the index finger and small finger
6	Extensor carpi ulnaris	Snapping wrist	Extensor carpi ulnaris tears or subluxation on ulnar when ulnar retinaculum is damaged. Causes painful snapping on ulnar aspect of wrist

"*Fight bite*." A fight bite occurs when the fist strikes a tooth of another person, usually over the knuckles of the ring or little fingers. This type of injury carries high risk of penetration of tendon or even bone, and even a very small mark on the skin may overlie a more serious injury. These injuries are at high risk for infection and should be referred for surgical exploration.

Burns. Severe burns, especially on the palmar side of the hand or wrist, carry risk of underlying tendon injury and should be referred for management.

Injury from high-pressure tools. Air and paint guns can cause high-pressure injury to underlying structures with only a small entry point in the skin and should be referred.

Tendon lacerations. Wounds involving tendon laceration should not be explored in the office; bleeding should be controlled and the patient immediately referred to the appropriate specialist.

"*No man's land*" *lacerations*. Lacerations in the area between the PIP joint and the proximal palm are likely to injure the numerous nerves, tendons, and arteries in this area and should be referred for evaluation.

General Approach to the Patient with Hand Pain

Hand complaints are very common. Many are overuse-type injuries and can be managed conservatively. The challenge of the primary care provider is identifying those with pathology that requires intervention to prevent harmful sequelae.

History should include location and duration of symptoms, inquiry about any trauma or mechanism of injury, and, in the case of overuse injuries, questioning about occupation and/or daily activities. Inquiry should be made regarding the presence of any neurologic or radicular symptoms, which may be referred from the neck or arm.

The "primary" physical examination should be performed on all patients presenting with hand and wrist complaints [5]. Based on history findings as well as these primary examination findings, appropriate secondary examination can be performed.

Primary Hand Examination

Observe the hand in the "safe hand position" as pictured in Fig. 5.6.

1. Note any fingers that are abnormally flexed or extended. This may indicate tendon disruption.

2. Have the patient flex the fingers toward the palm. All of the fingers should be pointing toward the scaphoid bone. Overlapping or crossing of fingers may indicate a fracture with rotational deformity of the finger.
3. Look closely at the distal digits for skin color change or loss of sweating ability, which can involve the whole digit or only a portion of the finger. This finding indicates distal nerve injury.
4. Test capillary refill. In the distal finger, blanching that lasts more than 2 s may indicate microvascular compromise.
5. Test 2-point discrimination of the distal fingertip. The patient should be able to discriminate two points 5 or more millimeters apart. Failure indicates neurologic compromise.
6. Grasp the patient's hand in a handshake. If the patient is able to grasp your hand without significant pain, (s)he is unlikely to have a wrist or hand pathology that requires urgent evaluation [5, 6].

Based on findings in the history and above primary examination, the examiner then performs the appropriate secondary examination focusing on the area(s) in question. See Table 5.2. Simple palpation for tenderness can oftentimes assist in obtaining a diagnosis.

Fig. 5.6 Safe hand position

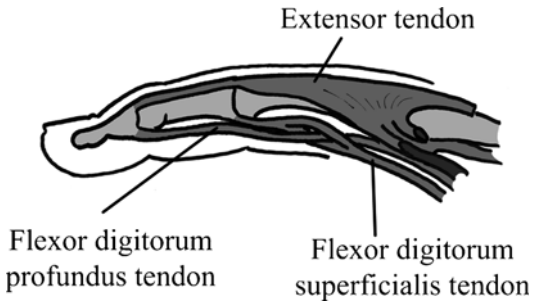


Table 5.2 Secondary hand and wrist exam

Exam technique	Abnormal result	Possible pathology
While shaking hands with examiner, patient attempts to pronate and supinate against examiner's resistance	Cannot complete or has pain with the movement	Distal ulnar joint pathology or
		TFCC pathology (if no radiographic findings)
Palpate the small bony prominence on the ulnar aspect of palm in the palmar crease area	Tenderness	Pisiform trauma

(continued)

Table 5.2 (continued)

Exam technique	Abnormal result	Possible pathology
Palpate hook of hamate by placing IP joint of examiner's thumb on pisiform, then direct thumb toward patient's index finger. When the patient flexes the wrist, the hook of the hamate can be felt with the tip of the thumb	Tenderness	Fracture of hook of hamate
Follow the flexor carpi radialis tendon distally where it intersects the palmar crease, then palpate the small protuberance	Tenderness	Fracture of scaphoid tubercle
Palpate the depression between the distal extensor pollicis longus and abductor pollicis longus tendons (anatomical snuff-box)	Tenderness	Fracture of distal pole of scaphoid (may be present even with negative X-ray)
Examiner's thumb is placed on scaphoid tubercle while the wrist is in ulnar deviation, then the patient radially deviates while the examiner exerts pressure on the tubercle	Pain	Fractured scaphoid
	Pain with clunk	Scapholunate instability
Patient folds thumb under fingers and ulnarly deviates wrist (Finkelstein's test)	Pain or "catching" reproduced along radial side of forearm over tendons	DeQuervain's tenosynovitis (DQT)
Examiner taps over carpal tunnel area (Tinel sign) and/or has patient perform prolonged forced wrist flexion (Phalen test)	Reproduces pain or paresthesias to the thumb, index, and middle finger areas	Carpal tunnel syndrome (CTS)

Adapted from Ref. [5]

Common Clinical Presentations

Trauma

All patients with wrist and hand complaints who have a history of significant trauma should have X-ray evaluation done as part of their workup. Any fracture or bony anomaly seen on X-ray with the exception of the specific diagnoses listed on the flow sheet should be referred to a specialist for management. In the case of negative X-ray findings with negative clinical examination for worrisome pathology, most patients can be conservatively managed using the flow diagram found in the appendix.

Acute Nontraumatic Hand and Wrist Pain (<8 Weeks Duration)

Most patients who have no history of trauma but have pain that has been present for days to weeks will have overuse-type injuries. After doing appropriate secondary examination to rule out major pathology, the clinician can usually manage these conservatively; however, the clinician should consider X-ray if there is any suspicion of underlying bony pathology, as sometimes, traumatic incidents are forgotten by the patient.

These patients will generally fall into either an easily diagnosable condition, such as DeQuervain's tenosynovitis (DQT), carpal tunnel syndrome (CTS), or will have nonspecific but benign hand or wrist complaints. The former two conditions can be managed appropriately in the primary care setting following the flow diagram. The latter can be managed via the RICE protocol (rest, ice, compression, elevation) and reevaluated. If pain persists after RICE therapy or appropriate treatment, X-ray should be performed, if not already done. If X-ray findings are negative, conservative management can be continued for a short time, but referral should be made if symptoms persist.

Chronic Nontraumatic Hand and Wrist Pain (>8 Weeks Duration)

Pain present for 8 or more weeks at first assessment should usually receive radiologic evaluation. Exceptions may be made for classically presenting CTS and DQT, which may be diagnosed clinically without the use of X-ray, as long as the provider carefully rules out other pathologies. Any positive findings on X-ray can then be appropriately managed, but those with chronic undiagnosed wrist and hand pain should be referred to a specialist for evaluation. Similarly, those with DQT and CTS who have continued symptoms after appropriate treatment should be referred.

The flow sheet which follows can help the provider in the appropriate evaluation and management of common hand and wrist complaints. It is by no means exhaustive but represents the most common pathologies encountered in the primary care setting. In general, the primary care provider should err on the side of caution when evaluating hand and wrist complaints, as misdiagnosis or lack of diagnosis and correct management can have potentially disastrous consequences.

Please refer to Fig. 5.7 for the Hand and Wrist Meaningful Use form.

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____
_____
Occupation/Sport /Position: _____
Handedness: ☐ Right ☐ Left ☐ Both

Red Flags:

1. Compound Fracture
2. Fight Bite
3. Burn
4. High pressure injury
5. Injury "no man's" land
6. Severe pain with no definitive diagnosis
7. Pain continues after 3-4 weeks

Q1. Is this a medical emergency?
a) Any limb threatening injury
b) Infection
c) Compound fracture
d) Burn
e) Deglove or injury in "no man's" land
f) Deep infection

Q2. Why is this patient here on this particular day?
a) Missed emergency?
b) Chronic problem?
c) Undiagnosed pathology?

Q3. How to treat?
a) Thumb spica splint
b) Ulnar gutter splint
c) Consult
d) Radiograph
e) Immunization

Common and Don't Miss Conditions:

- See Red Flags
- Ligament instability
- Nerve entrapment
- Fracture
- Tendon disruption
- Tenosynovitis of 1st dorsal compartment (DeQuervain's Tenosynovitis)
- Intersection Syndrome (2nd and 3rd dorsal compartment)
- TFCC injury

Fig. 5.7 The Hand and Wrist Meaningful Use Form

TREAT APPROPRIATELY	Hand/Finger Pain ..... 719.44 Forearm/Wrist Pain ..... 719.43 Wrist Sprain/Strain ..... 842.00 Finger or Hand Sprain/Strain ..... 842.10 DeQuervain's Tenosynovitis ..... 727.04 Carpal Tunnel Syndrome ..... 354.0 Cubital Tunnel Syndrome 354.2
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Tender Anatomical Snuffbox with normal x-ray Decreased ROM of wrist with normal x-ray
CALL CONSULTANT THAT DAY	Fight bite High pressure injury Palmar burn Compound fracture Flexor tendon disruption Suspected joint infection
CONSULT OR REFER	Distal radius fracture Scaphoid fracture Pain in wrist >8wks Persistent anatomic snuffbox tenderness after 2 wks with neg x-ray

Plan:
☐ Xray / Imaging What: _____
☐ Laboratory Eval What: _____
☐ NSAIDs _____
☐ Acetaminophen _____
☐ Other _____
☐ PRICE Protocol
☐ Physical Therapy

Disposition:
☐ Treatment initiated: Follow-up _____ weeks
☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
☐ Immediate call to Dr. _____
☐ Consultation initiated with Dr. _____
☐ Referral to Dr. _____

Fig. 5.7 (continued)

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Chapter 6
The Fingers

James M. Daniels, Michael W. Neumeister, Jon Humphrey, and Careyana Brenham

Functional Anatomy

Digits 2 through 5 (index, middle, ring, and small) all have a distal, middle, and proximal phalanx. Digit 1, the thumb, has a distal and proximal phalanx only. A neurovascular bundle is on each side of the finger. Each of the five digits has both flexor and extensor tendons. There are six dorsal extensor tendons of the wrist. The extensor tendon inserts on the base of the distal phalanx of the finger and broadens out to a wider "hood" that laps over the PIP joint (proximal interphalangeal joint). Each finger has two flexor tendons – the profundus or deep tendon inserts on the base of the proximal aspect of the distal phalanx, while the superficial flexor tendon inserts on the base of the middle phalanx. Figure 6.1 demonstrates how to check both the profundus and superficial tendons.

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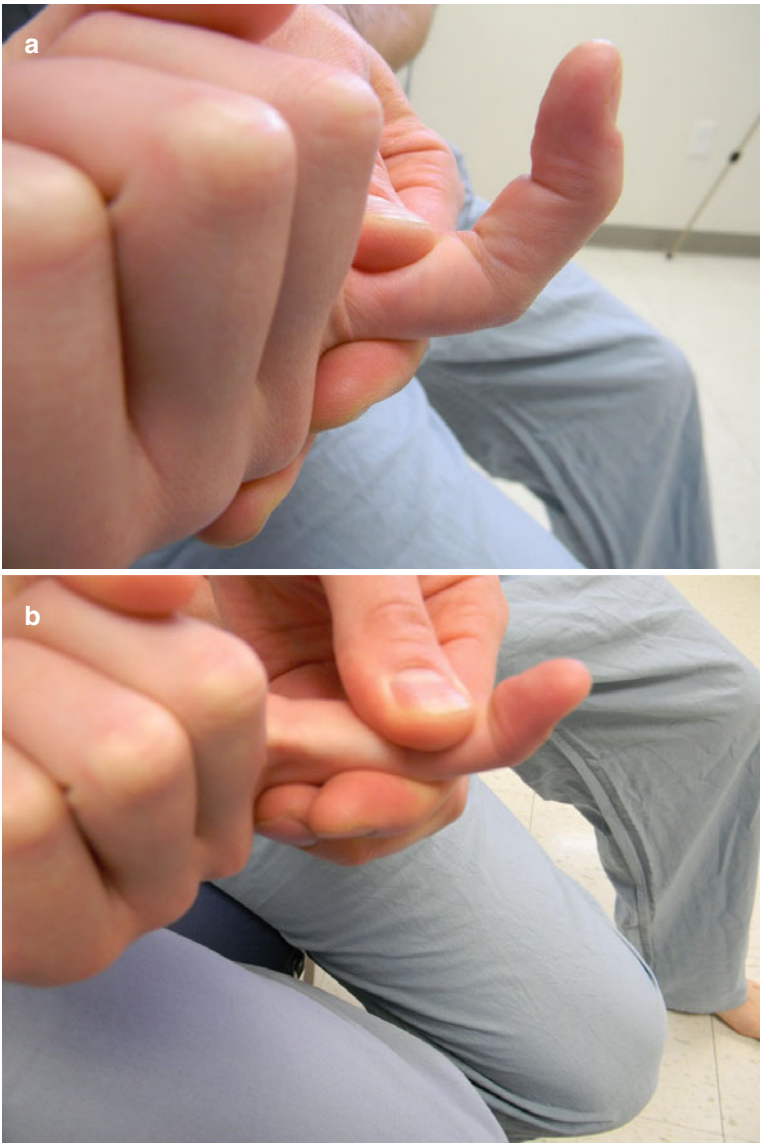

Fig. 6.1 Testing the superficial and deep flexor tendons. (**a**) Test the superficial flexor tendon by immobilizing the base of the finger and have the patient flex the PIP joint. (**b**) Test the profundus or deep flexor tendon by immobilizing the finger just distal to the PIP joint and have the patient flex the DIP

Red Flags

1. *High-Pressure Injury*. If the patient is working with any power equipment with air or liquid substance under pressure, this injury can occur. The patient may only complain of a stinging or burning sensation. A very small puncture wound may be observed, but no discernable wound sometimes occurs with these injuries. These injuries require urgent consultation. Even if left untreated for a few hours, a great deal of damage can occur to the affected finger.
2. *Bites*. Any type of bite requires special care. In the wrist chapter, there was discussion on the "fight bite." Bites may occur from any mammalian, marina, or insect to the finger or hand. Upon close inspection, one should determine if there is any retained foreign body. Table 6.1 (Daniels 2004) reviews the evaluation and treatment of uncomplicated puncture wounds from animal bites.
3. *Tendon Injuries*. Figure 6.2 shows the appearance of a lacerated flexor or extensor tendon. The profundus flexor tendon (deep tendon) which attaches to the base of the distal phalanx may be avulsed when a patient's hand or finger is forced into extension. The common term for this is called "jersey finger," and it occurs most often on the ring and small finger. Commonly, the mechanism of injury occurs when a player grabs a jersey during a football game and the finger is partially extended when the opposing player runs away. These conditions must be identified and treated quickly to avoid major dysfunction of that phalanx.

Table 6.1 Evaluation and treatment of uncomplicated puncture wounds

Clinical situation	Antibiotic prophylaxis
Low-risk, traumatic injuries (clean wounds with easily demarcated borders, no devitalized tissue)	None
Injuries in immunocompromised patients (e.g., patients with human immunodeficiency virus infection, diabetes)	Gram-positive cocci coverage
Wounds with devitalized tissue	Gram-positive cocci coverage if wound tendon or joint space is contaminated[a]
Animal and human bites (other than superficial abrasions)	First-generation cephalosporin. In patients with bites that may contain *Pasteurella multocida* or *Eikenella corrodens*, consider penicillin or amoxicillin-clavulanate potassium (Augmentin). In immunocompromised patients, consider erythromycin or amoxicillin-clavulanate. In patients with sepsis and petechial rash, consider intravenous ciprofloxacin (Cipro) and clindamycin (Cleocin)[b]
Puncture wounds	Case-by-case decision

Information from (Daniels 2004)
[a]If the wound is contaminated, debridement is required
[b]Patients with sepsis or petechial rash should be hospitalized

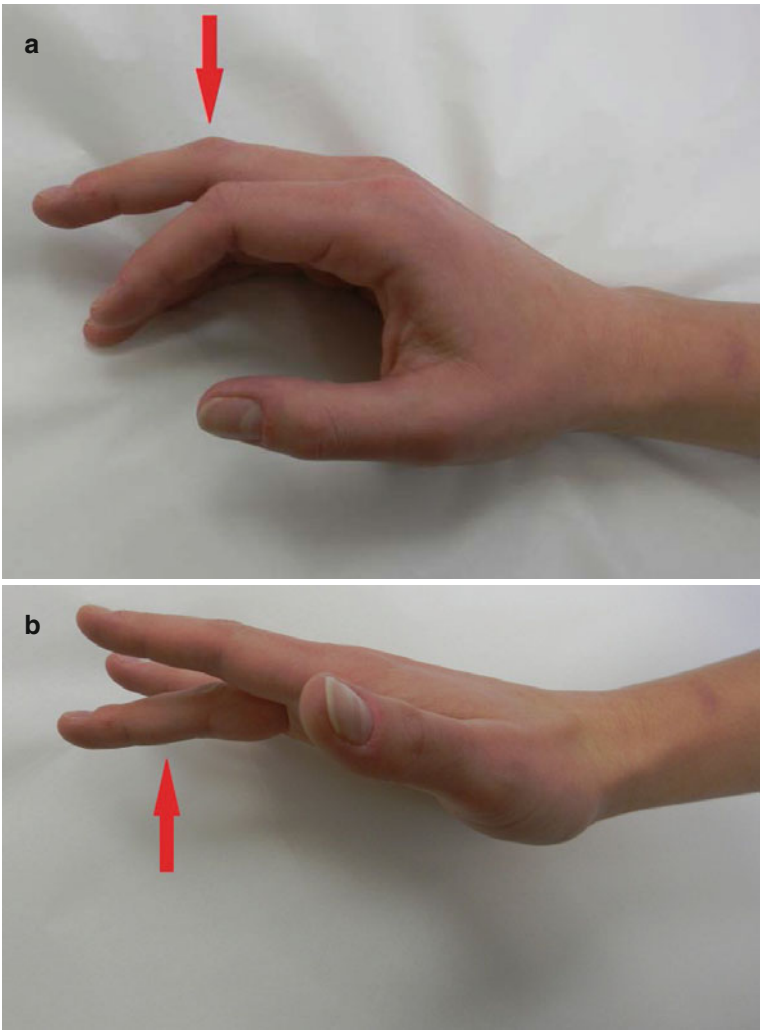

Fig. 6.2 Testing for lacerated flexor or extensor tendon. (**a**) Lacerated flexor tendon. (**b**) Lacerated extensor tendon

4. *Unstable Fractures*. Any open fracture is a medical emergency, and prompt consultation of a hand surgeon is necessary. Many fractures with benign appearance on radiograph can oftentimes be unstable. A general rule of thumb is if over one-third of the joint is involved with the fracture, it is unstable. Radiographs of any traumatized phalanx should be obtained as some fractures can cause malalignment of the fingers. Figure 6.3 reviews how this can easily be checked.
5. *Septic Tenosynovitis*. The flexor tendon has a sheath that can be punctured and become infected. The sheath becomes inflamed and fills up with purulent material. Kanavel's cardinal signs occur. This includes slight digital flexion, uniform

volar swelling, flexor tendon sheath tenderness, and pain on extension. It is not necessary for all four of these signs to be present to make the diagnosis. Purulent tenosynovitis should highly be suspected with increased swelling after puncture wound or on the volar surface of the hand.

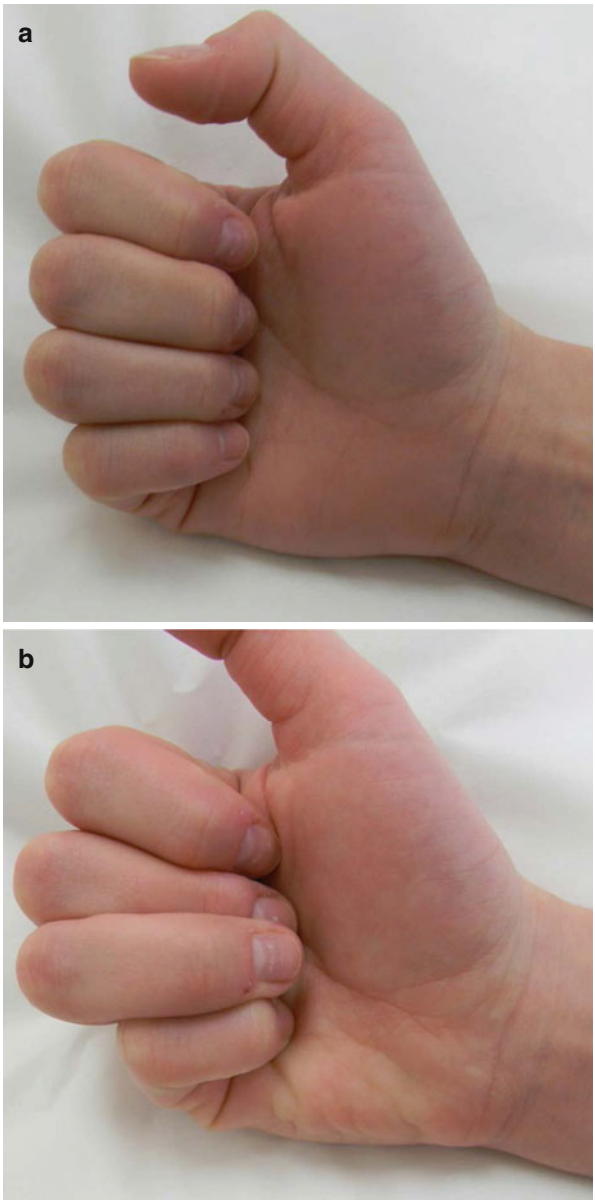

Fig. 6.3 Malalignment of fingers. (**a**) Demonstrates the patient flexing their fingers and there is no scissoring. (**b**, **c**) Demonstrates how the patient's fingers will scissor or crossover when they flex

Fig. 6.3 (continued)

Table 6.2 Indications and contraindications for attempted reattachment of an amputated finger or hand

Indications	Relative contraindications	Absolute contraindications
Amputations occurring in children	Amputations that are due to severe crush or avulsion injuries	Life-threatening medical problem or injury that precludes surgery or transfer
Clean amputations of the hand, wrist, or distal forearm	Heavily contaminated amputations	Patient refusal to fully abstain from smoking for 3 months post-implantation
Multiple digit injury (amputated digit with other digits partially severed)	Patient has a significant smoking history	Psychiatric patient who has intentionally self-amputated the extremity
Thumb amputations	Single amputations between the metacarpal and proximal phalangeal joints, especially border digits (index and fifth fingers) in adults	Severe multilevel injury of the amputated part

Information from (Daniels 2004)

6. *Acute Trauma*. The area on the palmar surface of the hand between the MP joint and the carpal bones has been referred to in the past as "no man's land." There are a large number of intrinsic and extrinsic tendons in this area that can be damaged. Any patient with a deep laceration to this part of the hand should have a surgical consultation. Finger amputation or maceration is also a medical emergency. Table 6.2 reviews the indications/contraindications for reattachment of an amputated digit. The residual finger should be gently cleansed and irrigated with saline and wrapped in nonadherent petroleum gauze and bulky dressing put in place. The amputated digit should be wrapped in nonadherent gauze, moistened with saline, and put into a sterile container or tied-off plastic bag. The amputated

part should not be manipulated or submerged in water. The plastic bag or container should be placed in a larger container with ice. No tissue of any type should be removed or debrided prior to consulting the replant surgeon.

General Approach to the Patient with Finger Injuries

The patient's age, occupation, and handedness should be recorded. Description of the injury or mechanism of injury should be obtained as it is often helpful in ascertaining the patient's diagnosis. Any type of jewelry should be removed before examining the digit. The vascular condition of the digit should be obtained by gently pressing on the patient's finger and counting. The area should blanch and there should have pink capillary refill within 2 s. A digital nerve injury can be identified if part of the affected finger has a different skin color (blanched or hyperemic) or lacks the ability to sweat. The use of blunt calipers or paper clip can be used to determine two-point discrimination. The patient should be able to distinguish this at least to 5 mm. See Fig. 5.6 for the normal anatomic position of the hand, also known as the "safe hand" position.

If the patient is holding the affected hand with their opposite hand above their head, this can indicate a more severe injury. If the patient can easily flex and extend their finger and grasp the examiner's hand with a handshake, this is reassuring that no major injury has occurred. The extensor tendon and both flexor tendons should be evaluated, and if there is any history of trauma, it is highly recommended that a radiograph be obtained of the digit. Interphalangeal fractures that can become unstable can easily be missed without radiographic evaluation. In an emergent situation (red flags described above), referrals to the emergency department or consultation with a hand surgeon is necessary. Many injuries, however, can be treated with ice, elevation, and dorsal splinting of the digit in a "safe hand" position. Fingers should never be splinted in complete extension. This is discussed in Chap. 15.

Common Finger Injuries

Crush Injury to the Distal Phalanx

Patients often present with crushed injury to the distal phalanx. The patient's neurovascular status should be checked as described above. The patient may or may not have a subungual hematoma. When it is present, it is important to drain the subungual hematoma as it is the cause of a lot of pain. There are a number of ways to do this. To accomplish this, it is important to note that it is not necessary to use cautery; an 18 gauge needle can be used to drain this. If the subungual hematoma is already draining from the nail edge, drainage is not necessary. The digit should be

radiographed. Many of these patients have a distal pulp fracture. Unless this is an open fracture, these can be treated conservatively. Recent studies have shown that it is safe to drain a subungual hematoma when a tuft fracture is present. It does not convert this to an "open fracture." The patient can be followed for a number of weeks, but the injury usually stabilizes within the month. These patients may be highly susceptible to ambient cold temperatures for the next year or so.

Volar Plate Injury

Figure 6.4 shows the anatomy of a number of common injuries of the finger including an injury to the volar plate, which is a thick fiber band on the palmar aspect of the finger that connects the middle and proximal phalanx. When the finger is hyperextended, this structure can be torn. The finger, at times, can even be dislocated. The dislocation usually happens dorsally. If the dislocation happens ventrally, radiograph should be obtained before attempting to manipulate the finger. Unless the clinician is present when the injury occurs (sideline), most of these injuries present after the finger has been relocated, many times by the coach, therefore given the name "coach's finger." When these patients are evaluated after a relocation, there is usually an ecchymotic area on the palmar aspect of the hand in the crease between the proximal and middle phalanx. It is very important that radiographs be obtained to ensure that there is no fracture associated with this. There are collateral ligaments on each side of the joint and these should be stressed. If the collateral ligament is felt to be damaged along with the volar plate, this is an unstable situation and consultation should be obtained. For the most part, these patients can be splinted or

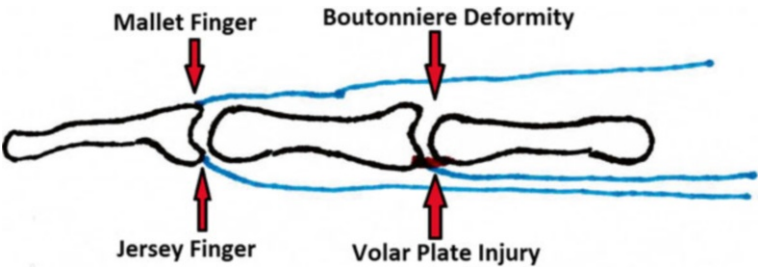

Fig. 6.4 Anatomy of common finger injuries. Mallet finger injury: extensor tendon avulses from the base of the distal phalanx. Jersey finger injury: deep or profundus tendon avulses from the base of the distal phalanx. Boutonniere deformity: extensor tendon splits longitudinally and PIP joint protrudes through the tear. Volar plate injury: also known as coach's finger. The volar plate tears from a hyperextension injury

buddy-taped. The dorsal splint in the safe hand position can also be considered. It is very important that these injuries are not splinted with the joint in complete extension as this will cause a tightening of the collateral ligaments which is sometimes more difficult to treat than the original injury.

Extensor Tendon Injury

The extensor hood inserts into the distal phalanx. When the extensor hood is disrupted, the DIP joint will fall into flexion. This is known as a "mallet finger." When these injuries occur, it is important that the integument along the dorsum of the hand is evaluated to make sure that there is no laceration, which may indicate an occult open fracture. An x-ray should be obtained, and if a fracture is distracted or if it affects more than one-third of the joint, these patients should be referred for consultation. These patients should all be splinted using a special STAX splint or O-Ring splint to keep the finger in complete extension. The patient should be warned not to remove the splint at all. These injuries can be treated conservatively by clinicians who feel comfortable and have the training to do so.

A Boutonniere injury occurs when the patient sustains a tear in the extensor hood. This most often occurs over the PIP joint where the extensor tendon is particularly wide. This tear can extend over time and open up like a "button hole" (Boutonniere means button hole in French) for which this injury was named. These injuries can present after trauma to the dorsum of the hand or after a patient forcefully flexes his finger against resistance. These injuries can be splinted by buddy-taping, and it is also strongly recommended that these injuries be referred to a hand surgeon. Splinting these injuries for prolonged periods of time can result in a condition that is more difficult to treat than the original injury.

Jersey Finger

As described in the Red Flag section earlier, this type of injury happens when the patients small or ring finger is flexed and is forcefully extended. The patient may or may not feel a pop, and the patient may just come in with a complaint of weakness in the hand. AP and lateral radiographs should be obtained. If musculoskeletal ultrasound is available, it could be valuable in identifying these injuries. If these injuries are identified and prompt referral is made, they can be easily fixed. Unfortunately, these injuries may not be appreciated resulting in treatment that has less than optimal outcomes.

Trigger Finger

This injury is also known as stenosing flexor tenosynovitis. It has also been referred to as texting tendinitis or Gameboy thumb. This condition occurs when there is swelling of the flexor tendon sheath and constriction of the sheath and tunnel where the tendon flows through the metacarpal phalangeal joint. This often occurs at the site of the A1 pulley. The patient commonly experiences these symptoms in the ring finger following frequency by the thumb and second finger. The patient often experiences catching or triggering on awakening in the morning. At times they may complain that the finger is stuck in a flexed position. Patients may not recognize that the triggering is occurring at the palm of the hand around the metacarpal phalangeal joint. They may feel that the catching is up in the finger at the PIP joint. A clinician can easily palpate the palm of the hand right at the MCP joint and feel the triggering as the patient flexes and extends his finger. When the triggering starts, medication and splinting are typically not useful. Most clinicians agree that injection of the tendon sheath right at the A1 pulley is the treatment of choice. The sheath has two sections where it can become entrapped. This can easily be seen with musculoskeletal ultrasound if it is available in the office, and a higher success rate is obtained when injecting both sides of the pulley. Injection of the trigger finger can be performed by any clinician with proper training and comfort. Care should be made to injecting steroids in this area, as injecting medication into the wrong site can result in fat atrophy of the palm of the hand. Patients can be referred to a hand surgeon for an injection and/or pulley release.

Please refer to Fig. 6.5 for the finger meaningful use form.

CC: ☐ Right ☐ Left ☐ Both
☐ Thumb ☐ Index ☐ Middle ☐ Ring ☐ Small
☐ PIP ☐ DIP ☐ MP

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____
_____
Occupation/Sport /Position: _____
Handedness: ☐ Right ☐ Left ☐ Both

Red Flags:

1. Compound Fracture
2. Fight Bite
3. Severe burn, amputation, degloving injury
4. High pressure injury
5. Deep laceration (especially palmar aspect, tendon laceration)
6. Infection: Kanavel's Signs
7. Tendon rupture DIP (Jersey Finger)

Q1. Is this a medical emergency?
a) Any digit threatening injury
b) See Red Flags: Check each PIP, DIP, Flexion, Vascular, Kanavel's Signs

Q2. Why is this patient here on this particular day?
a) Missed emergency?
b) Chronic problem?
c) Undiagnosed pathology?

Q3. How to treat?
a) Dorsal splint
b) Mallet finger splint
c) Close follow up
d) Radiograph
e) Immunization

Common and Don't Miss Conditions:

- See Red Flags
- Mallet Finger
- Jersey Finger
- Coach's Finger
- Boutonniere Deformity
- Fracture
- Subungual hematoma
- Trigger Finger
- Dupuytren's Contracture

Fig. 6.5 The fingers meaningful use form

TREAT APPROPRIATELY	Hand/Finger Pain.....719.44 Finger or Hand Sprain/Strain.....842.10 Fracture, Finger.....816.00 Coach's Finger.....834.02 Mallet Finger..... 736.1
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Tender anatomical snuffbox with normal x-ray
CALL CONSULTANT THAT DAY	Fight bite High pressure injury Palmar burn Flexor tendon disruption
CONSULT OR REFER	Extensor tendon disruption (splint, consult) Gamekeeper's thumb Persistent anatomic snuffbox tenderness after 2 wks with neg x-ray

Plan:
- ☐ Xray / Imaging What: _____
- ☐ Laboratory Eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 6.5 (continued)

Suggested Readings

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Chapter 7
Lumbosacral Spine

Joseph M. Kim and Per Freitag

Functional Anatomy

Figure 7.1 illustrates the surface anatomy of the LS. The LS is typically composed of five vertebrae (see Fig. 7.2). Unlike the cervical spine, whose facets allow for multidirectional movement, the primary motion of the LS is flexion and extension with some side bending. The spinal cord itself ends around L1 or L2, but spinal nerves continue down the canal as the cauda equina. Each nerve root exits the bony spinal canal hugging the pedicle and is named for that vertebra. At each level, the exiting nerve leaves the canal just above the disk, and another traversing nerve exits at the next level. When disk herniations occur, the traversing nerve usually is affected, while if the facet joints are involved, the exiting nerve root will be affected (see Fig. 7.3) [1–3].

Load in the LS is shared by the lumbar intervertebral disk and the posterior joint facets. The disk itself is made of two sections, the central nucleus pulposus, which is made of a proteinaceous gel, and the outer portion (annulus), which is made of fibrous material. With age, the disks tend to dry out, as there is no direct vascular supply to the disk. This leads to an increasingly friable disk as a person ages, and the nucleus pulposus becomes more solid. When disk herniations occur, they tend to protrude posterolaterally, which then affect the traversing nerve root. This can cause symptoms in the radicular pattern of the nerve involved [3, 4] (Fig. 7.4).

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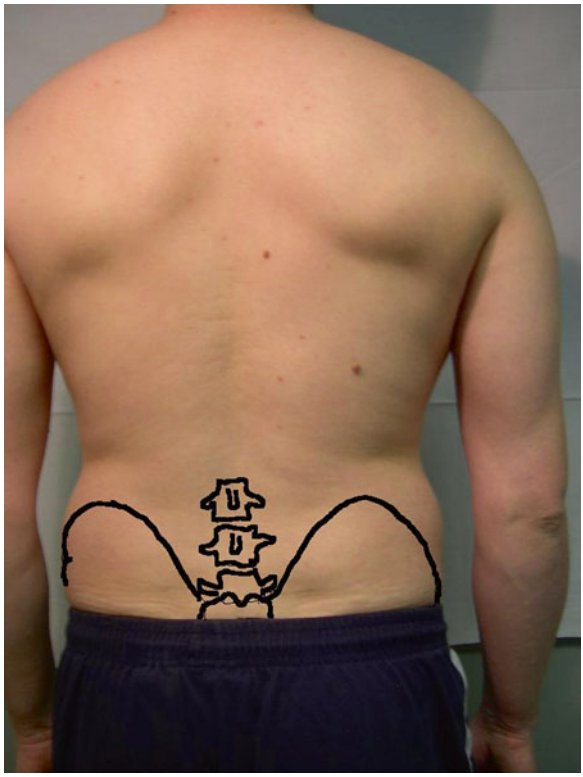

Fig. 7.1 Surface anatomy of the lumbosacral spine – posterior view

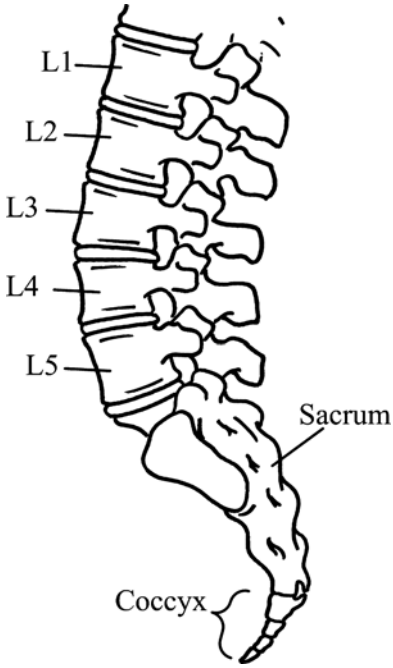

Fig. 7.2 Skeletal anatomy of the lumbosacral spine

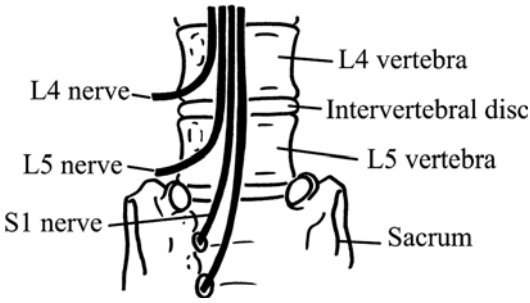

Fig. 7.3 Skeletal and neuroanatomy of the lumbosacral spine at the L4–L5 level

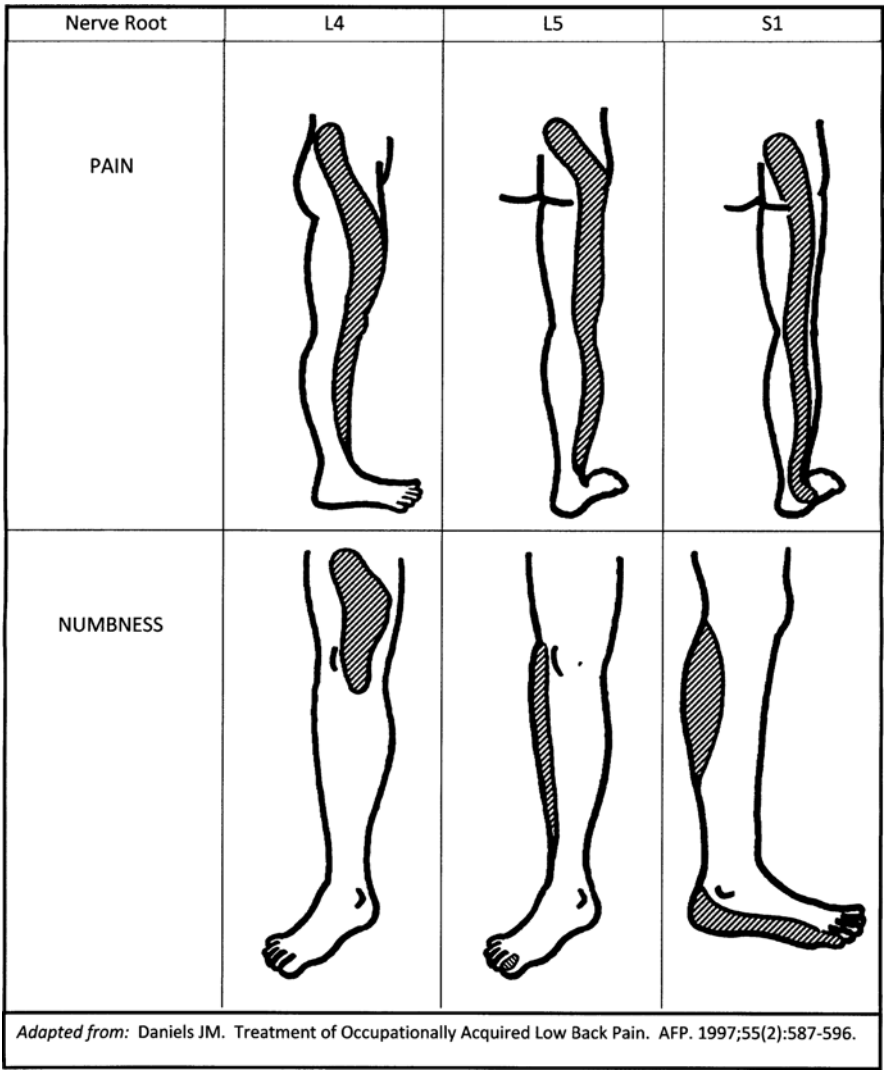

Fig. 7.4 Lumbar nerve root radicular patterns (Adapted from Daniels [12])

Many theories exist as to the cause of mechanical (nonneurological) back pain, and most patients with mechanical back pain cannot be given a specific diagnosis. Pain may be due to the irritation of muscles, ligaments, or other soft tissues, but a popular theory is that pain is produced by the irritation of the posterior vertebral facets as well as chemicals from the nucleus pulposus [3, 4].

Red Flags

1. *Cauda equina syndrome*. This occurs when there is a large herniation or blockage in the lumbar spinal canal and occurs in about 2 % of patients with disk herniations [3]. This is a true surgical emergency, since unless the obstruction is removed quickly (in less than 24–48 h), permanent fecal or urinary incontinence or saddle numbness may occur. It is imperative to inquire about saddle area numbness and incontinence when evaluating a patient with low back pain. When this condition is suspected, CT or MRI and immediate consultation with a spine surgeon are indicated.
2. *History of malignancy or systemic symptoms* (*weight loss*, *fever*, *multiple joint*, *or multisystem involvement*). These patients may have recurrent malignancy or systemic conditions that warrant more aggressive investigation than the average patient with back complaints [4].
3. *Age greater than 50*. Patients who present with the low back pain at advanced age warrant also aggressive investigation to rule out nonmechanical causes including cancer. [5]
4. *Progressive neurologic deficit*. These patients need more detailed evaluation for their complaints, often involving urgent imaging and/or referral [6].

General Approach to the Patient with Back Pain

Lumbosacral back pain is one of the most common reasons patients visit healthcare providers in the United States [7]. Studies in Canada and Europe have found that the prevalence of low back pain in the general population is 22–48 % [2, 6], and some experts believe that back pain is simply a part of the human condition. In the primary care setting, the physiologic cause of back pain cannot be diagnosed definitively in up to 85 % of patients; however, most patients with back pain will improve within 6–12 weeks. Outcomes are similar when patients see primary care providers, chiropractors, and orthopedic surgeons.

There are three main questions that need to be answered when evaluating the patient with back pain:

1. Is there evidence of systemic disease?
2. Is there evidence of neurological compromise?
3. Are there psychological factors that may contribute to disabling pain?

In the absence of neurologic symptoms or signs, most patients will have mechanical back pain due to benign causes. In general, the history and physical examination is directed at identifying more serious causes that require further investigation.

For all patients, a thorough history should be taken, inquiring about their medical history, medications, presence of any risk factors, trauma, recent infections, and history of prior back injuries, pain, or surgeries. Aggravating and relieving actions should be identified, and if radicular symptoms are present, the pattern can help determine etiology of pain. The red flag symptoms of cauda equina syndrome should always be addressed (see above) [1–3].

A brief vascular examination should always be performed. Palpation of the dorsalis pedis and posterior tibialis pulses is usually adequate. If abnormal, a more detailed examination should be performed.

The back should be inspected for obvious deformity. Palpation of the spine and paraspinous muscles rarely helps make a specific diagnosis; however, isolated vertebral tenderness may indicate bony pathology.

A detailed neurologic exam is not always necessary. All patients should have a straight leg raise test (SLR). This test is done having the patient supine while the examiner passively flexes the hip with the knee extended. A positive test occurs when the patient's symptoms are reproduced below the knee [1–3]. Reproduction of the patient's back pain is not a positive test. This test is very sensitive but is not specific; specificity can be improved by addition of the cross-table straight left raise test (described later). Neurological involvement occurs most commonly at the L5 and S1 nerve root levels, and even in the absence of neurologic symptoms, the following assessments should be performed:

1. Motor L5: have the patient raise (dorsiflex) the great toe
2. Sensory L5: medial foot and webspace between first and second toes
3. Motor S1: ankle jerk reflex (may be absent in elderly even without pathology)
4. Sensory S1: posterior calf and lateral foot

Another option for L5 testing is to have the patient walk on the heels; S1 by walking on the toes. If these examinations are negative in a patient who has no neurological complaints, no further neurological assessment is needed [8].

It is a good idea to assess the patient's level of psychological stress when dealing with pain, particularly chronic pain. If the patient has pain which seems out of proportion to the clinical findings and is not improving as expected, or if there is concern about psychological stressors or symptom magnification, additional physical exam maneuvers may be used [9]. These are listed in Table 7.1, but have not been validated in all populations. A list of "yellow flags" that might alert the provider to watch for symptom magnification is shown in Table 7.2 [10]. It is important to note that these have only been used in primarily Anglo-Saxon cultures and that many patients with legitimate medical conditions may have positive Waddell test results. It is also important not to confuse symptom magnification with "malingering." Malingering implies a conscious deception, implying that the patient is lying about

Table 7.1 Waddell's tests for nonorganic physical signs [10]

Tenderness:
Superficial, nonanatomic tenderness to light touch simulation
Axial loading on standing patient's skull produces low back pain (LBP)
Passive rotation of the shoulders and pelvis in the same plane produces LBP distraction
Discrepancy between findings on sitting and supine straight leg raising tests regional disturbances
"Cogwheel" (give-away) weakness nondermatomal sensory loss overreaction
Disproportionate facial expressions, verbalization, or tremor during examination

Table 7.2 Yellow flags (potential psychosocial barriers to recovery) [10]

Belief that back pain and activity are harmful
Sickness behaviors (extended rest)
Social withdrawal or no social support
Emotional problems (low or depressed mood, anxiety, stress)
Problems or dissatisfaction with work
Problems with claims for compensation or applications for social benefits
Prolonged time off work (>6 weeks)
Overprotective family members Inappropriate expectations

Table 7.3 Selective indications for radiographs [10]

Age >50 or <18
Progressive neurologic deficit
Neuromotor deficit on physical examination
Constitutional symptoms (unexplained weight loss, fever, etc.)
Trauma
History of malignancy
High risk of infection (drug or alcohol use, indwelling lines or catheters)
History of osteoporosis or chronic corticosteroid use
History of ankylosing spondylitis
Multiple visits for same complaint in less than 1 month or patients seeking compensation for pain/injury

his pain complaints and should not be applied to patients without absolute proof. Accusing a patient of malingering is a serious offense which can even be prosecuted in some locales.

Radiological imaging is not usually required for acute low back pain unless the patient falls into one of the following categories (see Table 7.3, selected indications for radiographs in acute low back pain) [1–4].

Common Clinical Presentations

Mechanical Low Back Pain

Mechanical low back pain makes up the vast majority of low back complaints. When findings are negative for any neurological or vascular compromise on initial evaluation, the provider can be reassured that the cause is likely benign mechanical back pain. A specific diagnosis is rarely possible, nor is it usually necessary. This type of pain may be due to any number of underlying issues, including SI joint pathology, muscle strain, facet joint irritation, and core muscle weakness. These patients do not need to undergo imaging unless their complaints have persisted more than 4–6 weeks, or if they fall into any of the categories mentioned above (see selective indications for imaging).

Patients with mechanical back pain can benefit from short-term use of NSAIDs or other analgesics, muscle relaxants, exercises, and structured physical therapy (PT) programs. Proper lifting technique, postural improvement, and strengthening of core muscles can prevent further problems. Patients should be reassured that their symptoms will improve and that they are given realistic expectations of the time frame for improvement. Those patients who do not improve as expected should have AP and lateral radiographs performed, and the yellow flags should be reviewed. If improvement is not noted by 12 weeks despite maximum conservative therapy, further imaging with MRI may be entertained, or the patient may be referred to a specialist. Caution must be taken when interpreting MRIs of the low back, because large numbers of asymptomatic patients have positive findings [4, 8].

Disk Herniation

Posterolateral disk herniation is relatively common. These patients will often complain of pain in the low back or buttock with pain or paresthesias that radiate below the knee if there is neurologic involvement. Pain may be aggravated by cough, Valsalva, or prolonged sitting. Patients often find some relief by repositioning or standing.

Herniations are most common at the L5 and S1 levels, and these patients may have neurological findings elicited by the primary back examination as described earlier. If SLR testing is positive, specificity can be improved by performing a cross-table SLR test, in which the examiner performs the same SLR test on the opposite extremity. If this test reproduces pain or symptoms in the *contralateral* leg below the knee, the test is positive and is more specific for neurological involvement [4]. If any other radicular symptoms are elicited, further directed examination can be performed, including sensory and motor examination for the involved nerves.

Patients with suspected disk herniation do not require immediate imaging unless they fall into one of the groups listed in Table 7.2. Those with motor deficits should

have X-ray followed by MRI imaging in most cases. Those with no neurological deficits or isolated sensory deficits can be managed with NSAIDs or other analgesics, muscle relaxants, and home exercise programs or structured PT. If their sensory symptoms persist beyond 1 month, referral or further investigation with imaging studies should be considered.

Spinal Stenosis

Spinal stenosis occurs when the spinal canal is narrowed from any variety of causes. Most patients with this problem will be older adults, and some have a history of previous trauma. These patients will often complain of numbness or pain in the leg with walking that is relieved by rest. Pain may be made worse by extension and relieved with flexion, as is seen with a patient who achieves relief by leaning on a shopping cart. Other historical items with high likelihood ratio include bilateral buttock pain or leg (+LR = 6.3), no pain with seating (+LR = 7.4), burning sensation around the buttocks, intermittent priapism associated with walking or both (+LR = 7.2), and urinary disturbances (+LR = 6.9) [11].

The physical examination in spinal stenosis often does not reveal neurological findings, but can if the condition is severe enough. It is a good idea to evaluate for long-track signs such as an abnormal Babinski reflex, since stenosis can occur at multiple spinal levels. As vascular claudication can present with similar symptoms, evaluation of distal pulses is very important. Unlike patients with disk herniation and mechanical back pain, whose symptoms are aggravated with flexion, patients with spinal stenosis will have worse symptoms with back extension which can sometimes be reproduced on physical examination. Wide-based gait during the examination has the highest likelihood ratio (+LR = 13) [11].

Patients with suspected spinal stenosis who have motor weakness or acute bowel or bladder complaints should be referred to a specialist immediately [1–4]. Other patients with suspected spinal stenosis should have X-ray imaging performed. Those with mild symptoms can be managed with education regarding activity and positioning, PT, and pain control. If the patient's symptoms are having a significant impact on his or her quality of life, MRI can demonstrate the site(s) of narrowing, and epidural steroid injections can be considered. Those with severe symptoms can be referred to a spinal surgeon for consideration of surgical intervention, although surgery is not always successful for this condition.

In summary, low back pain is extremely common. In the absence of neurological findings or concerns about systemic pathology, most patients can be managed conservatively and will improve. Those with concerning neurologic findings or who do not improve as expected must be further evaluated or referred for specialist evaluation. Primary care providers need to be alert for psychological stressors that can magnify symptoms and impair recovery.

Please refer to Fig. 7.5 for the LS Meaningful Use Form.

CC: Radicular symptoms: ☐ Positive ☐ Negative

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH:
Chronic Medical Conditions: _____
Occupation/Sport /Position: _____
Homework/School/Stressors: _____

FH:
Substance Abuse: _____
Disability: _____

Red Flags:

1. Cauda Equina Syndrome
2. Progressive neurological deficits
3. Systemic symptoms or history of malignancy
4. Pediatric patients / Very elderly patients

Q1. Is there evidence that systemic disease is causing the pain?

- History of malignancy
- UTI
- Fever
- IV drug use
- Weight Loss
- Night Pain
- Increased risk of bone fragility

Q2. Is there evidence of neurological compromise?

- DTRs
- Straight Leg Raise Test
- L_5
- S_1

Q3. Are there any social or psychological factors that may contribute to disabling the patient?

a) Persistent back pain without definitive diagnosis longer than 90 days
b) History of substance abuse
c) History of physical or psychological abuse
d) Family history of disability
e) Major home or work stressors

Common and Don't Miss Conditions:

- Mechanical back pain without specific diagnosis
- Herniated disk
- Spinal stenosis
- Cauda Equina Syndrome
- Systemic disease causing or contributing to back pain

Fig. 7.5 The LS Meaningful Use Form

TREAT APPROPRIATELY	Mechanical Back Pain Lumbar degenerative disc disease 722.52 Disc herniation 722.2 Low Back Pain 724.2 Lumbar radiculopathy 724.4 Lumbar sprain/strain 846.0 SI Joint strain 846.1 Nonspecific low back pain with negative evaluation 724.2 Spinal stenosis with mild symptoms 724.02
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Atypical pain with negative findings
CALL CONSULTANT THAT DAY	Severe symptoms Cauda equine Significiant motor symptoms
CONSULT OR REFER	Failure of conservative therapy Abnormal x-ray findings Spinal stenosis (severe or not responding to conservative management)

Plan:
- ☐ Xray / Imaging What: _____
- ☐ Laboratory Eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 7.5 (continued)

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Chapter 8
The Hip

Evan Plowgian and Tamara Pylawka

Anatomy

The hip is a ball and socket joint, an articulation of the femoral head with the acetabulum (see Fig. 8.1). Its range of motion (ROM) includes flexion, extension, adduction, abduction, and internal and external rotation [1].

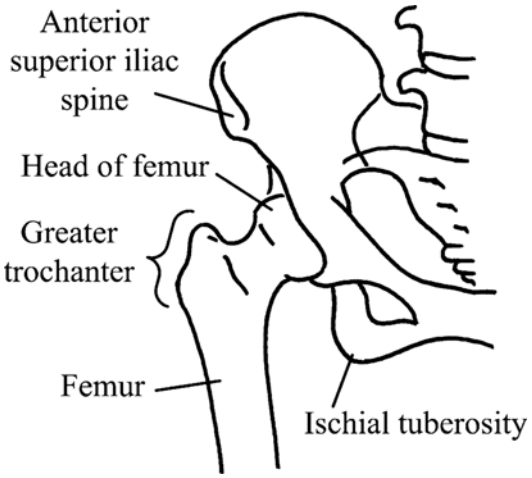

Fig. 8.1 Skeletal anatomy of the hip – anterior view

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Red Flags

- Systemic symptoms, such as fever or weight loss, may indicate systemic illness, such as infection (septic joint) or malignancy, and these patients should be evaluated thoroughly to rule out major pathology.
- Pain that is worse at night is also concerning for malignancy.
- Patients who are completely unable to bear weight should also be evaluated immediately by X-ray. Inability to bear weight may indicate fracture or avascular necrosis of the femoral head [1].

Approach to the Patient with Hip Pain

As with any chief complaint, it is important to obtain a thorough history. History should include onset, location, and duration of pain, as well as risk factors including past medical history, past surgical history, history of injury or trauma, and medication use. Activity level including regular exercise, or lack thereof, and occupational activities and exposures should also be included. History is very helpful in determining the etiology of the pain and will guide your focused clinical exam. The location of the pain can be very helpful in organizing your differential diagnosis, as the causes of anterior, posterior, and lateral hip pain are often very different. Also, a patient complaining of "hip pain" may actually be experiencing symptoms stemming from the low back or pelvis, so these should remain on a working differential diagnosis.

Hip Exam

All hip exams should include the following: gait assessment; assessment of range of motion (ROM) of the hip, as well as brief neurovascular exam, strength testing, including distal pulses, and straight leg raise and/or slump test, to rule out radicular etiology. Limited ROM, particularly of internal rotation, suggests intra-articular pathology, such as a fracture, or arthritis. Normal external rotation ranges from 30 to 45°, internal rotation from 20 to 35°, and flexion from 120 to 125° [1].

Anterior Hip Pain

In the adult population (pediatric patients are discussed in Chap. 12), the most concerning etiologies of anterior hip pain are those involving the joint itself, or intra-articular causes. These include osteoarthritis (OA) and femoroacetabular impingement (FAI).

OA of the hip occurs typically in patients over the age of 50. In addition to age, other risk factors such as obesity, prior injury, and family history may predispose a patient to OA. Elements of the history that may indicate OA are as follows: groin pain that is worse with activity, morning stiffness usually lasting less than 30 min, and specific activity triggers, such as getting into and out of a car. On physical exam, pain with active or passive internal or external rotation (particularly internal), often, is an indication of intra-articular pathology such as OA. Radiographs are not necessary to make the diagnosis but should be obtained if other diagnoses are being entertained or conservative therapy has failed. Treatment involves weight loss, analgesic medication, PT, steroid injection, and ultimately hip replacement, when all other treatment measures fail to control or manage the symptoms [1].

Femoroacetabular impingement (FAI) is the abnormal articulation of the acetabular rim and the proximal femur. It can lead to injuries of the labrum and articular cartilage and can lead to osteoarthritis of the hip if left untreated. Elements of history that may indicate FAI include the following: anterolateral hip pain, aggravated by prolonged sitting, leaning forward, or pivoting motions in the young adult population [2]. On physical exam, range of motion will often reproduce the pain for patients, as will many special maneuvers. The most sensitive of these is the FADIR test or flexion, adduction, and internal rotation (Fig. 8.2) [2].

Other intra-articular causes of hip pain may present as anterior pain. Stress fracture, avascular necrosis (AVN), septic arthritis, and mild undetected congenital or developmental conditions may all present as anterior hip pain or groin pain [3].

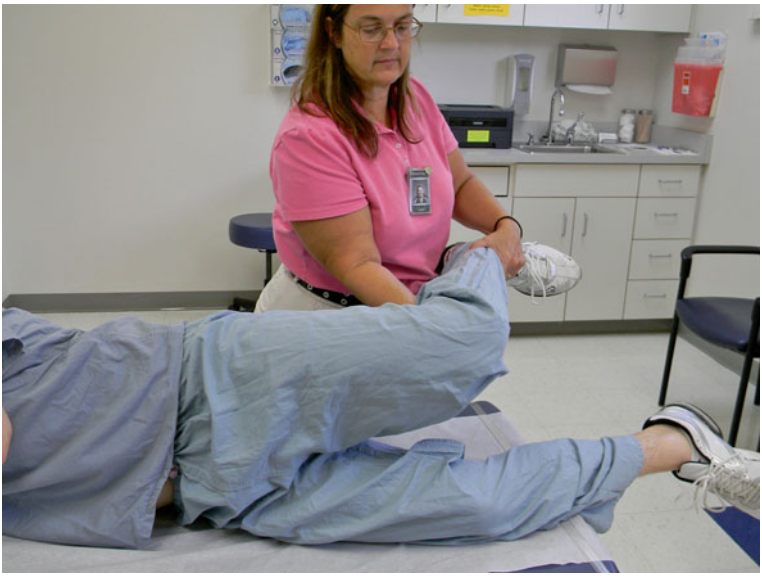

Fig. 8.2 FADIR

Table 8.1 Extra-articular sources of hip pain

Condition	Typical presentation
"Hip pointer"	Lateral pain after direct trauma, tender on iliac crest
Abdominal or inguinal hernia	Anterior or groin pain worse with Valsalva
Sportsman's hernia	Hernia-like pain with no demonstrable hernia on exam or imaging
Meralgia paresthetica	Anterolateral hip/thigh pain and numbness
Osteitis pubis	Pubic symphysis inflammation and pain, difficult to distinguish from adductor strain
Adductor strain	Adductor muscle pain, often associated with pelvic instability and SI joint path
Femoral neck stress fracture	Anterior hip pain associated with recent increase in running

These will often present with difficulty or inability to bear weight and should be imaged by X-ray and MRI if X-rays are negative.

Those related to extra-articular sources are listed on Table 8.1 [1]. When evaluating groin pain, it is important to examine the groin for any soft tissue masses, such as testicular masses, hernias, or enlarged lymph nodes that may be the cause of the pain [1].

Those patients with anterior hip/groin pain with no other findings can be managed conservatively. Physical therapy and analgesic medication for 30–90 days may bring a resolution of symptoms. If the pain persists, however, further evaluation by referral or MRI should be considered [1].

Posterior Hip Pain

Often patients complaining of posterior hip pain have conditions related to pathology in the lower back or pelvis. A thorough low back exam and neurologic exam, including performing a straight leg raise and/or slump test, are particularly important in patients with posterior pain. Patients may have radicular symptoms stemming from the lumbar spine.

Testing for SI joint is also important in patients with posterior pain. The FABER test (Fig. 8.3), during which the examiner flexes, abducts, and externally rotates the hip, is particularly sensitive for SI joint pathology [1]. Physical therapy is the first-line treatment for SI dysfunction; chiropractic adjustment or osteopathic manipulation may also be helpful. Referral may be appropriate if the cause of symptoms is unclear, or patient has prolonged course of symptoms, not improving with treatment.

Fig. 8.3 FADER

Lateral Hip Pain

Lateral hip pain is often attributed to a single diagnosis: greater trochanteric bursitis. Pain around the greater trochanter is a common problem, but recent literature suggests that it may be secondary to a variety of either intra-articular or periarticular pathologies [4]. The gluteus medius and minimus tendons insert at this site, as well as the tensor fasciae latae, and these structures are more likely pain generators than the trochanteric bursa itself. Gluteal tendon tears as well as tendinopathy are often present in patients with trochanteric pain and can be readily seen on ultrasound [4]. Bursal fluid collections may also be seen, often coinciding with tendon pathology, making it unclear whether bursal fluid collection is a sequela of tendon disease, or if these two conditions are both causes of lateral hip pain. Steroid injections are often provided as treatment for trochanteric bursitis, whereas rest and physical therapy are first line for gluteal tendinopathy. However, steroid injections may be used in refractory cases [4].

Please refer to Fig. 8.4 for the Hip Meaningful Use Form.

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____
_____
Occupation/Sport /Position: _____

Red Flags:

1. Inability to bear weight
2. Constitutional symptoms
   a) Weight loss
   b) Fever
   c) Amenorrhea

Q1. Is the problem coming from the hip?
Consider pelvic, lumbar spine, SI involvement,
Hernia versus true hip pathology
Low back exam, provocative maneuvers –SLR & Slump test
ROM, to determine intra-articular vs extra-articular, consider imaging

Q2. What type of imaging should I use?
XRays are appropriate to evaluate for fracture, dislocation, OA.
MRI (w/ or w/o contrast) may be necessary for labral tears, other soft tissue pathology
Ultrasound may be useful for detecting effusions, bursitis, tendinopathy, to confirm diagnosis, and for treatment (injections, etc)

Q3. How to treat?
a) Conservative
b) Imaging
c) Referral

Common and "don't miss" conditions

- Femoroacetabular Impingement (FAI)
- Trochanteric pain syndrome (trochanteric bursitis)
- Osteoarthritis
- Labral tear
- Piriformis syndrome
- Femoral neck stress fracture
- Slipped capital femoral epiphysis(pediatric)
- Leg Calve Perthes (pediatric)

Fig. 8.4 The Hip Meaningful Use Form

• **TREAT APPROPRIATELY**	Trochanteric Bursitis.....726.5 Osteoarthritis.....715.95 ITB Syndrome.....728.89 SI Joint Pain.....719.45 Sprain/Strain.....843.x Low Back Pain.....724.2
TREAT WITH CLOSE FOLLOW-UP	Soft Tissue
CALL CONSULTATNT THAT DAY	Can't walk AVN Fracture
CONSULT OR REFER	OA, failed conservative treatment Suspected fracture Diagnosis unknown

Plan:
☐ Xray / Imaging What: _____
☐ Laboratory Eval What: _____
☐ NSAIDs _____
☐ Acetaminophen _____
☐ Other _____
☐ PRICE Protocol
☐ Physical Therapy

Disposition:
☐ Treatment initiated: Follow-up _____ weeks
☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
☐ Immediate call to Dr. _____
☐ Consultation initiated with Dr. _____
☐ Referral to Dr. _____

Fig. 8.4 (continued)

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Chapter 9
The Knee

James M. Daniels and Patrick A. Smith

Functional Anatomy

Figures 9.1 and 9.2 illustrate the surface anatomy of the knee joint. The knee is essentially a hinge joint between the femur and the tibia, with the patella riding anterior to and slightly superior to the joint. The knee joint (and therefore knee pathology) can be thought of in terms of three anatomic compartments, the medial, lateral, and patellofemoral (anterior).

There are four major ligaments of the knee, the anterior cruciate ligament (ACL), which inserts on the anterior tibia; the posterior cruciate ligament (PCL), which inserts on the posterior portion of the tibia; the tibial (medial) collateral ligament; and the fibular (lateral) collateral ligament. The ligaments passively support the knee joint. The menisci located medially and laterally function as shock absorbers, improve stability, and provide nutritional support to the knee [1]. The basic anatomy of the knee is shown in Fig. 9.3.

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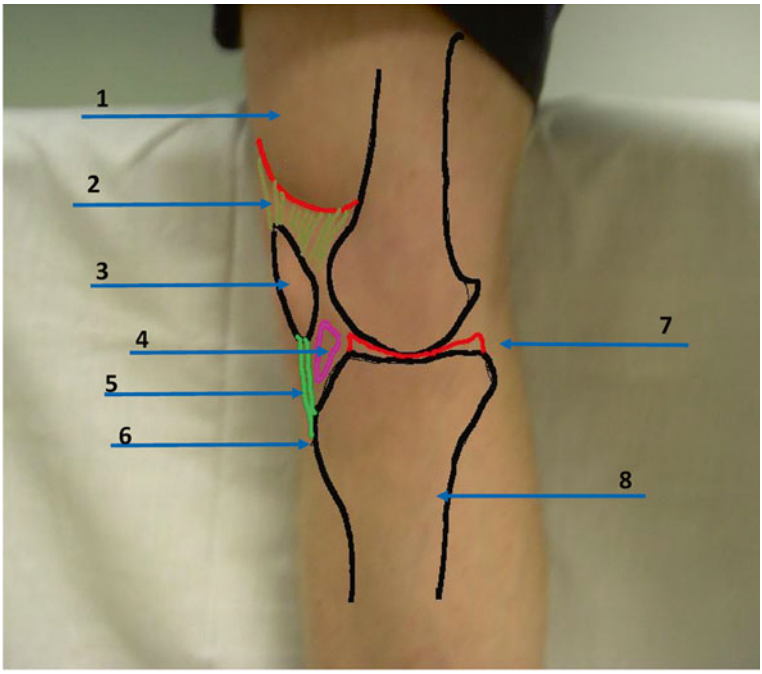


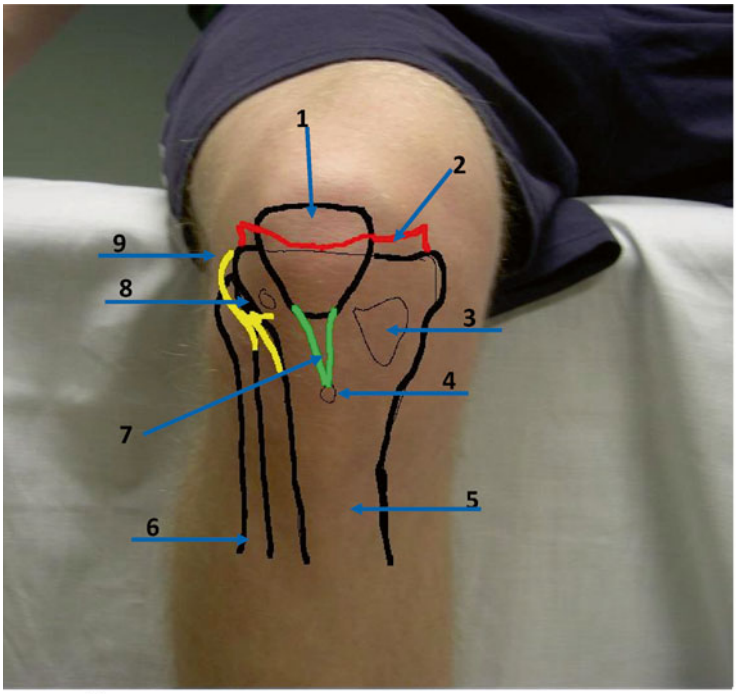
Fig. 9.1 Surface anatomy of the knee – medial view

Red Flags

1. An acutely effused knee with history of trauma: fracture must be ruled out (see below).
2. A red, hot knee joint. While other pathologies may exist, with an isolated red, hot joint, consideration must be given to septic arthritis.
3. Patients with systemic symptoms or multijoint involvement. These patients are likely to have a systemic condition and should be appropriately evaluated.

General Approach to the Patient with Knee Pain

When a patient presents to a clinician with knee pain, a rapid diagnosis can be facilitated by asking a few simple questions. Age, mechanism of injury, location of pain, history of swelling and the reason the patient presented today at this particular place



1 – Patella 2 – Meniscus
3 – Pes Anserine (Sartorius, Gracilis, semitendinosus muscles all insert here)
4 – Tibial Tuberosity (Patellar tendon inserts here)
5 – Tibia 6 – Fibula
7 – Patellar Tendon 8 – Gerdy's Tubercle (Iliotibial tract inserts here)
9 – Superficial Perone al Nerve

Fig. 9.2 Surface anatomy of the knee – anterior view

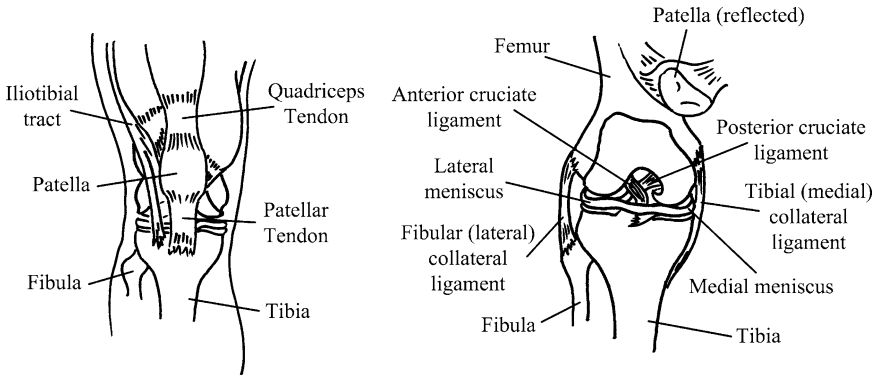


Fig. 9.3 Basic external and internal anatomy of the knee. *Left*. External view. *Right*. Internal view

and time all provide great clues as to the pathology present. For example, a preteen with no trauma who presents with nonspecific knee pain on a Friday afternoon urgent care clinic because the discomfort was too great to wait for an appointment with his primary healthcare provider would raise one's suspicion for an unusual problem. When physical exam reveals that the pain is reproduced by internal rotation of the ipsilateral hip, the diagnosis of a slipped femoral epiphysis should be strongly considered. A positive straight leg test would point toward spinal pathology that can masquerade as leg pain.

Determining what conditions worsen the pain and which relieves the pain is also important. For example, increased pain at rest and decreased pain with activity point to a non-musculoskeletal etiology of the patient's problem.

Determining the mechanism of injury is also essential. If a patient falls directly on their patella and if their foot is plantar flexed, there is an increased risk of a PCL tear as opposed to a patient who falls with his foot dorsiflexed, where there is an increased risk of a patellar fracture or a resultant osteochondral lesion of the posterior aspect of the patella. Patients who injure their knee when it is in complete extension have an increased risk of ACL or meniscal tear, whereas patients who fall on a flexed knee have an increased risk of a PCL tear. There are a number of protocols that can be helpful in determining if the patient is in need of radiography. See Table 9.1 [2].

When examining the patient, noting the position of rest is helpful in determining what is wrong with the knee [3]. A patient with a large knee effusion would not be able to flex their knee past 90°. A large effusion indicates intra-articular pathology. In addition, it is quite common in patients with an acute ACL tear and a significant joint effusion to splint their knee in 10–15° of flexion. Those with osteochondral irritation of the posterior aspect of the patellae will tend to keep their leg in extension at rest. Asking the patient to use their index finger to point out where they are having discomfort can also be useful, i.e., a young female with Osgood–Schlatter syndrome points to her tibial tuberosity.

It is of utmost importance that the knee be evaluated without clothing covering it. Patients should be placed in shorts or in some type of gown so that their modesty is preserved. Conditions, such as shingles or a red hot joint, cannot be evaluated unless the patient is properly exposed during the examination.

Table 9.1 Indications for radiography in patients with acute knee injury [2]

A patient with a history of fall or blow to the knee who has one or more of the following should receive imaging with radiography:
1. Age ³55 years
2. Isolated tenderness of the patella
3. Tenderness at head of fibula
4. Inability to flex knee to 90°
5. Inability to bear weight (four steps) both immediately and in the emergency department or at initial evaluation

Common Clinical Presentation

Anterior Knee Pain

Anterior knee pain is one of the most common causes of patients presenting to their primary healthcare provider. Almost all of these patients can be treated nonsurgically, and so a good physical examination is necessary to identify the cause of the anterior knee pain and guide treatment accordingly. The generic diagnosis and treatment of patellofemoral syndrome is often unsatisfactory to the patient and the healthcare provider. Extensor mechanism pain can be caused by a number of conditions; if all are grouped into one diagnosis and treated the same, the patient will have a suboptimal outcome. The patient's trunk and lower extremity strength needs to be evaluated. A good way to check this is to have the patient stand on one leg and try to do a slight deep knee bend. If the patient has pain when performing this test, the test becomes invalid; however, if the patient can squat without pain, the test is valid and the clinician should observe to see if their trunk leans forward or their knee goes into valgus. These two findings uncover muscular hip weakness. The ability for the patient to maintain neutral spine position has a profound effect on lower extremity dynamic posture. This can be evaluated by having the patient lay supine on the table, and while the examiner puts their hand behind the patient's back, ask the patient to press the examiner's "hand against the table" by extending their back. This is easily done when the patient's knees are flexed 30° to 60°.

Palpation of the bony prominences in the pelvis can rule out apophyseal injuries in the adolescent patients. Palpation of the patient's quadriceps muscle bilaterally is important to check for atrophy and loss of tone. If present, this infers a chronic process that needs to be addressed by strengthening exercise.

The patella should be evaluated after the trunk and proximal lower extremity have been evaluated as described above. The position of the patella should be noted with the patient sitting with 90° of knee flexion. If the affected patella is sitting "too high" compared to the opposite side, this may indicate that the patella tendon is ruptured. If the patella sits "too low," this can indicate that the quadriceps tendon is disrupted. Pain caused by compression of the patella indicates potential pathology in the articular cartilage on the posterior aspect of the patella. It should be noted that patellofemoral crepitus without pain is part of the aging process of the knee.

If the patient has had a history of a patellar dislocation or subluxation, they may have a positive apprehensive sign. This test is best done with the patient lying supine with their leg resting on the sitting examiner's leg at approximately 20° of flexion so the patient relaxes the quadriceps muscle. The examiner then pushes the patella laterally, and if the patient stiffens up and resists this motion, this is suggestive of patellar subluxation. Patients who have had recurrent subluxation or have catching in their knee should be considered for referral for surgical evaluation.

Pain with palpation of the tibial tuberosity can be decisive in diagnosing apophysitis in preadolescent patients. Tenderness over the patellar tendon particularly at the inferior pole can indicate patella tendinopathy, which is common in athletes that require a lot of leaping. This is often referred to as "jumper's knee." Pain with palpation posterior to the

patella tendon may produce tenderness or crepitus. This is the area of Hoffa's fat pad which can be injured after the patient undergoes arthroscopy. Also, palpating toward the medial aspect of the patella may reveal a thick and tender plica which is a normal synovial fold that can become irritated and cause patellofemoral pain and dysfunction.

Most patients can be reassured that with a good home program of icing, simple isometric quadriceps strengthening with straight leg raises, hip abductor strengthening, the use of over-the-counter pain medication (acetaminophen or naproxen), and time, their symptoms will resolve. It is important, however, to note that this treatment usually takes 4–8 weeks before the patient notices much of a difference. The use of an anterior knee sleeve or patellar taping by the properly trained clinician or physical therapist may speed up this process. Initially, focus is on quadriceps and hip abductor strengthening but then progression is to strengthening for musculature of the lower extremity and trunk to ensure lasting symptom relief. These patients will not tolerate open chain exercises due to increased force generated on the patellofemoral articulation (exercise in which the foot is not in contact with another object during the whole exercise cycle such as knee extensions). However, closed chain exercises are encouraged. (The foot is in contact with the surface during the whole exercise cycle such as leg press, bicycling, elliptical, and swimming.)

Acutely Effused Knee

When assessing a patient with an acutely effused knee, a number of points should be kept in mind. The patient is oftentimes in pain or anxious, and the examiner should take their time in a private setting to evaluate this properly. Many times having the patient lay in a comfortable position with a pillow or some type of prop under their knee allowing their knee to flex about 30° can assist in examining the patient. If the knee is already tightly effused, many of the tests that have been described become invalid. Any type of systemic symptom such as fever, chills, etc. should alert one to possible sepsis. Crystal-induced arthritis can occur, particularly in patients over the age of 40, and should be considered in the proper setting. Juvenile rheumatoid arthritis can present in children initially with a significant knee effusion. If trauma to the knee has occurred, four possible conditions should be evaluated.

Trauma to the Knee

Subluxed/Dislocated–Relocated Patella

The first one is a subluxed or dislocated–relocated patella. If the patient's knee is in a semi-extended position, the posterior aspect of the patella is not engaged with the distal condyles of the femur and so the patella can be in an "at-risk" position for either subluxation or frank dislocation. This may happen if there is a mismatch of the bony parts such as a high riding patella or the lateral condyle of the femur that has failed to form completely so that the femoral groove is pathologically "shallow." The patient's

mechanism of injury generally involves twisting along with the knee bending into a valgus position causing the patella to sublux or dislocate laterally. When this happens, the posterior aspect of the patella may be damaged which can lead to loose body formation. For this reason, x-rays including a patellar sunrise view are recommended in this setting. An excellent test to rule this condition out is the patellar apprehension test as described above (Fig. 9.4). If the radiograph is negative, the patient can be treated

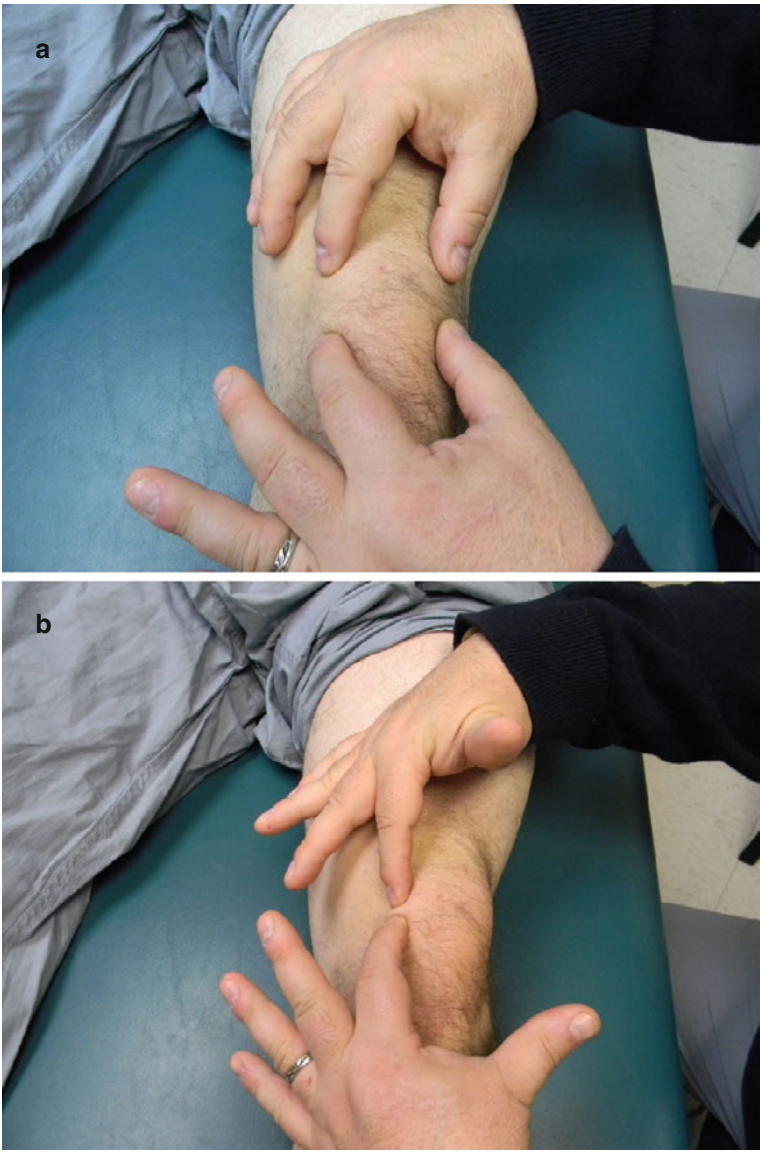


Fig. 9.4 Patellar apprehension test. (**a**) Isolate the patella. (**b**) Gently sublux the patella laterally with the patient in a relaxed, supine position with heir knee in complete extension. As the examiner slides the patella laterally, the examiner observes the patient's facial expressions for signs of apprehension and/or pain

with a knee sleeve, ice, weight bearing as tolerated and rehabilitation focusing on quadriceps strengthening to enhance dynamic stabilization of the patella. Recurrent subluxation or patients that complain of physical catching of the patella or locking with the joint with activity should be referred to an orthopedic surgeon.

Fracture

The second condition is fracture. Osteopenic patients, or elderly patients after a fall, may fracture their tibial plateau that may not be evident on x-ray. Patients with open growth plates may fracture the tibial growth plate if there was a high-energy impact. When evaluating geriatric and pediatric patients in this setting, if there is any type of high-energy trauma (MVA, fall from over 3 ft) and a large effusion or if the patient experiences a pain level outside of what one clinically expects, orthopedic consultation should be made, even if the initial radiographs are negative. A tibial plateau fracture is often best seen on lateral view, but ordering oblique views can be confirmatory. Any evidence of a small bony fragment off the lateral aspect of the tibia should alert one to an ACL tear. This fracture is referred to as a Segond fracture and is pathognomonic for ACL injury.

Meniscal Tear

The third condition is a meniscal injury. Meniscal tears occur quite commonly. The recent medical literature has called into question the ability of the physical examination to identify meniscal tear in the primary care setting [3–7]. A number of tests that are traditionally taught (McMurray) lack the sensitivity and specificity to be reliable. When evaluating the meniscus, it is important to recognize a number of anatomical features shown in Figs. 9.1 and 9.2. First, the medial meniscus is larger and less mobile than the lateral meniscus and so is most often injured. Second, the meniscus is composed of a number of layers of circumferential "hoop" fibers that are stacked on top of each other.

An acute meniscal injury is oftentimes relatively easy to diagnose. If the patient is tackled, for example, their knee is stressed with a twisting injury, and the patient experiences a "pop" and pain, and then immediate swelling of the knee occurs. They then may experience catching or even locking due to the unstable meniscal fragment. The most common area in which the meniscus is injured is just posterior to the medial joint line. These tears have a tendency to completely tear through the whole meniscus in a plane perpendicular to the tibial plateau termed a vertical or longitudinal tear. Our past experience has proven that patients with lack of menisci (trimmed or torn) are at increased risk for rapid onset of osteoarthritis of the medial compartment. For this reason, the standard of care is now to preserve as much

meniscus as possible, so these injuries are now repaired if possible depending on the location of the tear to the peripheral blood supply of the meniscus.

The other type of meniscal tear is more of a degenerative one. In this care, the meniscus "delaminates." Because of the shear force experienced by the meniscus, the tear occurs in a horizontal instead of vertical plane in relation to the tibial plateau. In actuality, many of these tears are complex and occur in various planes. They may even be comminuted. The majority of these types of tears are not feasible to repair, and oftentimes the symptom is primarily pain, as opposed to mechanical catching. Currently, most surgeons will recommend a trial of nonoperative management of patients with degenerative horizontal meniscus tears. These tears often occur in middle-aged patients and may not be associated with one acute traumatic episode.

Patients with an acute vertical tear of the medial meniscus and an acutely effused knee are oftentimes very tender over the joint line just posterior to the MCL. Recently this has been shown to be a fairly sensitive test [7]. Clinicians should perform this joint line tenderness test (very sensitive) followed by a McMurray test (very specific, but not very sensitive) [3] to increase their accuracy in diagnosing vertically torn medial menisci. Other authors do not believe that the McMurray test is useful at all [3]. The most accurate way to diagnose a meniscal tear in a primary care setting is a universal assessment of the knee. In other words, use both history and physical examination to assess for an acutely torn meniscus.

A chronically torn meniscus is a bit more difficult to diagnose. In fact, asymptomatic patients have been shown by MRI to have these tears [8–10]. A test has been proposed to identify these types of tears in a primary care setting described by Thessaly [6, 11]. Figure 9.5 demonstrates the Thessaly test.

Patients with an acutely vertically torn meniscus should be placed on the PRICE protocol (*P*rotect, *R*est, *I*ce, *C*ompression, *E*levation described in the chapter "Soft Tissue/Bracing") and instructed on the proper use of crutches. Those with a chronic horizontal tear may not need crutches, but should be protected until the diagnosis is confirmed. There is good evidence that unless some other injury, such as occult fracture, tumor, etc., is suspected, an MRI of the knee in patients older than 40 should *not* routinely be obtained. If there is ongoing concern with these patients, it is much better to refer them to an orthopedic surgeon knowledgeable in this area [4, 8, 9, 12].

Ligamentous Injury

There are four main ligaments of the knee: medial (MCL) and lateral (LCL) collateral ligaments and the anterior (ACL) and posterior (PCL) cruciate ligaments. Our discussion will focus on the ACL, PCL, and MCL. A number of studies [4–6, 8, 9, 11] show that a drawer test done at 90° of flexion is not a useful test in diagnosing ligamentous instability in a primary care setting. The most successful way to diagnose an ACL tear is by history and universal physical examination. Patients, who experience a cutting-type injury with their knee toward full extension, feel a

Fig. 9.5 Thessaly test

pop, and have an acute (within one hour) effusion, should be strongly suspected of having an ACL injury [11]. Patients should be placed in PRICE protocol and put on crutches until further evaluation can be made. (This sometimes includes serial examination by the healthcare provider or consultant.) Another common way that patients tear their ACL is running and stopping suddenly while their knee goes into valgus and extension followed by a pop. A third way ACL injuries commonly occur is the patient experiences a valgus trauma to the knee and feels a pop followed by acute effusion. Patients with suspected ACL injury should be promptly referred to an orthopedic specialist for consultation.

The PCL is most often injured when the patient falls on a flexed knee. Oftentimes the ankle is also plantar flexed at the time of injury. The PCL may also be injured if a patient's flexed knee hits the dashboard in an automobile accident. Those injuries may be associated with other pathology. This discussion will focus on low-energy injuries described in the first example. PCL tears can be evaluated by palpating the patient's tibial plateau. The clinician should place a thumb on each side of the patella and then slide both thumbs downward until the tibia plateau is palpated. Normally the plateau is approximately one centimeter anterior to the femoral condyles. If the tibial plateau is not prominent, a PCL tear is suspected. These patients

should be treated with the PRICE protocol and crutches. An isolated PCL injury is treated nonoperatively unless it is associated with other injuries. Many clinicians will consult an orthopedic surgeon for these injuries.

The MCL originates on the femur and inserts on the tibia. Acute injuries will have tenderness to palpation and soft tissue swelling present either at the medial epicondyle area of the femoral origin or toward the tibial insertion approximately 6 cm below the joint line. To test the integrity of the MCL, the knee is placed in extension and a valgus stress is placed on the knee. If the knee "opens up" (no end point) with the patient in complete knee extension, it infers that the patient not only has a torn MCL, but a torn PCL. A multiple ligamentous injury is a red flag, and immediate consultation should occur. After the knee is stressed in complete extension, it should then be checked at 30° of flexion with a valgus stress. The examiner should compare how much the knee moves in this position to the opposite knee. Attention should focus on the "end point." This is the term used to describe when the knee is stressed in a valgus direction. The ligament is stretched until it stops moving. Does it stop abruptly and suddenly like it is attached to a leather belt, or is it less pronounced such a bungee cord being stretched? If the "end point" is abrupt or stiff, this indicates that the ligament is intact. If it is soft or spongy, it indicates that the ligament is damaged. This may be a different concept to a clinician just learning these techniques. The amount of movement of the knee when stressed has to do both with the patient's innate ligament structure and associated injury. Many patients will have a "loose jointed" tendency, and so the opposite knee should always be stressed and compared to the affected knee. If there is a difference in the amount of joint laxity, this would represent a possible disruption of the MCL.

Most patients with isolated MCL injuries can be treated with a hinge brace, PRICE protocol, and graduated return to activity. The MCL is attached to the medial meniscus and can be associated with a meniscal tear. MCL injuries can also be associated with ACL injuries. These patients should be referred to an orthopedic surgeon.

Chronic Atraumatic Knee Pain

In older patients, particularly those over 50 years of age, osteoarthritis (OA) of the knee joint is extremely common. These patients typically complain of diffuse knee pain that worsens with weight-bearing activities, and they often report some morning stiffness. In general, the pain is chronic but can be exacerbated by heavy activity causing acute flare-ups, and patients may even report episodes of swelling.

On physical examination, there may occasionally be a visible/palpable effusion, but stability of the knee (as described earlier) will be intact on testing. Crepitus is a common finding, but does not necessarily relate to the degree of OA present. The range of motion of the knee may be reduced, but is neither specific nor sensitive for OA. Many criteria for the diagnosis of OA have been proposed over the years. The most widely used clinical criteria were developed in 1986 by the American College of Rheumatology (ACR) and are summarized in Table 9.2 [13]. Radiographs are not necessary for this clinical diagnosis.

Table 9.2 ACR clinical criteria for clinical diagnosis of osteoarthritis of the knee [13]

Knee pain and three or more of:
1. Age >50 years
2. Morning stiffness <30 min
3. Crepitus
4. Bony tenderness
5. Bony enlargement
6. No palpable warmth
These criteria have reported sensitivity of 95 % and specificity of 69 % for knee OA

Table 9.3 Other common knee conditions

Condition	Presentation/exam findings	Typical patient
Pes anserine bursitis	Localized tenderness and pain over bursa	Middle age patient, no trauma
IT band pain	Lateral knee and thigh pain	Young adults with repetitive activity
Osgood–Schlatter	Tibial tuberosity pain	Young adults, adolescents
Patellar tendonitis	Tenderness and pain of the tendon	Patient with repetitive use
Prepatellar bursitis	Swelling localized to prepatellar bursa	Patient with repetitive kneeling
Baker's cyst	Posterior (popliteal) swelling	Adults with underlying arthritis or hx of trauma
Chronic meniscal pathology	Catching/locking, pain, positive exam findings	Adults with prior hx of injury or repetitive use

Symptomatic relief may be obtained with acetaminophen or NSAIDs. Physical function and pain are often improved with maintaining a healthy weight, water exercises, physical therapy, and/or home exercises which are focused on improving strength and reducing wear and tear on the joint. Corticosteroid injections of the knee joint may provide temporary pain relief but do not slow degeneration [14]. Hyaluronic acid injections are employed by some primary care providers and orthopedists. (ACR and the American Academy of Orthopedic Surgery have recently provided statements that this treatment may not be as effective as once believed.)

If the knee pain or disability progresses to an unsatisfactory state, knee arthroplasty is the final management strategy. The decision to refer a patient for arthroplasty should be based on the patient's symptoms; if quality of life can be maintained without surgery, this should be attempted. The use of the Arthritis Foundation guidelines on muscle strengthening and lessening weight-bearing exercise has been the mainstay of treatment for years. It is also incumbent upon the primary healthcare provider to stress to the patient that even small amounts of weight loss may greatly reduce symptomatology of the osteoarthritic knee. A multidisciplinary approach involving trainers, therapists, and other healthcare providers is much more satisfactory than use of pharmacological methods alone.

Many other knee conditions certainly exist; see Table 9.3 for the most common of these. Please refer to Fig. 9.6 for the knee meaningful use form.

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____
_____
Occupation/Sport /Position: _____

Red Flags:

1. Acutely effused knee: must rule out fracture
2. Red hot knee: septic? Inflammatory?
3. Systemic conditions
   - Fever
   - Weight loss
   - Night Pain
4. Referred pain Syndromes
5. Hip pathology
6. Radicular symptoms

Q1. Does this patient have an acutely effused knee?
a) Ligamentous injury
b) Meniscal injury
c) Subluxed patella
d) Fracture
(Ottawa Knee Rules: use with caution with patients with open growth plates)

Q2. Does this patient have anterior knee pain?
a) Worse with knee flexion
b) Evaluate weakness in hip Abductors
c) Ability to control core
d) Lower extremity alignment

Q3. How to treat? Is this patient ambulatory
- PRICE
- Crutches
- Knee sleeve or Brace

Radiograph (if meets Ottawa Knee rules or high suspicion)
Note: Very rare to require MRI early in treatment unless very high suspicion for unstable knee (more than one ligament torn). Consider consultation prior to ordering this test.

Common and Don't Miss Conditions:

- Subluxed patella
- MCL sprain
- Non-specific anterior knee pain
  - o Patellar tendinopathy
  - o Osgood-Schlatter

Fig. 9.6 The knee meaningful use form

- Osteoarthritis (See Table 9.2)
- Multiple ligamentous tear
- Meniscal tear
- Bakers cyst
- IT Band pain

TREAT APPROPRIATELY	Osteoarthritis..... 715.96 Knee Pain..... 719.46 IT Band Syndrome ..... 728.89 Patellofemoral Pain Syndrome..... 719.46 Patellar Bursitis..... 726.65 Meniscal Injury..... 836.2 Sprain/Tear Cruciate Ligament ..... 844.2 Sprain/Tear Medical Collateral Ligament..... 844.1 Soft Tissue Pain 719.56
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Cellulitis Acute effusion with negative x-ray Crystal deposition disease
CALL CONSULTANT THAT DAY	Fracture Dislocation Impaired Neurovascular Status Septic Joint
CONSULT OR REFER	Acutely effused knee, if not comfortable with close f/u Atypical knee pain Failure of conservative therapy Recurrent effusion Recurrent locking or catching Vascular disease requiring intervention

Plan:
☐ Xray / Imaging What: _____
☐ Laboratory Eval What: _____
☐ NSAIDs _____
☐ Acetaminophen _____
☐ Other _____
☐ PRICE Protocol
☐ Physical Therapy

Disposition:
☐ Treatment initiated: Follow-up _____ weeks
☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
☐ Immediate call to Dr. _____
☐ Consultation initiated with Dr. _____
☐ Referral to Dr. _____

Fig. 9.6 (continued)

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Chapter 10
The Ankle

Erica Miller-Spears and Brian Kleiber

Functional Anatomy

Figures 10.1, 10.2, 10.3, and 10.4 illustrate the surface anatomy of the ankle joint. Osseous anatomy of the ankle includes the tibia which is the medial malleolus, the fibula which is the lateral malleolus, and the talus which articulates in the ankle mortise. The tibia sees 80 % of the weight-bearing stresses in the lower extremity. The syndesmosis is the articulation between the tibia and fibula at the ankle. It consists of four ligaments: the anterior tibiofibular, the posterior tibiofibular, the transverse, and the interosseous. The lateral ankle ligamentous support is provided by the anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament. Medially there are the superficial and deep deltoid ligaments.

Red Flags

1. *Very young* (*prepubescent*) *or elderly patients*. It is unusual for prepubescent children to have ankle sprains. One must consider a fracture that may involve the growth plate (physis) in these situations. This is because the physis is weaker than the ligaments about the ankle. These fractures, also called Salter-Harris fractures, can be quite serious, as poor healing can have implications for future bone growth. The *Ottawa Ankle Rules* (Table 10.1), a set of rules that help decide

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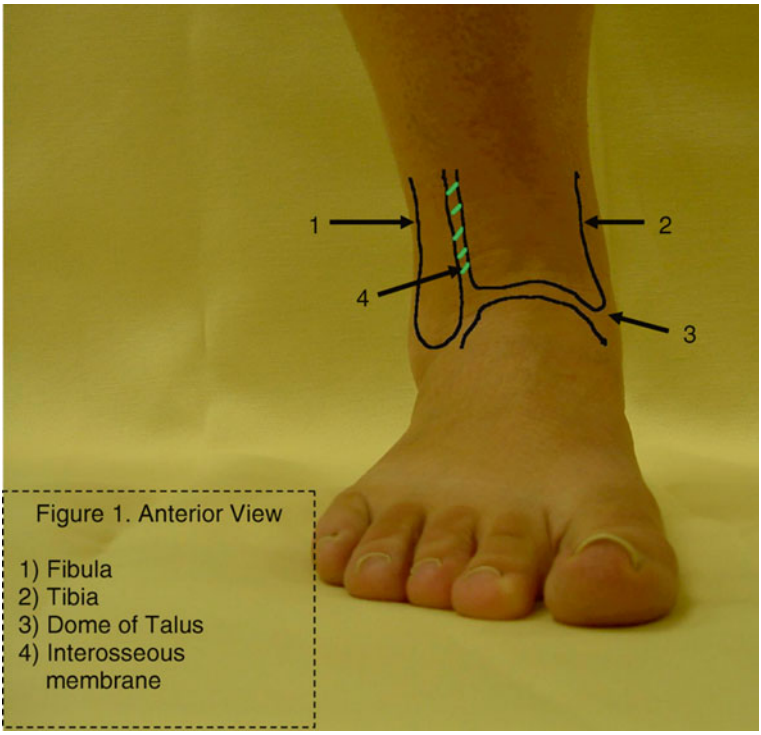

Fig. 10.1 Surface anatomy of the ankle – anterior view

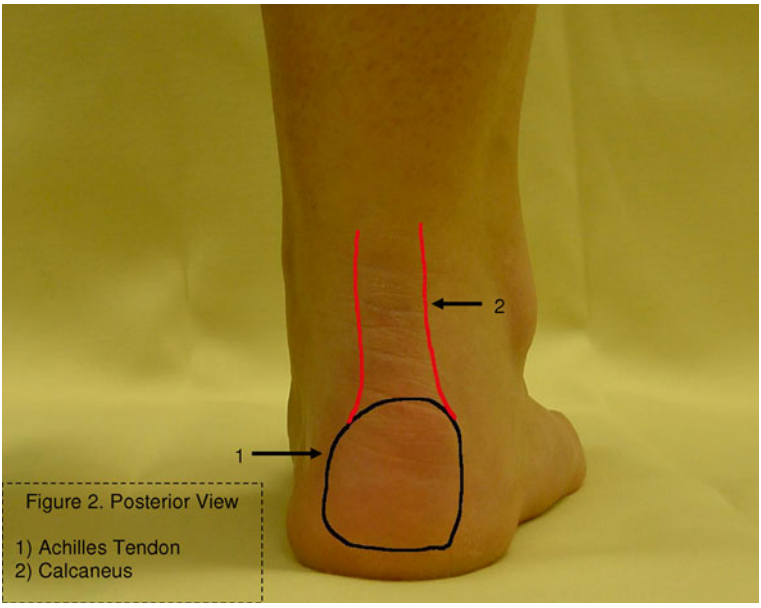

Fig. 10.2 Surface anatomy of the ankle – posterior view

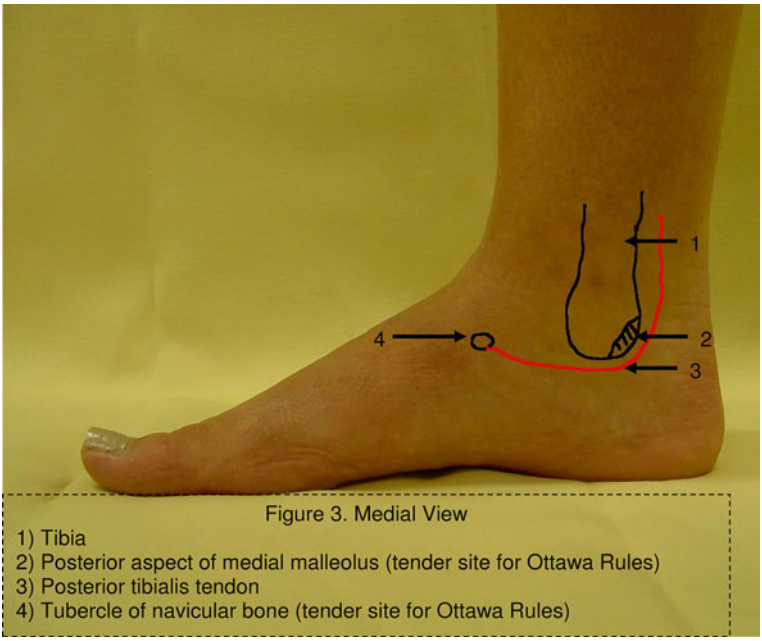

Fig. 10.3 Surface anatomy of the ankle – medial view

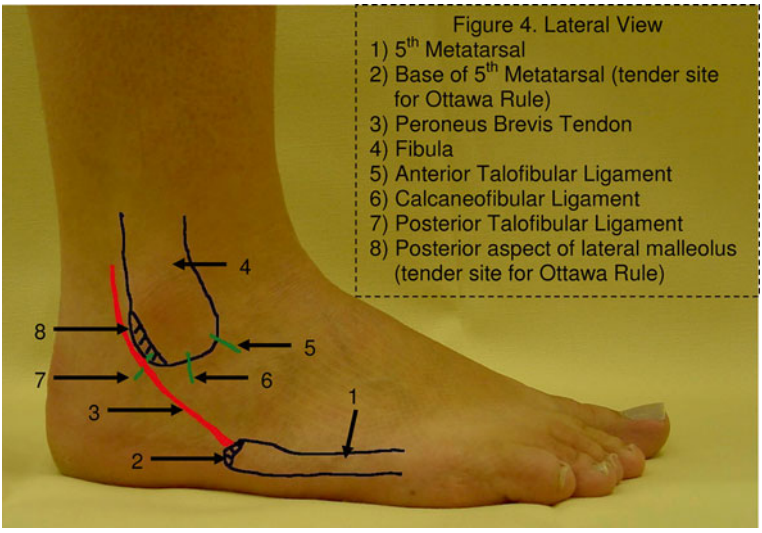

Fig. 10.4 Surface anatomy of the ankle – lateral view

Table 10.1 Ottawa Ankle Rules

For the patient presenting with *malleolar zone* pain:
The patient should be able to take four steps (two loading and two unloading gait cycles)
Palpate the posterior edge of the medial and lateral malleoli for tenderness
Failure of either of these rules mandates a complete *ankle* series of radiographs
For the patient presenting with *midfoot zone* pain:
The patient should be able to take four steps as described above
Palpate the base of the fifth metatarsal and navicular bone for tenderness
Failure of either of these rules mandates a *foot* series of radiographs

whether an ankle and/or foot x-ray is needed, have not been validated for children or the elderly. Therefore, all prepubescent and elderly patients with ankle injuries should have an x-ray.

2. *A red or hot joint*. In the presence of a red or hot joint, the clinician should consider the possibility of infection, neuroarthropathy (Charcot arthropathy), or inflammatory disease.
3. *Atypical pain*. Pain that occurs at rest, pain that wakes the patient out of sleep at night, and bilateral ankle pain are atypical presentations of pain. These symptoms are concerning and may represent a more serious condition, such as a stress fracture, neuropathy, or radicular symptoms from an intervertebral disc herniation. Any patient with pain out of proportion to the clinical findings should be monitored closely or referred for further evaluation.

General Approach to Patient

History is the most important part of evaluating any musculoskeletal condition. The history portion of the exam should include the patient's age, medical history, medication list, and mechanism of injury. It is also important to note location and intensity of pain and if the patient can bear weight.

Evaluation of the ankle begins with inspection. Take note of alignment with the patient in a weight-bearing position. Look for areas of swelling and/or ecchymosis after recent injury. A brief neurovascular examination must be performed on all patients, which includes sensation and palpation of the dorsalis pedis and posterior tibialis pulses. Assessment of the lumbosacral spine may need to be performed as well to rule out a secondary cause to the symptoms or a proximal nerve involvement (see Lumbar Spine chapter). Palpation of the major bony and soft tissue areas will assist the clinician in narrowing down the possible etiologies of pain (see anatomy pictures). Special tests can be performed to determine the status of the soft tissue. To evaluate the ligaments, the anterior drawer test and tibia/fibula squeeze test can be performed. To evaluate the status of the Achilles tendon, the Thompson squeeze test can be performed. Lack of foot plantar flexion with calf compression constitutes a positive Thompson test which is highly correlated with Achilles ruptures.

The Ottawa Ankle Rules are a guideline to determine whether or not a patient with an ankle injury needs further radiographic imaging. When used correctly, these rules have a sensitivity of 98 % for fracture (Bachman). It is important to note that these rules do not apply to the prepubescent and elderly patient (see "RED FLAGS").

Lateral Ankle

The lateral ankle sprain is the most common cause of lateral ankle pain seen in the primary care setting. This injury typically occurs when the foot is plantar flexed and vulnerable to inversion. This will cause damage to the lateral ligament complex of the ankle. The anterior talofibular ligament is most commonly injured. In more severe injuries, the calcaneofibular ligament, which is the strongest of the lateral ligaments, may be injured. Patients with lateral ankle sprains may present to the office in an acute condition, or they may present one to two weeks after the injury if they continue to have problems. They will often have significant swelling and ecchymosis and tenderness to palpation over the involved ligaments and soft tissues.

The Ottawa Ankle Rules, as described above, should be applied to those patients with a lateral ankle sprain for the purposes of decision making regarding the need for an x-ray. However, if there is substantial concern, radiographs are appropriate. The individual ligaments can then be assessed by a few physical examination techniques, but this can be difficult in the acute setting because of patient guarding.

The ATF can be evaluated by using the *anterior drawer sign* with the knee at 90° of flexion and the foot in neutral position. The examiner will pull anteriorly on the heel to evaluate for a solid endpoint. Comparison with the non-injured ankle can be very helpful in determining the extent of injury. The CFL crosses both the ankle and subtalar joints. To test its integrity, the *talar tilt* test has been commonly recommended, but in the setting of an acutely injured ankle, this can be difficult to perform. Another method of assessing the CFL is to perform the anterior drawer sign with the foot in a slightly plantar-flexed position. The posterior talofibular ligament (PTF) is difficult to isolate on examination. Usually, when the PTF is injured, other injuries are present with the most common being fracture of the distal fibula.

A high ankle sprain involves the syndesmosis ligaments between the tibia and fibula and is important to distinguish from a lateral ankle sprain. Syndesmosis injuries are more likely to require surgical stabilization in the acute setting. This injury typically occurs with an external rotation mechanism. History of the injury is very important in determining mechanism and should raise suspicion of syndesmosis injury. The ligaments can be injured alone or in combination with a fracture of the ankle. Tenderness over the anterior ankle mortise and/or pain with *tibia/fibula squeeze test* can indicate an injury to this area. Pain can also be reproduced with passive dorsiflexion and eversion of the foot which stresses the mortise. Pain will usually be more severe than with a typical ankle sprain. Radiographs of the ankle and tibia should be obtained. A syndesmosis injury with a proximal fibula fracture is termed a Maisonneuve injury and is, by definition, unstable.

Most ankle sprains are self-limiting, but decreased morbidity can be obtained by using the PRICE protocol (protect, rest, ice compression, elevation of extremity). Weight bearing as tolerated, with the aid of crutches, may be recommended. A walking boot or cast will help with pain and ambulation in more severe injuries, but prolonged use should be avoided. Application of ice to the area for 20 min per session should be done four times daily during the acute phase. Compression can be obtained several ways such as ACE wrap or compression stocking. Functional bracing becomes important as the patient moves out of the acute phase and increases activity. This can be obtained with a lace up or hinged ankle brace.

Physical therapy, through home exercises or formal setting, and protection of the ankle joint with bracing are needed to prevent the acute injury from becoming recurrent or chronic. Generally 6 weeks is needed to allow the collagen fibers and scar tissue to become strong and resist stresses. Patient's whose pain persists over 90 days should be referred or evaluated with further imaging. If the examiner is comfortable ordering and interpreting it, an MRI of the ankle can be performed. When ordering an MRI, the clinician has the responsibility of sorting out positive findings that may or may not be of any clinical relevance to the patient. For this reason, many primary care clinicians choose to refer these patient's to an appropriate specialist rather than order an MRI themselves.

A patient may present with a history or complaint of a "weak ankle." They may feel the ankle gives out easily or reinjures repeatedly when walking on uneven ground, stepping off of a curb, or playing sports. If the patient does not rehabilitate completely after an initial injury, this increases the patient's risk of chronic ankle problems. This can also indicate a more serious underlying problem and needs to be investigated. Formal physical therapy can be considered with these patients, but a referral to a specialist can also be made at this time.

Peroneal tendon injuries are commonly associated with lateral ankle sprains. The peroneal tendons pass posterior to the lateral malleolus and attach at the foot. The tendons work as lateral ankle stabilizers and will also evert the foot (see Foot chapter). When the foot is plantar flexed slightly, generally less than 15°, the tendons are most vulnerable. As the foot is plantar flexed further, the tendons are locked in posteriorly to the lateral malleolus and are less likely to be injured. Dislocation of the tendon can occur but is more common in athletes. The athlete will complain of a popping or snapping sensation laterally when they walk or run and may be painful. Conservative treatment with casting followed by physical therapy can be attempted in cases of acute peroneal instability; however, with chronic instability of the peroneal, conservative treatment is rarely successful. In this instance referral to a specialist is more appropriate.

Tendinopathy of the peroneals can occur with prolonged or repetitive activities. Commonly affected are those who run on uneven grounds, soccer athletes with their quick side to side motions, and skaters who have poorly fitting skates. The patient will complain of pain laterally, pain with walking or activity which improves with rest, and swelling can be variable. Pain will be reproduced with active and resisted eversion and dorsiflexion of the ankle joint. Conservative treatment is recommended initially with use of ice, taping or bracing of the ankle, lateral heel wedge, and eversion strengthening. If the problem persists and becomes chronic, patients may start to experience popping or snapping and may need referral to a specialist.

Medial Ankle

The tibialis tendons are the most common medial ankle structure that can be injured. *The anterior tibialis tendon* is visualized on the anterior aspect of the ankle with dorsiflexion and inversion of the foot. This tendon can be injured with new athletic activities such as hill running or cycling. The patient may have tenderness at the insertion of the tendon on the medial cuneiform and medial aspect of the base of first metatarsal. The examiner may also note swelling along the course of the tendon. Pain will be reproduced with resisted dorsiflexion and inversion of the ankle. The patient will usually respond to conservative treatment with anti-inflammatories and the use of ice. Eccentric strengthening and stretching is also helpful.

The posterior tibialis tendon runs posterior to the medial malleolus and will insert on the navicular bone. The tendon provides stability of the ankle on the medial aspect but also is integral to the structure of the foot and arch (see Foot chapter). This structure can be injured acutely with a twisting type of injury such as stepping off of a curb or can present as a tendinopathy with gradually worsening medial ankle pain over several weeks. Dysfunction of the posterior tibialis tendon is a leading cause of adult-acquired flatfoot deformity. Swelling and tenderness will be present over the structure (see anatomy). Because this tendon affects the foot as well, evaluation should also include the arch and midfoot and testing with heel raises along with checking for "too many toes sign" (see Foot chapter). If left untreated, the patient can later develop lateral ankle pain due to impingement as the foot goes into valgus position "falling arch." This can be observed when the patient raises onto their toes, and from behind the examiner will note an inward or varus position of the heel.

Treatment with modified activity, ice, anti-inflammatories, and supportive shoe inserts or orthotics for the arch and heel are recommended initially. If symptoms are not improving quickly, the provider should consider referral.

Posterior Ankle

Achilles tendinopathy is a common cause of posterior ankle pain. This problem can affect patients from competitive-level activities to the sedentary. Foot mechanics, poor foot ware, decreased flexibility of the calf muscles, trauma, and exercise on uneven ground increase the risk of developing this problem. The provider may also note swelling of the tendon and crepitus with active motion. Tendinopathy may cause insertional pain located at the calcaneal insertion of the Achilles or can cause non-insertional pain and nodularity several centimeters proximal to the tendon insertion. Conservative treatment initially is recommended which includes activity modification, ice, and heel lifts. Anti-inflammatory medications may provide some relief of symptoms. Stretching exercises that concentrate on eccentric loading are also recommended for treatment.

Rupture of the Achilles tendon can occur. A patient may describe feeling or hearing a pop or a sudden feeling of being kicked in the back of the ankle at the time of the injury. A pitfall for some providers is the patient may still be able to ambulate into the office with a partial tear of the Achilles and can be missed if not evaluated thoroughly. The Thompson test or calf squeeze test is used to evaluate for an Achilles tendon rupture. The patient lies on their stomach on the exam table, lower leg is partially off the end, and the provider squeezes at the mid-calf and should note plantar flexion of the foot. Comparison to the non-injured side will be useful. This test can miss partial tears so it is also important for the provider to palpate along the tendon into the mid-calf for a possible defect. Musculoskeletal ultrasound, if available, is a good tool to identify partial tears. Full tendon ruptures require immediate referral to an orthopedic surgeon for possible repair.

Other causes of posterior ankle pain can range from benign to more serious conditions. Bilateral ankle pain at the insertion of the Achilles tendon can be due to more serious conditions such as a seronegative arthritis, rheumatoid arthritis, or a postinfectious syndrome such as Reiter's syndrome. These patients will describe pain that is more severe first thing in the morning and generally improves through the day. History of patient's symptoms may reveal urinary or inflammatory bowel symptoms. Laboratory testing will generally begin with CBC, CMP, sedimentation rate or CRP, ANA, and rheumatoid factor.

Atypical pain such as pain at rest or pain at night (see red flags) should raise the examiner's suspicion of a more serious cause of posterior ankle pain such as a stress fracture of the calcaneus, neuropathy, or peripheral nerve entrapment. These conditions will require more workup, treatment, and possibly referral. Other causes of posterior ankle pain are described in Table 10.2.

Please refer to Fig. 10.5 for the ankle meaningful use form.

Table 10.2 Other causes of posterior ankle or foot pain

Condition	Location of pain/findings	Typical presentation
Sever's disease (benign)	Tender over calcaneus or insertion of plantar fascia	Prepubescent with heel pain upon awakening or with weight bearing
Haglund's deformity (benign)	"Pump bump" bony prominence at base of Achilles tendon	Middle-aged woman who wears high heels
Peripheral neuropathy (serious)	"Stocking" numbness	Patient's with conditions producing neuropathy (DM, hypothyroidism, alcohol abuse)
Calcaneus stress fracture (serious)	Pain on lateral aspect of calcaneus	History of jump from height, over training, metabolic diseases
Posterior tibialis nerve entrapment (serious)	Tinel's sign (posterior to medial malleolus)	Heel pain at rest, radiates to great toe
Seronegative arthritis (serious)	Tender at insertion of Achilles tendon	Bilateral heel pain, consider Reiter's syndrome

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset: _____
Mechanism of Injury: _____
Relieving Factors: _____
Exacerbating Factors: _____

PMH: Chronic Medical Conditions: _____

_____

Occupation/Sport /Position: _____

Red Flags:
1. Very young
2. Geriatric
3. Hot joint
4. Atypical pain

Q1. Are there red flags?

Q2. Ottawa Rules
a) 2 gait cycles: can't walk (Need radiographs)
b) Tender base 5th metatarsal or navicular (Foot x-ray)
c) Tender posterior aspect of medial or lateral malleoli (Ankle x-ray)

Q3. How to treat?

a) High grade sprain
- Cotton Test
- Mechanism of Injury

Treat
- PRICE
- Crutches
- Sugar Tong Splint

b) Fracture
- Consult if unstable or mortise

Otherwise, treat
- PRICE
- Crutches
- Sugar Tong Splint

c) Sprain
- PRICE
- Compression Sleeve
- Lace up Brace
- Ace-wrap
- Ambulate with PRICE

Common and Don't Miss Conditions:
- Fracture
- High Grade Sprain
- Subluxation of Peroneal Tendons
- Neuropathy
  - Diabetes
  - Anemia
  - Chronic Alcoholism
- Achilles Tendon Rupture

Fig. 10.5 The ankle meaningful use form

TREAT APPROPRIATELY	Ankle/Foot Pain ..... 719.47 Achilles tendonitis ..... 726.71 Ankle Sprain ..... 845.00 Tendonitis 726.79
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Unable to bear weight with negative X-ray findings Cellulitis of Foot/Ankle
CALL CONSULTANT THAT DAY	Uncertain X-ray findings Fracture Diagnosis uncertain/perplexing
CONSULT OR REFER	Septic joint Nerve entrapment Fractures, if not comfortable treating Torn Achilles Vascular disease needing surgical treatment

Plan:
- ☐ Xray / Imaging What: _____
- ☐ Laboratory Eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 10.5 (continued)

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Chapter 11
The Foot

E. Nambi Ramamoorthy and Brian Kleiber

Functional Anatomy

Anatomy

Anatomically, the foot can be divided into forefoot, midfoot, and hindfoot (Fig. 11.1). The forefoot is distal to the tarsometatarsal joints, the midfoot is distal to the transverse tarsal joint excluding the forefoot, and the hindfoot is the talus and calcaneus. There are static and dynamic components that maintain the foot shape in both the longitudinal and transverse planes. Static stabilizers include the plantar fascia, joint capsules, and interosseous ligaments. The posterior tibial tendon is a dynamic stabilizer of the longitudinal arch and it serves to invert the hindfoot to make it a more rigid structure for toe off during gait.

Red Flags

1. *Inflammatory Arthritis*. About 90 % of people with rheumatoid arthritis eventually develop symptoms related to the foot or ankle. Symptoms may occur in any segment of the foot. Other inflammatory types of arthritis that affect the foot and ankle include gout, ankylosing spondylitis, psoriatic arthritis, and Reiter's syndrome.

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J.M. Daniels (ed.), *Common Musculoskeletal Problems: A Handbook*,
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Fig. 11.1 Foot – plantar aspect

Symptoms can be vague with these problems and include warmth, swelling, and pain in the joints. Rheumatoid arthritis has a hallmark symptom of stiffness in the morning that usually improves after a few hours.

2. *Neuropathy*. Most common cause is diabetic related but many etiologies have been described. An insensate foot can be prone to neurotrophic ulcers, foreign bodies, infections, etc. Charcot neuroarthropathy is a potentially severe destruction of the bony anatomy. In the acute phase, it presents similar to infection with erythema, swelling, warmth, and pain. As opposed to infection, the erythema

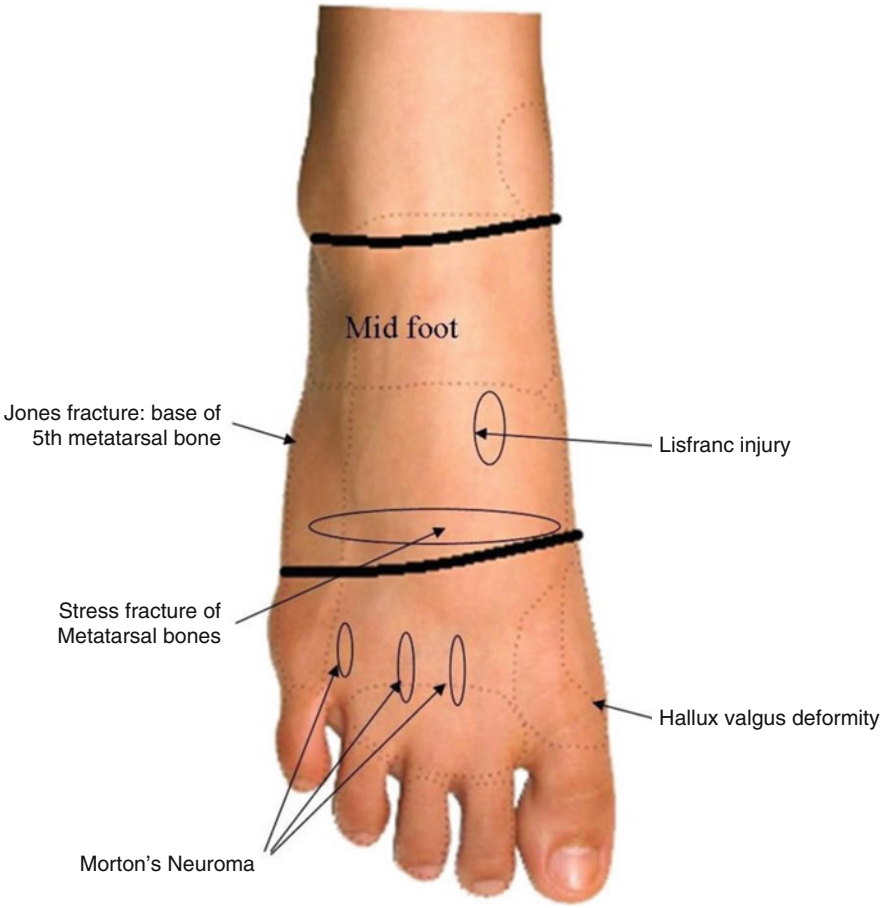

Fig. 11.2 Foot – dorsal aspect

associated with Charcot arthropathy will typically resolve with elevation. Suspicion of Charcot arthropathy should trigger specialist referral.

3. *Trauma*. Pain in the midfoot after trauma can indicate a Lisfranc injury. This is a serious problem that occurs at the midfoot tarsometatarsal joint (Fig. 11.2). A sprain of this joint occurs as a result of a low energy type of injury like rolling over of the foot or dropping objects on the foot. A fracture dislocation of this joint occurs as a result of a high energy type of injury like a car accident or fall from a high position. Symptoms can include pain over the Lisfranc joint complex (Fig 11.1), bruising over the bottom of the foot (plantar ecchymosis sign), inability to bear weight, and pain with stress exam. Weight-bearing AP X-ray of bilateral feet might show instability of the midfoot and will allow detection of subtle asymmetry. This is a commonly missed injury, but when identified, it needs orthopedic referral.

Talus and calcaneal fractures are serious injuries that require orthopedic referral. Talus fractures are higher-energy injuries, whereas calcaneal fractures usually occur after fall from height.

Exam

Evaluation of the foot should always involve examination of the ankle joint as described in the previous chapter. Foot examination can be divided into forefoot, midfoot, and hindfoot exams. Observe the foot in weight-bearing position, walking, and on heel rise. Inspect and palpate for hindfoot and forefoot alignment, arch height, deformities of the toes or foot, callus formation, tenderness, and changes in neurological examination both sensory and motor. If any deformity is observed, it is useful to see if it is passively correctable with the patient in a seated position. Inspection of the shoe inside and out along with the sole for abnormal wear can also be helpful.

Forefoot

Metatarsalgia (Forefoot Pain)

Claw toes and hammer toes are the common causes of metatarsalgia due to subluxation of the MCP joints of the toes, and the metatarsal heads become prominent on the sole causing the callosities and tender spots. Treating the causes will help treat metatarsalgia. Patients with a cavus (high-arched) foot commonly have metatarsalgia because of increased pressure over the metatarsal-phalangeal joint (MPJ). Equinus contracture also contributes to forefoot overload. Metatarsalgia is common in elderly patients due to loss of the plantar fat pad with aging. Offloading with orthotics or metatarsal pads should be the first-line treatment.

Hammer Toe and Claw Toe

Typically these develop due to flexor/extensor imbalance. This imbalance leads to flexion at the proximal interphalangeal joint and extension at the metatarsal phalangeal joint, creating the clawing effect. It usually affects the lesser 4 toes. These deformities may be flexible or fixed. Conservative treatment while the deformity is still correctable passively can be effective. Treatment options include wearing shoes with wide toe box, padding the dorsal aspect of the toes involved, taping, and over-the-counter orthotics. Resistant and rigid deformities of claw or hammer toes which are symptomatic may need surgical correction.

Hallux Valgus (Bunion) Deformity

Valgus deformities of the first metatarsal phalangeal joint with prominent bump (medial eminence) on the medial forefoot. Hallux valgus may have a genetic predisposition, so they "usually run in the family." Women are affected more than men; this can often be related to shoewear choices. The degree of the deformity does not always correlate well with the severity of the symptoms. It is important to obtain full weight-bearing X-rays in order to adequately assess the alignment in the hallux valgus deformity. This will help in determining the treatment options. Most bunions are treatable without surgery. Properly fitting comfortable shoes with a wide nonconstrictive toe box is important in all cases. Medial bunion pads may also be helpful in decreasing the symptoms associated with the bunion, and a toe spacer placed between the great toe and the second toe can help reduce the bunion deformity. Surgery is indicated when pain and discomfort are not getting better with conservative management and not for cosmetic reasons. Always treat according to the severity of patient's symptoms.

A deformity similar to a bunion on the lateral forefoot is called a bunionette (tailor's bunion). This can lead to a hard corn and occasionally painful bursitis. This is largely caused by poorly fitting tight shoes. Bunionette deformities can be treated conservatively with a change in shoes to those with a large toe box. This allows plenty of toe space decreasing constriction and relieving symptoms. In the rare case of persistent pain, surgical correction may be necessary.

Morton's Neuroma

Morton's neuroma is a thickening of the tissue that surrounds the digital nerve leading to the toes. Morton's neuroma most frequently develops between the third and fourth toes, usually in response to irritation, trauma, or excessive pressure between the metatarsal heads. The incidence of Morton's neuroma is eight to 10 times greater in women than in men. The common symptoms include the feeling of "walking on a marble" or burning pain in the ball of the foot that may radiate into the toes. The patient can also experience tingling or numbness in the toes. High-heeled and tight narrow shoes aggravate this condition. Treatment can include offloading, NSAIDs, and occasional steroid injections. Neuroma resistant to conservative treatment may be surgically excised.

Stress Fracture

A stress fracture develops due to repeated stress reaction applied to the weight-bearing bones of the feet, generally the metatarsals and calcaneus. These fractures are often a result of overuse and can be seen in those with a sudden increase in

activity like long-distance runners or in jumping sports. The pain develops gradually, becoming more intense with physical activity. Pain can be relieved by rest but as the conditions worsens will persist during rest, and a person may complain of night pain. An individual will likely have tenderness localized to a specific area and may have swelling. The patient will rarely have bruising or discoloration in the area. These most commonly are treated conservatively. Modifying activity and boot immobilization to decrease stress on the area over a period of 6–8 weeks will generally lead to uneventful healing.

Stress fracture of the navicular bone is a more complicated injury. Symptoms primarily will be vague activity-related pain over the dorsal midfoot. When suspected the patient should be promptly given crutches and be non-weight bearing until a workup (MRI, radiographs) or orthopedic referral is completed.

Midfoot

Midfoot Arthritis

Common cause of midfoot pain in adult patients. Causes can include previous trauma, inflammatory arthritis, and osteoarthritis. On exam one may see swelling and tenderness to palpation of the dorsal midfoot. Radiographs will show joint space loss and occasionally collapse of the longitudinal arch. Conservative treatment can include rigid orthoses or shoes, NSAIDs, and selective image-guided injections. Arthrodesis (fusion) of the involved joints is the surgical option.

Tarsal Coalition

Tarsal coalition represents abnormal fusion between two or more tarsal bones of the foot. The two most common sites of tarsal coalition are talocalcaneal or calcaneonavicular joints; bridging can be either fibrous, cartilaginous, or osseous and commonly becomes symptomatic in the 2nd decade of life, corresponding to approaching skeletal maturity. Tarsal coalitions can be completely asymptomatic, but when symptoms do occur, they may include pain in the midfoot or hindfoot and loss of subtalar joint motion. Clinical examination may show a rigid flatfoot and pain in the sinus tarsi or hindfoot. Recurrent ankle sprains can occur due to lack of motion in the tarsal joints. Foot X-rays and/or CT scan are needed to make the diagnosis. Conservative treatment can include rest, immobilization, and NSAIDs. Surgical referral is indicated for those who fail conservative treatment.

Hindfoot

Adult-Acquired Flatfoot Deformity

Adult-acquired flatfoot deformity (AAFD) is a progressive flattening of the arch of the foot that occurs as the posterior tibialis tendon becomes insufficient. When the posterior tibialis tendon does not work properly, a number of changes can occur to the foot and ankle. Symptoms often start with pain and tenderness along the posterior tibialis tendon behind the medial malleolus. As the tendon progressively fails, deformity of the foot and ankle occurs. This may include progressive flattening of the arch, shifting of the heel laterally into valgus, rotation and deformity of the forefoot, and/or tightening of the Achilles tendon. At certain stages of this disorder, pain may shift from medial to lateral as subtalar or subfibular impingement occurs. In late stages it might lead to development of arthritis and deformity of the ankle joint.

Posterior tibialis tendon dysfunction may occur in patients who already have a flatfoot for other reasons. As the arch flattens with weight-bearing activities, more stress is placed on the posterior tibialis tendon, which results in progressive disorder. The peroneus muscle and tendons on the lateral aspect of the ankle act to counterbalance the action of the posterior tibialis tendon. When the posterior tibialis tendon fails, the counteracting muscles and tendons become a relatively unopposed deforming force. Table 11.1 describes the diagnosis and management of this condition.

Table 11.1 Adult-acquired flatfoot deformity

Signs and symptoms	Pain and swelling on the inside of the ankle Loss of the arch and the development of a flatfoot Gradually developing pain on the outer side of the ankle or foot Tenderness over the midfoot, especially when under stress during activity On asking patient to do a single limb heel rise, they may be unable or normal heel inversion does not occur
Risk factors	Obesity, diabetes, hypertension, previous surgery or trauma such as an ankle fracture, local steroid injections and rarely Inflammatory diseases such as Reiter's syndrome, rheumatoid arthritis, spondylosing arthropathy, and psoriasis
Conservative management	NSAIDs, rest and immobilization in case or CAM boot during acute painful period followed by orthotics (arch support), braces (lace up or hinged), and physical therapy
Surgical management	Considered only after completely exploring all aspects of conservative management Tenosynovectomy: debridement of inflamed tissue surrounding the tendon Osteotomy: calcaneal osteotomy to improve alignment of the heel Tendon transfer: the flexor digitorum longus is used to replace the function of the damaged posterior tibialis tendon Arthrodesis: fusion of the tarsal joints at late stage of the disease with severe arthritis

Pes Cavus

Pes cavus (high-arched foot) can be seen during the evaluation of other ankle or foot conditions. Typically there is marked elevation of the longitudinal arch, and the hindfoot will be in a varus position when viewed from behind. This position leads to stress on the lateral foot and hindfoot. It can be associated with ankle instability, peroneal tendinopathy, chronic lateral foot pain, and stress fractures (especially 5th metatarsal). Orthotics crafted with lateral hindfoot and midfoot posting can help with management. Surgical reconstruction is not uncommon in those that fail conservative management. Most cases are idiopathic, but pes cavus is a hallmark of Charcot-Marie-Tooth disease. Classic "champagne flute" appearance of the lower leg due to muscle wasting, neurological abnormality, or family history may indicate need for neurology referral for definitive diagnosis.

Plantar Fasciitis

The plantar fascia is a tough layer of connective tissue that supports the arch of the foot; it originates at the plantar calcaneus and extends to the base of the toes. Plantar fasciitis is caused by overloading of the fascia due to prolonged standing, walking, and occasionally a tight heel cord or calf muscle. These stressors cause overloading repetitive "microtraumas" to the fascia. Clinically, it usually presents as painful spot in the heel at the medial calcaneal tuberosity. Pain during weight bearing, especially with the first few steps in the morning or after sitting for a time, occurs. Management includes rest, NSAIDs, orthotics or heel pads, physical therapy, and even night splints. Cortisone or PRP injections can mitigate symptoms but should not be overutilized.

Mechanical Heel Pain

The heel pad is made up of elastic adipose tissue that can be injured or can degenerate gradually over time. Mechanical heel pain most often occurs after the age of 40 but can be injured any time with repeated stresses or trauma. Obesity and footwear with poor cushion can contribute to it as well. Pain is generally localized to a small area in the heel pad. Management includes use of ice (immersion of heel), NSAIDs, heel cup or cushion, and avoiding walking barefoot at all times.

Please refer to Fig. 11.3 for the Foot Meaningful Use form.

CC: ☐ Right ☐ Left ☐ Both

HPI:
Onset : _____
Mechanism of Injury : _____
Relieving Factors : _____
Exacerbating Factors : _____

PMH: Chronic Medical Conditions: _____

Occupation/Sport /Position: _____

Red Flags:

1. Deep puncture wound; rule out foreign body
2. Ruptured Achilles tendon
3. Midfoot Pathology
   - Lis Franc
   - Navicular
   - Tendon rupture
4. Persistent symptoms (90 days) with no specific diagnosis
5. Systemic symptoms, neuropathy

Q1. Rear foot pathology?
a) Differential diagnosis for heel pain (See Figure 11.1)
b) Posterior impingement
c) Achilles tendinopathy
d) Reactive arthritis

Q2. Midfoot pathology?
See Red Flags

Q3. How to treat?
a) Splint
b) Boot
c) Radiographs

Common and Don't Miss Conditions:

- Red Flags
- Heel pain differential diagnosis
- Retained foreign body
- Neuropathy
- Morton's Neuroma
- Metatarsalgia
- Tendinopathy

Fig. 11.3 The Foot Meaningful Use form

TREAT APPROPRIATELY	Ankle/Foot Pain .....719.47 Achilles tendonitis.....726.71 Tendonitis .....726.79 Foot Sprain/Strain.....845.10
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Unable to bear weight with negative X-ray findings Cellulitis of Foot/Ankle
CALL CONSULTANT THAT DAY	Uncertain X-ray findings Fracture Cold/Avascular Foot Diagnosis uncertain/perplexing
CONSULT OR REFER	Septic joint Nerve entrapment Fractures, if not comfortable treating Torn Achilles Vascular disease needing surgical treatment

Plan:
- ☐ Xray / Imaging What: _____
- ☐ Laboratory Eval What: _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____

Fig. 11.3 (continued)

Suggested Readings

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Chapter 12
Pediatric Musculoskeletal Complaints

Quincy Scott and Keith Gabriel

Pediatric musculoskeletal concerns can be challenging for the clinician because of the age and communication ability of the patient. In addition, pediatric orthopedic conditions are of particular concern to parents and healthcare providers alike, as the presence of growth plates leads to concerns about lifelong consequences to poor healing. There are certainly many pediatric conditions which are best cared for by pediatric orthopedic specialists, but many other conditions can be safely managed in the primary care clinician's office. A reasonable general rule of thumb is to refer pediatric patients with musculoskeletal complaints that are potentially serious, difficult to diagnose, or involve joints or areas which are prone to poor healing or poor outcomes.

Red Flags

Suspected Abuse

Children with multiple injuries, reported mechanisms of injury that do not seem to make sense, or suspicious injuries should be closely evaluated and followed up. Skeletal surveys can be used to determine the presence of past injuries, and if suspicion is high, social agencies or child protection services should be involved.

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Refusal to Use a Joint/Refusal to Bear Weight

A child who completely refuses to use a joint should be suspected of having a serious condition, such as fracture or a septic joint, until proven otherwise. These patients need careful evaluation to rule out serious pathology.

Musculoskeletal Concerns in a Child with Poor Growth or Development

Patients with musculoskeletal complaints, who also have developmental concerns, are unusually small or large for age or who have systemic symptoms should be carefully evaluated for the presence of systemic disease and metabolic/endocrine problems.

This chapter deals with the most common pediatric musculoskeletal issues encountered in the primary care setting. Many excellent textbooks are available to cover a comprehensive review of pediatric musculoskeletal complaints. A list of suggested reading can be found at the end of this chapter.

Common Clinical Presentations

Slipped Capital Femoral Epiphysis

The "capital" femoral epiphysis refers to the growth plate of the femoral head. If the forces going through the hip are greater than the strength of the epiphysis, the femoral head can slip off the neck, and hence the name slipped capital femoral epiphysis (SCFE). There are two main reasons for a slip to occur: (1) increased load across the joint (usually because of increased body weight, but can also rarely be from repetitive heavy lifting) and (2) weakened epiphysis because of increased activity of the growth plates.

SCFE is reported to have a prevalence of 10.8 cases per 100,000 children and is the most common hip disorder in adolescents (ages 8–15 years of age, with the average range being 12 years for girls as compared to 13.5 years for boys) and most common in children of ages 9–15 who have a high BMI. The presenting complaint is pain and/or limp. Diagnosis is frequently delayed because the patient complains of knee pain rather than hip pain. The pain may be acute, chronic, or acute on chronic (rapid increase in pain after steady low level of pain). The patient might be able to walk in unassisted and walk with crutches or might not be able to walk at all.

Gait must be assessed. Early on, antalgic gait may be the only abnormality, but as the slip progresses, the foot will start to externally rotate. Hip examination should start with the patient sitting, with comparison of the way the legs hang. The hip in

Fig. 12.1 Child with SCFE. Note the increased external rotation of the hip when the leg is hanging

SCFE will usually be excessively externally rotated, which makes the foot appear inward compared to the knee. Range of motion (ROM) can be performed in both sitting and prone positions. Typically, internal rotation will be limited, and external rotation will be increased, although the inflammation of the hip joint (synovitis) can cause guarding and irritability with hip rotation in both directions. While comparing to the unaffected side can be helpful, SCFE can occur bilaterally, so any pain with ROM is significant, even if it is symmetric. As the femoral head slips further, the hip will have progressively more external rotation and lose internal rotation. Hip flexion is decreased and external rotation occurs during attempts to flex the hip. If the patient presents primarily with knee pain, it is important to assess both the hip and knee. Figures 12.1, 12.2, and 12.3 show the position and ROM anomalies seen with SCFE.

With suspected SCFE, immediate X-rays are necessary. An AP pelvis X-ray (visualizes both hips) and frog view should be obtained as long as the patient can walk (see Fig. 12.4). Those who cannot walk can have bilateral cross-table lateral

Fig. 12.2 Child with SCFE. Note the decreased internal rotation on testing of the left leg

Fig. 12.3 Child with SCFE. Note the increased external rotation of the left leg compared to the right

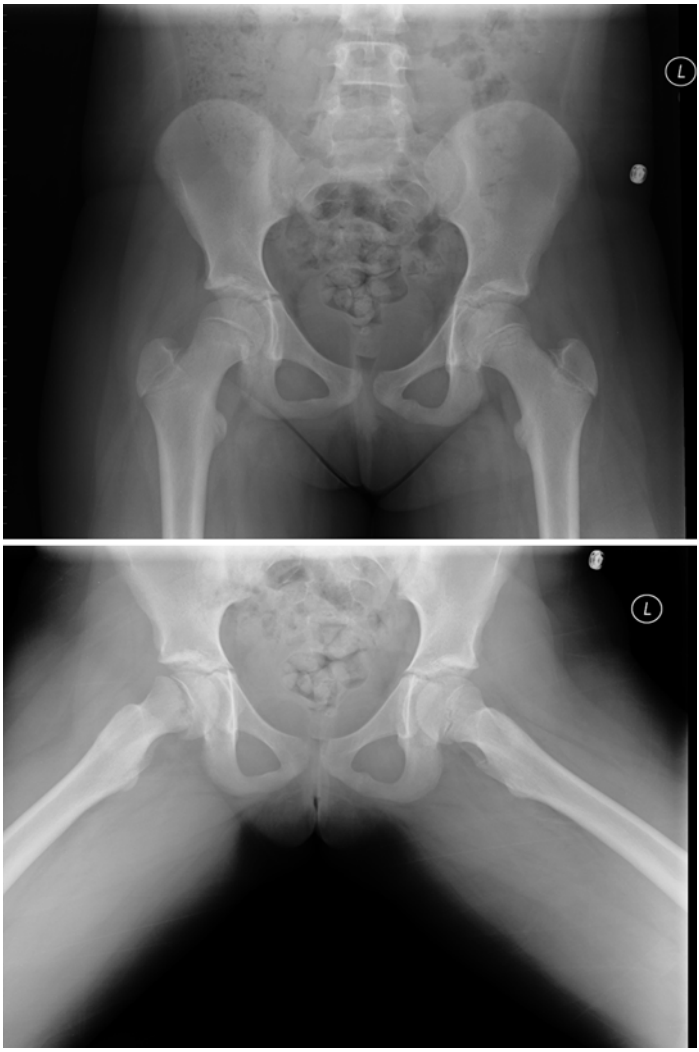


Fig. 12.4 X-ray findings in SCFE. Note that the SCFE is not obvious in AP view; lateral or frog-leg view is required to see the anomaly

views instead. X-rays should be read immediately, and if SCFE is diagnosed or suspected, the patient should be made non-weight bearing and an immediate consultation with an orthopedic surgeon should be made. Surgery is usually performed within 24 h. For cases with equivocal X-ray results, phone consultation with the orthopedist is recommended as it is possible to catch the disorder in the "pre-slip" phase. With surgical intervention, outcomes are excellent. Delayed treatment can lead to hip deformity or avascular necrosis of the femoral head, necessitating multiple surgeries and early arthroplasty.

Bowlegs and Knock-Knees

Bowlegs (genu varum) and knock-knees (genu valgum) are common reasons for parents to request evaluation of their children. The vast majority of these children do not require any intervention, as their condition simply represents normal childhood growth and development. Babies are generally born with mild bowing of the tibia that becomes more noticeable when they begin walking and then usually resolves around 2 years of age. The legs then begin to have a knock-knee appearance, which usually peaks around age 3–4 and resolves by age 6–8.

Genu Varum (Bowlegs)

In toddlers 2 years of age and younger with normal height and weight, and who have no red flags, the bowing is likely physiologic and should resolve spontaneously. If red flag conditions are present (Table 12.1), referral to a pediatric orthopedist should be made. Conditions such as rickets, skeletal dysplasia, Blount's disease, and others must be considered.

Genu Valgum (Knock-Knees)

Children aged 2–6 who are of normal height and weight, who are otherwise healthy, and who have no red flags most likely have physiologic knock-knees, which should resolve spontaneously. If red flags are present (Table 12.2), referral to a pediatric orthopedist should be made.

Table 12.1 Red flags for bowlegs

Age >2 years
Decreased calcium and vitamin D intake (dietary) or lack of sun exposure
Family history of short stature, adult bowlegs, severe kidney disease, or neurofibromatosis
Child with short stature, underweight, or significant overweight
Severe tibia deformity (look for dimple on the apex of the bow) and/or small, deformed foot
Unilateral deformity or significant asymmetry
"Thrust" during gait (knee looks like it's buckling)

Table 12.2 Red flags for knock-knees

Age >6 years
Past history of or symptoms of endocrine, renal, or metabolic disorders
Family history of skeletal dysplasia
History of lower extremity fracture
Severe deformity
Unilateral deformity or significant asymmetry, child with short stature or underweight

Imaging to evaluate alignment should be done using full-length X-rays that include hips to ankles on a single view. Laboratory testing includes calcium, phosphorus, and 1,25-OH vitamin D levels if rickets are suspected and BUN and creatinine if renal disease is suspected or if knock-knees are present in an older child.

In most cases, reassurance and parental education are the only treatment needed, as most of these children have physiologic angulation. Those with endocrinologic, renal, or metabolic disorders require treatment of their underlying conditions. Children with bowlegs who require orthopedic management are sometimes managed with braces; bracing is generally not helpful for knock-knees. In both conditions, surgery can be performed to help "guide" growth while the growth plates are still open, but if the deformity is severe, or if skeletal maturity has been reached, osteotomy is used to manually realign the bones. Untreated deformity can lead to early arthritis.

Intoeing

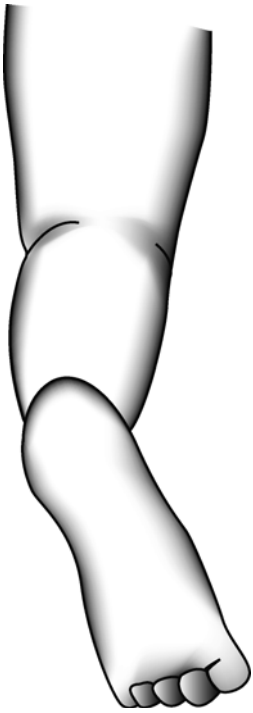
Intoeing is another common concern for which parents bring children in for evaluation. While many times, intoeing is physiologic and will resolve spontaneously, evaluation must be performed to determine if the cause is rotational deformity at the hip (femoral anteversion), tibia (internal tibial torsion), or the foot (metatarsus adductus). Based on expert consensus (Strength of Recommendation, SOR) level C, with the tools of taking a complete history and physical with a torsional profile, intoeing should be able to be correctly diagnosed. No standard guideline has been reported.

Femoral Anteversion

If the hips are rotated inward, the patellae will point toward each other when the patient stands and walks. This is usually due to increased femoral anteversion, which is common in young children and generally improves throughout childhood. Parents will complain that the child trips often, especially around age 2–4; this also improves with time. On examination, the child will have demonstrable increased internal rotation of the hips compared to external rotation (see Fig. 12.5). Unless the deformity is severe or the child is older than 8 years, referral is not warranted. Braces and special shoes do not help this condition, and even in older children, if the anteversion is asymptomatic, surgery is usually not indicated. Occasionally, children will complain of pain in the hip, knee, ankle, or foot, which is generally managed with symptom control, physical therapy, or orthotics. Surgery is only performed as a last resort. According to Staheli, LT, surgery may be needed if the child is older than eight years old, there is a severe deformity with disability, the anteversion is greater than 50°, the deformity is greater than three standard deviations, and the risks of the surgery are understood by the family.

Fig. 12.5 Femoral anteversion

Fig. 12.6 Internal tibial torsion



Tibial Torsion (Most Common Cause of Intoeing)

This is the most common cause of intoeing; it equally affects males and females and is usually not symmetrical by affecting the left side more than the right. If the hips are aligned normally with the patellae facing forward, but the feet are turned inward despite normal foot exam, the cause is likely internal tibial torsion. With the patient prone and the knees flexed, the foot will be turned inward relative to the thigh (see Fig. 12.6). Tibial torsion is sometimes associated with some bowing of the tibia as

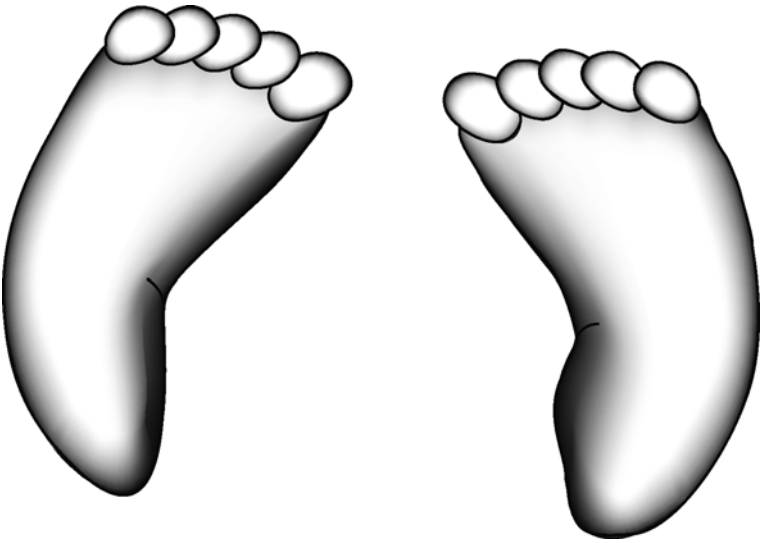


Fig. 12.7 Metatarsus adductus

well. If no bowing is present, this condition usually spontaneously improves with age; if it does not resolved by age 6, referral should be made. If there is significant bowing present, referral at or after the age of 2 should be made. Tibial torsion is not correctable with shoes or braces; surgery is performed only as a last resort.

Metatarsus Adductus

This condition is known to be the most common congenital foot deformity, occurring in one out of 1,000 births. In this condition, the legs are aligned properly, but the foot itself is shaped like a kidney bean when viewed from the bottom (see Fig. 12.7). This is commonly seen in infancy, and if the deformity is flexible (the forefoot can be realigned with only mild pressure), it usually does not require any treatment. With a flexible adductus, correcting stretching exercises performed by parents are helpful, and referral can be delayed unless it persists beyond 3 months of age; some advocate continued stretching exercises for up to 6 months before referral. Those with a rigid deformity should be referred as soon as the condition is identified. Those who require treatment may be treated with casting, orthotic shoes, or surgery.

Back Pain in Children and Adolescents

Back pain in a pediatric patient that lasts over a day or two should be viewed as a red flag. A high index of suspicion for pathology should be suspected when children and adolescents present with a compliant of low back pain. The differential

diagnosis should include muscle strain, disk disease, spondylolysis, scoliosis, and Scheuermann's kyphosis as well as sickle cell disease, tumor, and infection. A number of patients with malignancy present with back or lower extremity pain. These patients should be examined for hyperreflexia, tufts of hair or dimples between buttocks, or any neurological weakness. These patients should be evaluated with CBC, BMP, CRP, UA, and AP and lateral radiographs of the LS spine. Multiple lumbar X-ray views are considered an expert consensus (Strength of Recommendation, SOR) level C. These patients should be closely followed until a definite diagnosis is found, or they should be referred.

Adolescents with back pain often develop spondylolysis and present with pain on back extension. If these patients have any red flags described in the LS chapter, proper workup should be done. If pain persists, AP and lateral X-ray views should be done. Oblique views in these patients are NOT recommended. A SPECT-CT scan or referral should be considered in this group of patients. Unlike in adult patients, an MRI may not be the best first investigation in adolescents with back pain.

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Chapter 13
The Acutely Swollen/Painful Joint

Sharon Smaga and J. Kevin Dorsey

This chapter focuses on the evaluation of the adult patient with an acutely swollen, painful joint. A major concern with these patients is the possibility of infection of the joint space itself, which, untreated, can lead to permanent joint damage. Thus, the goal in the evaluation of these patients is to determine the etiology as quickly as possible.

Red Flags

The most serious cause of an acutely swollen and painful joint is a bacterial infection (septic arthritis). In addition, there are other red flag considerations:

1. *Trauma*. Rapid onset of an effusion after trauma may indicate hemarthrosis, which may be due to fracture or internal joint derangement, such as cartilage or ligament damage. These patients should all have radiographs performed.
2. *Multijoint involvement*. These patients are likely to have systemic conditions and should be evaluated appropriately.
3. *Immunocompromise*. Those patients who are immunosuppressed by disease or medications are at increased risk for joint infections and are also more likely to have fewer findings on diagnostic testing, such as blood tests and synovial fluid analysis [1]. Extra care should be taken to rule out infection in these patients.

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Approach to the Patient with an Acutely Swollen, Painful Joint

The first challenge in evaluating the patient with an acutely swollen, painful joint is to establish whether the problem is intra-articular or extra-articular. Disorders of extra-articular structures, such as bursae, tendons, extra-articular ligaments, and overlying skin, can present with swelling, erythema, and pain. These conditions are potentially less serious than intra-articular swelling and pain, which are regarded as infectious until proven otherwise.

Historical considerations include overall health status of the patient, chronic medical conditions, medications, alcohol use, recent joint surgery, and any history of trauma (particularly if it immediately preceded the onset of the complaint). In the absence of trauma, very abrupt onset (becoming severe within hours) is more characteristic of crystal deposition arthritis and septic arthritis than other inflammatory conditions [1].

Having the patient point to the precise location of the pain may help locate the source, as he or she may point directly to a tendon or bursa. The pain associated with joint pathology, on the other hand, is often more difficult for the patient to localize. Range of motion (ROM) evaluation is helpful; patients with extra-articular pathology will often have more pain with active or resisted ROM than with passive ROM, whereas those with intra-articular pathology will have pain with both active and passive ROM [1].

Joint aspiration is required in most patients with an acutely swollen, painful joint, especially if septic arthritis is suspected [1, 2]. The synovial fluid should be sent for WBC count with differential, Gram stain, and culture, as well as for evaluation for crystals. Aspiration can be quite difficult at times depending on the joint involved, and consultation may be necessary depending on the clinician's level of comfort and experience. Hemarthrosis may lead one to suspect trauma. Superimposed cellulitis is a relative contraindication to aspiration. Warfarin therapy is not a contraindication. Removal of as much synovial fluid as possible offers symptomatic relief. The details of aspiration of various joints are described elsewhere. With certain joints, particularly the hip, an effusion may be neither visible nor palpable. Blind aspiration should not be attempted; radiographically confirmed effusions can be drained with the aid of interventional radiology techniques. Table 13.1 lists synovial fluid findings in various conditions [3].

Common Clinical Presentations

Infection (Septic Arthritis)

Joint infection, also called septic arthritis, is relatively common in patients with swollen, painful joints and must be a priority consideration. Almost any infectious agent can cause septic arthritis, including fungi and viruses, but the vast majority are

Table 13.1 Synovial fluid findings in various conditions

Measure	Normal	Noninflammatory	Inflammatory	Septic	Hemorrhagic
Clarity	Transparent	Transparent	Translucent-opaque	Opaque	Bloody
Color	Clear	Yellow	Yellow to opalescent	Yellow to green	Red
Viscosity	High	High	Low	Variable	Variable
WBC/mm^3	<200	0–1,000	1,000–100,000	15,000 ≥ 100,000	200–2,000
PMNs, %	<25	<25	≥50	≥75	50–75
Culture	Negative	Negative	Negative	Often positive	Negative
Total protein g/dL	1–2	1–3	3–5	3–5	4–6
Glucose mg/dL	Nearly equal to blood	Nearly equal to blood	>25, lower than blood	<25, much lower than blood	Nearly equal to blood

Adapted from Ref. [3], UpToDate

caused by bacteria. Bacterial infections are generally referred to as gonococcal or nongonococcal, since *Neisseria gonorrhoeae* is a causative agent among young sexually active adults. Staph. and Strep. species are the most common gram-positive agents and cause up to 90 % of septic arthritis cases [4]. Gram-negative organisms are more common in older patients and in the immunocompromised.

Several risk factors for septic arthritis have been identified in recent studies. Those with the highest positive likelihood ratios (LR) were hip and knee prosthesis and skin infection (LR 15), recent joint surgery (LR 6.9), age >80 years (LR 3.5), and hip or knee prosthesis (LR 3.1) [5]. Diabetes and rheumatoid arthritis also increase the risk.

Septic arthritis typically presents as a hot, swollen, tender joint with a reduced range of motion. Fever occurs in approximately 50 % of patients with septic arthritis and does not distinguish this diagnosis from other inflammatory causes of joint pain and swelling [5]. An elevated peripheral WBC count, an elevated ESR, or an elevated CRP were found to increase the likelihood of septic arthritis minimally, so a high index of suspicion needs to be maintained.

Progressively higher WBC counts in the synovial fluid increase the likelihood of septic arthritis. In one systematic review and one meta-analysis, the likelihood ratio (LR) of septic arthritis with a synovial WBC count of <25,000/mm^3 (25×10^9/L) was 0.32 [5], the LR for a WBC count of ≥ 25,000/mm^3 was 3.2, for a WBC count > 50,000/mm^3 (50×10^9/L) the LR was 4.7, and the LR for a synovial WBC count > 100,000/mm^3 was 13.3 [6]. If 90 % or more of the cells in the synovial fluid are polymorphonuclear cells (PMNs), then the risk of septic arthritis is increased threefold (LR 3.4). Other markers in the synovial fluid, such as glucose, protein, and lactic acid, have not been found to be helpful [5, 6].

Gram staining of synovial fluid is very helpful when positive, but is not sensitive enough to rule out infection [4]. Culture results can take several days, so treatment should be instituted if infection is suspected. Blood cultures should always be

obtained when septic arthritis is suspected or diagnosed, and they can be very helpful for guiding therapy. Unfortunately, blood cultures are only positive in 10–50 % of cases [1, 7].

Prompt treatment with antibiotics along with drainage of purulent material from the joint is the mainstay of treatment [4]. With a positive gram stain, choices can be tailored early on; in the absence of this, many experts recommend broad-spectrum coverage for gram-positive and gram-negative bacteria. With the prevalence of MRSA increasing in all populations, some experts recommend coverage with vancomycin until culture results are available. There is also little evidence to guide duration of therapy. Experts recommend antibiotic treatment for 4–6 weeks for nongonococcal septic arthritis and 1–2 weeks for gonococcal arthritis [2, 7]. Successful treatment also includes removal of purulent material from the joint space either surgically or through closed needle aspiration. Consultation with a surgeon may be necessary.

Crystal Deposition Arthritis

Gout (deposition of monosodium urate crystals) and pseudogout (calcium pyrophosphate crystals) can both present with acute pain and swelling of a joint. It is a challenge to differentiate these conditions from septic arthritis, particularly if there is no prior history of crystal deposition disease. If the diagnosis is not completely clear based on history and physical findings alone, then joint should be aspirated and synovial fluid evaluated for infectious organisms and crystals. It is also important to remember that infection may coexist with crystal deposition arthritis, so the clinician's threshold to perform aspiration should be low. Risk factors for the development of gout include male sex, genetic predisposition, hypertension, metabolic syndrome/obesity, diuretic use, chronic renal disease, alcohol consumption (beer and spirits, not wine), and dietary intake of seafood, red meat, and high-purine foods [8]. Common triggers for acute gout include infection, IV contrast, dehydration, diuretic therapy, surgery, and starting or stopping allopurinol [9]

Recommendations for the diagnosis of gout were updated in 2011. The rapid development of severe pain, swelling, and tenderness that reaches its maximum within 6–12 h, especially with overlying erythema, is highly suggestive of crystal inflammation, although not specific for gout [10]. The presence or absence of elevated serum uric acid cannot be used alone to confirm or exclude the diagnosis of gout. The presence of monosodium urate crystals in synovial fluid is confirmatory [8, 10].

The European League Against Rheumatism (EULAR) guidelines state that an elevated uric acid blood level at the time of presentation and then at a follow-up visit in a patient with podagra (inflammation of first MP joint of the great toe) can be presumptively diagnosed with gout [11, 12]. Only 10 % of patients with gout are referred to rheumatology subspecialists with the vast majority being diagnosed and treated without joint aspiration [12, 13]. This, then, is a reasonable course to take in treating these patients.

Pseudogout can be very difficult to distinguish from gout by clinical evaluation; fluid analysis confirming calcium pyrophosphate crystals is needed.

Treatment of acute gout includes NSAIDs, corticosteroids, or colchicine; all have side effects and precautions that must be considered. Pseudogout is typically treated with anti-inflammatory medications.

Acute Exacerbation of Osteoarthritis

Although osteoarthritis is typically a chronic condition, acute exacerbations often occur. In one study of 500 patients, 47 % of patients had only one symptomatic joint, and 41 % of radiographically abnormal joint sites were knees [14]. Physical exam often reveals pain on range of motion as well as limited range of motion of the affected joint [15]. An effusion of the knee should be aspirated to rule out infection or hemarthrosis. The synovial fluid from osteoarthritis is usually clear and viscous with a leukocyte count less than 2×10^9/L [13]. Bloodwork is usually not helpful.

Treatment of acute exacerbations of osteoarthritis includes acetaminophen or NSAIDs if acetaminophen does not help. Rest of the joint is appropriate until the exacerbation has resolved; afterwards, an exercise program of muscle strengthening and range-of-motion exercises may reduce pain and improve physical function. The use of intra-articular corticosteroids may provide short-term relief lasting 4–8 weeks [15]. Some common nonpharmacological treatments for osteoarthritis. There is good evidence that one of the most effective, long-term treatment plans for patients with osteoarthritis is referral to the Arthritis Foundation for patient education and support.

Trauma

Trauma is an extremely common cause of the acutely swollen, painful joint. All patients with a swollen joint or joint effusion, pain, and a history of trauma need X-ray evaluation. If no history of onset can be obtained from the patient (such as a patient who is delirious, confused, unconscious, or noncommunicative), trauma should be suspected and X-rays performed. Internal derangement (cartilage or intra-articular ligament damage, in addition to fracture) should be considered if hemarthrosis is diagnosed on synovial fluid aspiration. Further management depends on the particular injury found.

In summary, all patients with an acutely swollen, painful joint require detailed evaluation to rule out a septic joint and to properly diagnose their condition(s). Those with even a moderate possibility of septic arthritis should either be treated empirically and/or require urgent consultation with a specialist; those in whom the diagnosis is clearly not infectious can be managed conservatively by the primary care provider. Close follow-up is essential for all patients. The flowchart that follows can help guide the provider through management of these patients.

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Chapter 14
Musculoskeletal Radiology

Adam C. King and John B. Becker

Because musculoskeletal complaints are common in day-to-day practice, primary care providers should be familiar with the various radiographic studies available. Radiographic studies should be used as an extension of a focused history and physical examination. Typically, radiographs (aka "plain films" or X-rays) should be considered the first line of imaging when a patient has a musculoskeletal complaint. A detailed description of advanced imaging such as magnetic resonance imaging (MRI), computed tomography (CT), nuclear medicine bone scintigraphy (bone scan), ultrasound, and arthrography is beyond the scope of this chapter, and there are many great resources available if advanced imaging is of interest to the reader. This chapter provides guidance for ordering radiographic studies as well as outlining a few pitfalls along the way.

When ordering radiographic studies, keep these general rules in mind:

1. Patients who can be clinically diagnosed with common conditions do not require imaging. However, if the patient does not respond as expected to treatment, radiographs should be considered.
2. Include detailed clinical information for the radiologist when ordering any radiological study. The higher the quality of the clinical information provided, the higher the quality of the interpretation provided. Similarly, the ordering physician should personally review the images, as the ordering provider has more clinical information than the radiologist interpreting the images. If there seems to be a discrepancy, review the images with the radiologist in person whenever possible.

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3. If radiculopathy is a potential diagnosis for the patient's symptoms, consider imaging the site of pain and the possible origin of the pain (i.e., lumbar spine, cervical spine, etc.).
4. If there is isolated bony tenderness that is not located at the insertion site of a tendon or ligament, consider obtaining radiographs.
5. If the radiographs are negative, but the clinical suspicion for serious pathology remains, consider advanced imaging studies (MRI, CT, bone scan, ultrasound, arthrography, etc.). The specific advanced imaging study to be considered depends on the suspected pathology as well as technical factors such as the eligibility of the patient for a specific examination and the location of symptoms, just to name a few.
6. If a fracture is a consideration, but the initial radiographs are negative and there are persistent symptoms for 7–10 days after the injury, consider repeating the radiographs. Seven to ten days after a subtle fracture, sclerosis at the site of healing can be the only sign to confirm an initially occult fracture. This is especially important in the pediatric population and with specific fractures such as a fracture of the scaphoid, which can have long-term implications if the fracture is not identified and allowed to heal appropriately.
7. Radiographs should be performed at the time of presentation in cases of significant trauma.
8. In radiology, having only one view is like having no view. Pathology, especially fractures, is more confidently diagnosed when visible on more than one imaging plane.
9. Be aware that some patients may have a "therapeutic" benefit from negative radiographs. In other words, their symptoms improve because they were told that their radiographs were negative, but they have significant pathology (occult fractures, ligamentous or tendon injury) that is yet to be diagnosed. *Remember, radiographs are not a substitute for a thorough history and physical exam.*

Ordering X-Rays for Specific Body Areas

Cervical Spine

When ordering radiographs in a patient with cervical spine pain, AP and lateral views are initially obtained to evaluate the vertebral alignment, vertebral body heights, intervertebral disc spaces, uncovertebral joints, and zygapophyseal (facet) joints. If radiculopathy is a consideration, right and left lateral oblique views can be added to look at the osseous neural foramina for osseous impingement on the exiting nerve roots. Degenerative disc disease is a common cause of radiculopathy in the cervical spine which is best evaluated by MRI or CT cervical myelography if MRI is contraindicated in the patient. In the setting of patients with trisomy 21, rheumatoid arthritis, or major trauma, an odontoid view should be added to evaluate the atlanto-occipital and atlantoaxial joints.

If major trauma is the presenting complaint (typically to the emergency department), the cervical spine should be stabilized and then imaged before further clinical evaluation is performed. Classically, this was done with cervical spine radiographs (AP, lateral, and odontoid views), but in recent years, CT has become a popular replacement of cervical spine radiographs to evaluate the spine in the setting of trauma as many trauma patients already have a CT of the head, chest, abdomen, and pelvis at the time of presentation.

Thoracic Spine

AP and lateral radiographs of the thoracic spine are the initial views of choice in the setting of thoracic spine complaints. There is improved osseous detail on a dedicated AP view of the thoracic spine as compared to an AP chest radiograph. The addition of the swimmer's view, an oblique view centered at the cervicothoracic junction with the humeral heads projected away from the spine, can be beneficial in assessment of the C7, T1, and T2 vertebrae. Radiographs can assess vertebral alignment, vertebral body heights, intervertebral disc spaces, and facet joints. The osseous neural foramina in the thoracic spine are suboptimally evaluated as the ribs typically cause overlap on the lateral view.

Lumbosacral Spine

When imaging the lumbosacral spine, the radiographs typically obtained are AP, lateral, and lateral coned-down L5–S1 views. These views are useful to evaluate vertebral alignment, vertebral body heights, intervertebral disc spaces, facet joints, and sacroiliac joints. The lateral views can be used to assess the osseous neural foramina for osseous impingement on the exiting nerve roots in the setting of radiculopathy.

Right and left lateral oblique views are not routinely obtained when evaluating the lumbar spine for osseous neural foraminal impingement in the setting of radiculopathy because the lateral views are typically sufficient. Degenerative disc disease is a more common cause of radiculopathy in the lumbar spine which is best evaluated by MRI or CT lumbar myelography if MRI is contraindicated in the patient.

Shoulder

Various radiographs of the shoulder used in imaging evaluation include AP with external rotation (anatomical positioning), AP with internal rotation, true AP (Grashey), axillary, scapular Y, and outlet (modified scapular Y) views. There are many other dedicated views of the shoulder which can be used for specific pathology.

Typically, radiographs of the shoulder are useful for assessing the joint for an acute dislocation, signs of prior dislocation such as a Hill-Sachs fracture or a Bankart fracture, an acute fracture, osseous abnormalities related to rotator cuff pathology, or the various arthritides affecting the glenohumeral and acromioclavicular joints.

The first-line imaging of the shoulder in the setting of suspected fracture or dislocation typically includes the AP with external rotation view, AP with internal rotation view, and either a scapular Y or an axillary view. The benefit of the scapular Y view over the axillary view is that the patient does not need to move the joint in the setting of a suspected dislocation whereas the patient will need to abduct the arm to obtain an axillary view. An axillary view or a Grashey view can be added later to better evaluate the glenohumeral joint. An outlet view can be added later to better evaluate the joint for rotator cuff impingement as this view optimally profiles the undersurface of the acromion while aligning the x-ray beam parallel to the supraspinatous tendon as it passes over the humeral head.

Humerus

The primary radiographs of the humerus are the AP with external rotation (anatomical positioning) and AP with internal rotation. As is the case in all imaging studies, the entire structure of interest (in this case, the humerus) must be included on a single film to best evaluate the structure for pathology.

Elbow

Radiographs of the elbow typically include an AP, a lateral with 90° of flexion, and an AP oblique view with external rotation. The AP oblique view is used to evaluate the radial head and decrease overlap of the osseous structures. In children, the many ossification centers of the elbow can be confused with a fracture in the setting of trauma or pain, so consider imaging the opposite elbow for comparison. Table 14.1 and Fig. 14.1 demonstrate the normal ossification centers. In addition, indirect signs may be the only indication that there is a fracture. The “fat pad sign” is an indirect sign of a fracture where the anterior or posterior intra-articular fat is displaced by an acute hemarthrosis that is associated with the fracture. In the setting of an elevated anterior fat pad from an acute hemarthrosis, the elevated fat pad classically looks like the sail of a sailboat, so it may also be referred to as the “sailboat sign.”

The radiocapitellar relationship is important to note when assessing the elbow. On the lateral view, the anterior humeral line and the radiocapitellar line are used to assess the elbow joint alignment. The anterior humeral line is a line drawn along the anterior cortex of the distal humeral metaphysis which should pass through the middle third of the capitellum (Fig. 14.2). If the anterior humeral line passes in the

Table 14.1 Approximate age of ossification

Site	Age in years
Capitellum	1
Radial head	3
Medial epicondyle	5
Trochlea	7
Olecranon	9
Lateral epicondyle	11

Fig. 14.1 Left elbow AP oblique with external rotation in a 15-year-old demonstrating the fused elbow ossification centers. *C* capitellum, *R* radial head, *M* medial epicondyle, *T* trochlea, *O* olecranon, *L* lateral epicondyle

anterior third of the capitellum or anterior to the capitellum, then the capitellum is too posterior, indicating a distal humeral fracture. The radiocapitellar line is a line drawn through the radial neck which should pass through the capitellum (Fig. 14.3). If the radiocapitellar line does not pass through the capitellum, then there is a radiocapitellar dislocation.

Fig. 14.2 Lateral view of the elbow with a normal *anterior humeral line*. The anterior humeral line is a line drawn along the anterior cortex of the distal humeral metaphysis which should pass through the middle third of the capitellum

Fig. 14.3 Lateral view of the elbow with a normal *radiocapitellar line*. The radiocapitellar line is a line drawn through the radial neck which should pass through the capitellum

Radius and Ulna

The primary radiographs of the radius and ulna are the AP and lateral views. For sufficient evaluation, the elbow and wrist should also be visible because there are important fractures that include dislocation components. A Monteggia fracture-dislocation is a fracture of the ulna shaft with an associated dislocation of the radial

head. A Galeazzi fracture-dislocation is a fracture of the radius with a dislocation of the distal radioulnar joint.

Another common fracture is a Colles' fracture. A Colles' fracture is a fracture of the distal metaphysis of the radius associated with dorsal angulation and displacement of the distal radius typically seen in the older population or women with osteoporosis. In addition to inclusion of the elbow and wrist joints, care must be taken to avoid pronation or supination between views as either of these changes in position will change the orientation of the osseous structures and potentially obscure pathology.

Wrist

Radiographs of the wrist should include the carpal bones as well as the metacarpals, distal radius, and distal ulna. AP, lateral, and oblique views of the wrist are the standard views obtained. In the setting of suspected fracture of a specific bone, particularly the scaphoid, dedicated views of the specific bone can be requested to improve evaluation.

The carpal alignment can be assessed by evaluating the three carpal arcs on the AP view. If there is disruption of the carpal arcs, then a fracture or ligamentous injury is suggested. The first arc traces the proximal convexities of the scaphoid, lunate, and triquetrum. The second arc traces the distal concave surface of the scaphoid, lunate, and triquetrum. The third arc traces the main proximal curvatures of the capitate and hamate. See Fig. 14.4 which demonstrates the normal carpal arcs. In addition to the carpal arcs, specific ligamentous injuries can be suggested on the AP view. In the setting of a scapholunate ligament injury, then there can be widening of the scapholunate joint. In the setting of a fracture of the ulnar styloid, then there may be injury to the triangular fibrocartilage (TFCC). If a ligamentous injury is suspected, MRI should be considered.

The most common wrist dislocations are the perilunate and lunate dislocations which can be assessed on the lateral view. Figure 14.5 demonstrates the normal lateral wrist alignment. If the capitate is centered over the radius with the lunate tilted towards the palmar surface, then there is a lunate dislocation. If the lunate is centered over the distal radius with the capitate located dorsally, then there is a perilunate dislocation.

Hand

To evaluate the hand, AP, lateral, and oblique radiographs are typically obtained. If individual phalangeal injuries are suspected, then dedicated radiographs of the designated phalanx should be ordered. The phalanges can be designated by name or number. Using the numbering system, the thumb is designated the first digit, the index finger is designated the second digit, and so on.

Fig. 14.4 AP view of the wrist with normal carpal alignment demonstrating the three carpal arcs. *Arc 1* traces the proximal convexities of the scaphoid, lunate, and triquetrum. *Arc 2* traces the distal concave surfaces of the scaphoid, lunate, and triquetrum. *Arc 3* traces the main proximal curvatures of the capitate and hamate

Pelvis and Hip

In the setting of a patient with a history of trauma and pain during weight bearing, images of both the pelvis and hip should be considered. Radiographs of the pelvis and hip starts with an AP view of the pelvis. After the pelvis has been imaged, AP and frog leg lateral views of the affected hip should be obtained. Weight-bearing AP views of the hip or pelvis can be subsequently considered if the initial images are negative. Keep in mind that hip pain can be referred from the lumbar spine or from extra-articular causes.

Femur

Upper leg complaints may be due to pathology of the hip, femur, knee, or lumbar spine. When the appropriate history and physical examination indicates the femur as the pathological source, AP and lateral views of the femur can be added to images of the hip or less commonly images of the knee.

Fig. 14.5 Lateral view of the wrist with normal alignment of the distal radius (*R*), lunate (*L*), and capitate (*C*)

Knee

Radiographs of the knee typically include an AP, lateral, and sunrise view. The initial views are typically obtained supine, but weight-bearing AP and PA can be subsequently obtained to further evaluate the medial and lateral compartments. The AP view primarily is used to evaluate the medial and lateral femoral compartments. The lateral view helps determine if a joint effusion is present. The sunrise view is used to primarily evaluate the patellofemoral compartment.

Certain fractures of the knee noted on plain films are highly suggestive of internal derangement requiring MRI for further evaluation. A Segond fracture is an avulsion fracture of the lateral tibial condyle associated with anterior cruciate ligament (ACL) disruption (75–100 %), medial meniscus tears (66–75 %), avulsion of the fibular collateral ligament (a ligamentous structure that makes up the lateral collateral ligament complex or LCL), avulsion of the fibular attachment of the long head

of the biceps femoris, and potentially a lateral capsular ligament injury. A reverse Segond fracture is an avulsion fracture of the tibial component of the tibial collateral ligament (also known as the medial collateral ligament or MCL) which is associated with posterior cruciate ligament (PCL) disruption and medial meniscus tears.

Tibia and Fibula

The tibia and fibula are evaluated with AP and lateral radiographs in the supine position. As with other long bone radiographs, inclusion of the adjacent joints (knee and ankle) while imaging the entire structure of interest, the tibia and fibula in this case, is the standard of practice. An important fracture to recognize is a tibial plateau fracture which is a commonly encountered fracture in the setting of motor vehicle collisions or in older women with osteoporosis. Tibial plateau fractures can be associated with internal derangement of the knee. Another important fracture to recognize in the pediatric population is the toddler's fracture which is a nondisplaced spiral fracture of the distal third to distal half of the tibia in the setting of low-energy trauma.

In addition to evaluating the osseous structures for fracture, determining the relationship between the osseous structures can be a clue to underlying interosseous ligament injury (such as in a Maisonneuve fracture) or distal syndesmosis injury (injury to the anterior and/or posterior tibiofibular ligaments that occurs in a so-called high ankle sprain). To confirm the suspicion of a ligamentous injury, MRI should be performed.

Ankle

The ankle is best evaluated with AP, lateral, and ankle mortise radiographs. In addition to evaluating for fracture, the ankle mortise is the primary structure to evaluate with dedicated ankle radiographs. Malalignment of the ankle mortise indicates underlying ligamentous injury requiring further evaluation with MRI. Subtle sclerosis of the talar dome can be a clue to an old cartilaginous defect that may be unstable and continue to cause pain. If talar dome injury is suggested, then MRI should be considered to determine stability. The lateral view of the ankle can be used to evaluate the joint for an effusion or for osseous coalition which may limit range of motion or cause pain.

Foot

To evaluate the foot, AP, lateral, and oblique radiographs are typically obtained. If individual phalangeal injuries are suspected, then dedicated radiographs of the designated phalanx should be ordered. Like the hand, the phalanges can be designated

by name or number, but numbering is preferred. Using the numbering system, the great toe is designated as the first digit and numbering continues laterally.

The Lisfranc fracture-dislocation is a well-known injury to the midfoot occurring in athletes, in the setting of major trauma, or in the diabetic neuropathic joint (Charcot's foot). The Lisfranc joint involves the articulation of the bases of the first three metatarsals with the three cuneiforms as well as the bases of the fourth and fifth metatarsals with the cuboid. The Lisfranc ligament attaches the medial cuneiform with the base of the second metatarsal on the plantar aspect of the foot. Injury resulting in dislocation of the midfoot joints or fracture of the midfoot osseous structures indicated a Lisfranc fracture-dislocation. In the setting of suspected Lisfranc fracture-dislocation, MRI should be considered to determine the extent of the injury and for operative planning.

Advanced Imaging

MRI, CT, bone scan, ultrasound, and arthrography typically are not ordered as the initial study in musculoskeletal complaints. Before ordering advanced imaging, the clinician should obtain a focused history and physical examination and the initial radiographic studies outlined above. If the initial radiographic studies are negative or further imaging is suggested by the interpreting radiologist, then the clinician could consider ordering advanced imaging.

MRI is primary used to evaluate the soft tissues such as muscles, ligaments, tendons, and cartilage. MRI also allows for the evaluation of bone marrow-related pathology. MR arthrography can be utilized to better evaluate labral pathology in the shoulder or hip or ligament/tendon pathology in the wrist, elbow, or ankle. In addition, if osteomyelitis is a consideration, contrast can be added for improved evaluation. MRI can be used to evaluate osseous structures for radiographically occult stress fractures. MRI has the added benefit of not involving ionizing radiation. But, some patients are not candidates for MRI due to pacemaker/defibrillator placement, cochlear implants, certain aneurysm clips, and many other medical devices. In addition, the table weight limits and the bore diameter of the machine can be limiting factors for some patients. Some patients require sedation to complete an MRI because of the anxiety associated with the examination due to both noise and claustrophobia. Lastly, if the patient is unable to remain still for the length of the imaging sequences, motion can degrade the images and limit interpretation by the radiologist.

CT is typically used in major trauma as an initial study in the emergency department (with the exception of evaluation of the extremities). CT can also be used for further evaluation of the pattern of a known fracture or to determine if displacement is present. If initial radiographs are determined to be equivocal for fracture, CT can be obtained to clarify the presence or absence of fracture. CT arthrography is occasionally used in patients who do not qualify for MRI arthrography and provides similar information to the clinician.

Bone scans can be used to evaluate osseous structures for radiographically occult stress fractures. In additional, bone scans are also useful in evaluating osseous structures

for the presence of osteomyelitis. A bone scan is a useful tool when the clinician is trying to determine if osseous metastases are present in the setting of malignancy. Although one must keep in mind that photopenic osseous metastasis, such as in the setting of multiple myeloma, are not well identified on bone scans.

Ultrasound can be used to determine if a joint effusion, tendon injury, or hernia is present. Targeted musculoskeletal ultrasound depends on experienced and reliable technologists to provide the appropriate images to the radiologist or clinician. If there is ever a question of what structures are being imaged on the still images provided by the technologist, the radiologist or clinician should perform real-time imaging for clarification.

Summary

Radiographs are typically the first line of imaging in musculoskeletal complaints after a focused history and physical examination is performed. Provide as much detailed clinical information as possible to the radiologist to improve the diagnostic accuracy of the interpretation. After ordering an imaging study, be sure to review the images personally. If the interpretation is discordant with your own personal review of the images, then review the images with the radiologist. If a fracture is a diagnostic consideration and pain persists after negative radiographs, a subtle fracture may be found by repeating radiographs in 7–10 days or ordering specialized views. Advanced imaging is typically reserved for a second-line evaluation of musculoskeletal complaints.

Tables 14.2, 14.3, and 14.4 summarize the views that should be ordered for each body area listed in this chapter, as well as some clinical pearls that may be helpful when ordering tests. If the ordering clinician is uncertain of the most helpful views, he or she should consider calling a radiologist for advice.

Table 14.2 The spine

Body area	Views	Clinical pearls
Cervical	AP, lateral, right and left lateral oblique, and odontoid	In the setting of acute trauma, first stabilize the patient prior to imaging Consider adding oblique views in the setting of radiculopathy (remember, MRI better evaluates the various causes of radiculopathy) Add odontoid in trisomy 21, rheumatoid arthritis, or major trauma
Thoracic	AP, lateral, and swimmer's	Osseous neural foramina are suboptimally evaluated due to rib overlap on the lateral view Consider adding the swimmer's view to better assess the cervicothoracic junction
Lumbar	AP, lateral, and lateral coned-down L5–S1	Oblique views are typically not needed as the lateral views can be used to assess the osseous neural foramina in the setting of radiculopathy As in cervical radiculopathy, MRI better evaluates the various causes of lumbar radiculopathy

Table 14.3 Lower extremity

Body area	Views	Clinical pearls
Pelvis	AP	Consider imaging the hip with the pelvis in the setting of trauma and pain A weight-bearing AP view can be considered if the initial view is negative
Hip	AP, frog leg lateral	A weight-bearing AP view can be considered if the initial view is negative Keep in mind that hip pain can be referred from the lumbar spine or from extra-articular causes
Femur	AP, lateral	If the femur is thought to be the source of pathology, the views can be added to images of the hip or less commonly images of the knee
Knee	AP, lateral, sunrise, weight-bearing AP, weight-bearing PA	Use the AP view to evaluate the medial and lateral femoral compartments Use the lateral view to determine if a joint effusion is present Use the sunrise view to evaluate the patellofemoral compartment Segond and reverse Segond fractures indicate internal derangement of the knee
Tibia and fibula	AP, lateral	Include the knee and ankle joints Important fractures of the tibia and fibula include the tibial plateau fracture, toddler's fracture, and Maisonneuve fracture
Ankle	AP, lateral, ankle mortise	The ankle mortise is the primary structure to evaluate with dedicated ankle radiographs Malalignment of the ankle mortise indicates underlying ligamentous injury Subtle sclerosis of the talar dome can be a clue to an old cartilaginous defect that may be unstable Use the lateral view to evaluate the joint for an effusion or for osseous coalition
Foot	AP, lateral, oblique	Use all three views to look for fractures and osseous alignment The Lisfranc fracture-dislocation is an important injury to the midfoot that requires surgical stabilization
Phalanges	Designate dedicated views	Phalanges can be designated by name or number, but numbering is preferred Using the numbering system, the great toe is designate as the first digit and numbering continues laterally

Table 14.4 Upper extremity

Body area	Views	Clinical pearls
Shoulder	AP with external rotation, AP with internal rotation, true AP, axillary, scapular Y, and outlet	Scapular Y view does not require the patient to move the joint Axillary view requires abduction of the arm Axillary or true AP view evaluates the glenohumeral joint Outlet view evaluates the joint for rotator cuff impingement
Humerus	AP with external rotation, AP with internal rotation	The entire length of the humerus should be included on each view

(continued)

Table 14.4 (continued)

Body area	Views	Clinical pearls
Elbow	AP, lateral in 90° of flexion, and AP oblique with external rotation	In children, consider imaging the opposite elbow due to the many ossification centers Look for indirect signs of fracture, i.e., "fat pad sign" or "sailboat sign" Use the lateral view to measure the anterior humeral line and the radiocapitellar line to assess the radiocapitellar relationship on Use the oblique view to evaluate the radial head
Radius and ulna	AP, lateral	Include the elbow and wrist joints Avoid pronation or supination between images Important fractures of the radius and ulna include the Monteggia fracture-dislocation, Galeazzi fracture-dislocation, and Colles' fracture
Wrist	AP, lateral, oblique	If there is a suspected fracture of a specific bone, particularly the scaphoid, dedicated views of the bone can be obtained Evaluate the three carpal arcs on the AP view Evaluate the relationship of the distal radius, lunate, and capitate on the lateral view
Hand	AP, lateral, oblique	Use all three views to look for fractures and osseous alignment
Phalanges	Designate dedicated views	Phalanges can be designated by name or number, but numbering is preferred Using the numbering system, the thumb is designated the first digit, the index finger is designated the second digit, and so on

Suggested Readings

1. Manaster BJ, May DA, Disler DG. Musculoskeletal Imaging: the requisites. 4th ed. Philadelphia: Elsevier Saunders; 2013.
2. Helms CA. Fundamentals of skeletal radiology. 4th ed. Philadelphia: Elsevier Saunders; 2014.

Chapter 15
Soft Tissue Injuries

Tao Lee Land, James M. Lynch, and Sue Stanley-Green

Injury to soft tissue encompasses a vast array of entities due to an assortment of mechanisms. The etiology of an injury can include physical, biological, thermal, metabolic, and chemical means. A sports medicine précis of soft tissue injuries includes sprains, strains, contusions, hematomas, and tendinitides. There are commonalities across this wide assortment of maladies however. The application of mechanical force to human tissue can cause one of two changes: a change in shape (deformation) or a change in velocity (deceleration or acceleration). If tissue tolerance is exceeded, a push can cause *contusions*, *hematomas*, and *fractures*, while a pull results in *sprains*, *strains*, and *dislocations*. A large magnitude of force applied to tissue results in *macrotrauma*, such as sprains, strains, and crush injuries. Smaller forces that recur over long and/or repetitive sequences result in *microtrauma*, such as stress fractures and overuse syndromes.

Acute Management

Acute management of the common soft tissue injuries is still governed by the acronyms RICE or PRICE. The R indicates rest, but this is *relative rest* to protect the injured structure(s) while maintaining or increasing the integrity of the surrounding structures. I stands for *ice or the application of cold*. This therapeutic modality

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reduces the heat (calor) and decreases the pain (dolor) of the inflammatory process. C entails *compression* by wrapping the injured area to prevent increased edema and swelling. This is most commonly accomplished with an ace wrap, but there are several options including sleeves, stockinette, or braces available to accomplish the task. E implies *elevation* in an attempt to drain accumulated fluid away from the injured area.

The P of the longer acronym is *protection* of the injured tissues. This may be as simple as sturdier shoes or an off-the-shelf ankle brace to more complicated and involved methods as crutches and casts.

Ice should be applied in a plastic bag directly on the skin for 20–30 min. Applying ice in this fashion every 2 h is as effective as leaving the ice on for the entire 2 h. The standard practice is to apply ice two to three times a day while symptoms persist. Other acceptable applications include cold immersion, cold whirlpools, or the commercially produced cold packs.

Compression and elevation both attempt to reduce the swelling and edema associated with musculoskeletal injuries. This is advantageous for two reasons. Reducing the amount of edema will improve the range of motion and vascular flow. Improved range of motion will assist in regaining muscle strength and function. Improved perfusion reduces the secondary ischemic mechanisms of injury. In fact, this is the strongest argument for using ice rather than heat in the management of injuries. The increased muscle range of motion will increase blood flow throughout a 24-h period more effectively than the vasodilation that occurs with the application of heat for minutes during a day.

A reasonable treatment program for soft tissue injuries must fulfill four requirements. The first is to minimize pain, swelling, hemorrhage, inflammation, and muscle spasm. The second requirement is protection and immobilization of the damaged tissue. The intent of this second requirement is to prevent repeat bleeding, secondary injuries, and early distension or lengthening of healing structures. The third requirement emphasizes controlled mobilization. This begins at the 2–3 week mark, but the demands of an active season may necessitate an advancement of the timing. The fourth requirement is simulation of activity-specific stress to ensure a complete return to the desired activity level. Approximately 6–8 weeks after a significant injury, collagen fibers can withstand tensile stress relatively well. Rehabilitation can then be geared to a complete return.

In the primary care setting, there are several advantages using splints as opposed to casting. Splinting techniques are easy to learn. In many cases, they can be used for definitive treatment in primary care. The splint is used to protect the injured joint or fracture while maintaining as much function as possible for the patient. Splinting techniques described here can be used in the office and/or athletic training room as opposed to an emergent situation in which both the distal and proximal joints should be splinted for patient transport.

Casting requires maintenance of technique, various sizes of cast tapes, cast padding, and stockinette. In addition to this, a cast saw is required. Splinting gives the advantages of increased flexibility and ease of application. Prefabricated splints can be purchased. This chapter will focus on custom splints, as they are more cost

effective and usually more comfortable for the patient. After injury, the extremity commonly swells, and casts must be "vented" with a cast saw by a healthcare provider. Splints can be loosened by the patient or nursing personnel by reapplying the ace wrap holding the splint in place. This chapter will cover some of the more common splinting compression techniques.

Basic Splinting and Bracing Principles

A few basic principles provide the guidelines for effective splinting and bracing. Neurovascular patency of the extremity must be evaluated prior to, during, and after application of the splint or brace. Immobilization of an injury should include the joints proximal and distal to the injury. Remember to allow for accommodation of swelling, especially with acute injuries.

A thorough initial evaluation will entail evaluation of the neurologic and vascular systems of the injured extremity. The patient should be instructed to notify the provider of any changes in condition during the application of the device, i.e., numbness, tingling, coldness. Neurovascular status should again be assessed once the appliance is in place and again a few minutes after application.

In order to effectively protect the injured structure, temporary immobilization should take place from the joint above to the joint below the injury. (After radiographs are obtained and the pathology is identified, this rule may no longer be necessary.) If the ankle is involved, immobilization should be from the knee to the foot. If the radius is the involved structure, the elbow and the wrist should be immobilized. Even if the injury requires "complete rest," (i.e., crutches or sling and swath) immobilization should be considered to limit movement of the injured area due to movement caused by incidental contact with the appendage.

Edema should be considered when applying an immobilization device. The first few minutes or hours after an acute injury may see significant accumulation of swelling at the site of injury. If the injury is subacute or chronic, site edema may vary depending on activity level or gravity-dependent positioning. Splints or braces that can be adjusted or removed and reapplied by the patient allow for changes in swelling, thus providing better protection of the injured structure.

Selection of Materials

When considering options for bracing and splinting, a wide variety of materials are available. Prefabricated splints and braces exist for almost every application. However, stocking the array of braces in the variety of sizes possible may not be feasible. Common braces that may be valuable to have available include crutches, walking boots, knee immobilizers, slings, hand-wrist-thumb braces, and stacks splints.

A wide array of splints and braces can be fabricated in the clinical or field setting with a supply of a few versatile items, such as AlumaFoam®, Orthoplast™, Orthoglass®, fiberglass casting tape (ridged and semi-ridged), plaster of Paris, elastic wraps, surgical or linen tape, webril, stockinette, and compressionette.

Thumb Spica Splint *(See Table 15.1 and Fig. 15.1a–d)*

The patient should be seated in a comfortable position with the affected extremity supported. The hand should be held in the "safe hand" position (see Fig. 5.6). The thumb is not placed in anatomic position or abducted in the "hitch hiker" position. The patient can be instructed to hold the hand as if holding a "favorite cold beverage" to demonstrate the safe hand position. The splint can be applied using stockinette, then cast padding, then tape. A splint material that has everything integrated is also available. This is the author's preferred method. The splint material is first placed in water. (If the water is hot, the casting tape will set up prematurely. If the water is cold, the casting tape may take up to 45 min to set.) The splint is folded around the distal part of the thumb. The MP joint is immobilized. The elastic bandage is overlapped by approximately one-half width and a very slight amount of tension is placed on the ace wrap. If too much tension is placed on the ace wrap, it will constrict the hand and the patient will complain of pain. The splint ends should cover approximately three-quarters of the forearm, and the excess casting padding should be folded back. The elastic bandage is wrapped until the splint is completely covered and the patient is held in a position of function until the material hardens (see Fig. 15.2). Proper instruction for care should be given to the patient. This splint may be removed when treating DeQuervain's tenosynovitis or it may be kept in place until the patient has a follow-up. The splinting material should not be allowed to become wet and should be covered in plastic when bathing. Splints function well for 7–14 days and are not designed to be used for prolonged therapy. Depending upon the patient's diagnoses, the splint may be replaced as many times as necessary at follow-up office visits.

Table 15.1 Thumb spica

Indications	Contraindications
Fall on outstretched hand	Compound fractures
Tenderness at anatomic snuffbox	Displaced fractures
Ulnar collateral ligament injury of the thumb (Gamekeeper's thumb)	Multiple trauma
DeQuervain's tenosynovitis	Open wound
Nondisplaced distal radius fractures	The inability to have the patient come in for proper follow-up
	The inability of the patient to follow instructions (developmentally disabled, child)

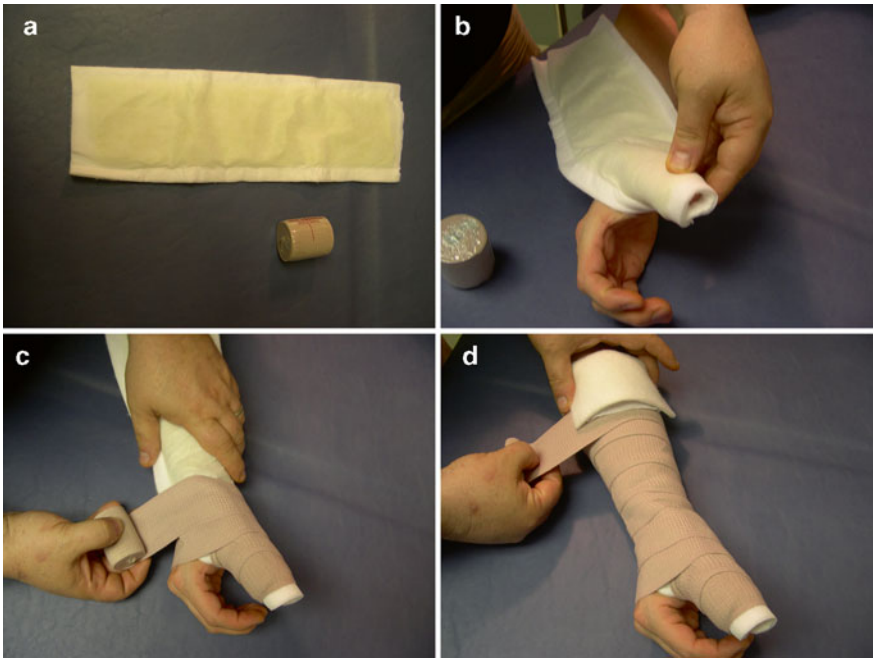

Fig. 15.1 Thumb spica splint. (**a**) Two or four inch prepackaged splint material (padding included) and a 2 in. ace wrap. (**b**) Padded side of splint applied facing toward the patient. Fold splint around distal thumb. Immobilize MP joint. (**c**) Wrap with 2 in. ace; overlap by one-half inch with *slight* tension. Do not over tighten. Notice how to efficiently wrap spica by unwrapping ace in a counter-clockwise direction. (**d**) Fold proximal aspect of splint material so splint only covers three-quarters of forearm and does not impinge upon the antecubital fossa

Fig. 15.2 After the splint is applied, mold the splint to the MP joint of the thumb by applying pressure as shown. Keep wrist in neutral position. Patients have a tendency to flex wrist, which is not acceptable

Sugar Tong Splint *(See Table 15.2 and Fig. 15.3a–d)*

The sugar tong splint may be used to immobilize the elbow and the wrist. When applying a sugar tong splint, it is imperative that the MP joints are allowed to flex 90°. When the wrist is splinted, the palmar aspect of the splint should be a number of inches shorter than the dorsal aspect of the splint. Excess material at the palmar aspect of the hand can be folded to allow the metacarpal phalangeal joints to flex 90°. It is important to keep the patient in an anatomic position. The wrist should be in a neutral position. Extension as well as radial and ulnar deviation should be avoided.

Arm Sling *(See Table 15.3)*

The sling should fit comfortably over the back of the shoulder and should not be placed around the patient's neck. The arm should rest comfortably at about breast level. The sling can be universal for both the right and left sides and can be modified for extra support. A large ace wrap could be wrapped around the arm and the chest to further immobilize the upper extremity. It is important to adjust the sling so the patient feels comfortable. The patient should be instructed to keep the wrist in neutral position. If the wrist is flexed, the median nerve may be compressed and the patient will complain of paresthesias.

Stax Splint *(See Table 15.4 and Fig. 15.4a–d)*

The stax splint places the distal phalangeal joint in slight extension. It is much more efficient in reducing and maintaining the position of a malfinger splint than a simple dorsal splint with the use of tape. The splint should be kept in place and should not be removed at all during treatment.

Table 15.2 Sugar tong splint

Indications	Contraindications
Transport patients with fracture of elbow or radius	Compound fractures
Short-term immobilization	Displaced fractures
Nondisplaced elbow fractures	Multiple trauma
Immobilization for treatment of distal radius fracture (some clinicians prefer thumb spica splint with use of arm sling)	Open wound
	The inability to have the patient come in for proper follow-up
	The inability of the patient to follow instructions (developmentally disabled, child)

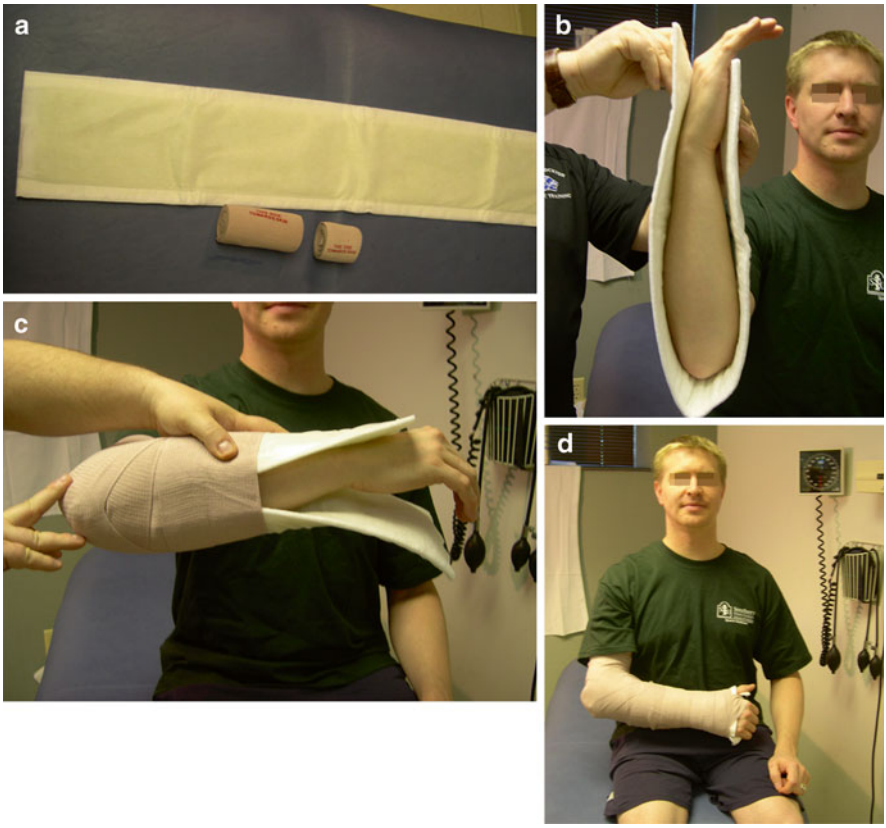

Fig. 15.3 Sugar tong splint. (**a**) Two or four inch packaged splint material and a 2 and 4 in. ace wrap. Should be long enough to immobilize elbow to forearm twice. If splint is not long enough, use two shorter splints and overlap them. (**b**) This is the most important step. Immobilize the elbow in 90° flexion. The splint should immobilize the wrist but allow for at least 90° of flexion of the MP joints of the hand. The dorsal aspect of the splint may slightly overlap the MP joints. (**c**) Apply 4 in. ace wrap around elbow, overlapping by one-half inch, very slight tension. After 4 in. wrap in place, use 2 in. wrap to hold splint around the wrist. (**d**) Complete, proper application of upper extremity sugar tong splint. Elbow held at 90°, wrist complete extension and the patient should be able to flex MP joints 90°. Always use an arm sling with this splint (not shown here)

Table 15.3 Arm sling

Indications	Contraindications
AC separation	The patient should not be put in sling for prolonged periods without follow-up
Fractured clavicle	Severe injury of the C-spine
Nonsurgical treatment of rotator cuff injury	
Treatment of patient recovering from a relocation of a dislocated shoulder	

Table 15.4 Stax splint

Indications	Contraindications
Mallet finger fractures (see Chap. 6)	Unstable fracture (fracture involves over 1/3 of the joint)
	Evidence of infection
	Open fractures

Extension Block Splint *(See Table 15.5 and Fig. 15.5a–d)*

A dorsally placed extension block splint is the preferred method for splinting patients with an injury to the volar plate of the PIP joint. This allows better hand function than a palmar splint. The material is measured to start proximally at the dorsal aspect of the hand and is secured with an elastic bandage. An elastic tape is used to secure the proximal phalanx. The distal phalanx is not taped which allows the patient to flex the finger at the PIP joint. To prevent the joint from being injured by extension, the splint is molded in the safe hand position but can be modified to keep the finger in more flexion. The same splint technique can be used for a fracture. In this case, the hand and finger should always be kept in the safe hand position and the distal phalanx should be taped.

Knee Immobilizer *(See Table 15.6)*

Although straight knee immobilizers are commonly used in the emergency room, their use is somewhat controversial. Patients with large knee effusions cannot completely extend their knee to fit comfortably in the knee immobilizer. Other options include a lock-out brace which permits a slight amount of knee flexion (5–10°) or a large (6–8 in.) ace wrap to support the knee. Patients often are not able to ambulate on crutches acutely and need to be placed in a wheelchair. Patients placed in a knee immobilizer over 4–5 days may develop quadricep muscle atrophy, thus increasing the rehabilitation time of the patient.

Knee Sleeve *(See Table 15.7)*

Many clinicians use various types of knee sleeves to help with proprioception at the joint and to allow the joint muscles to stay warmed up during exercise. These sleeves should not be considered supportive in any way. They are for patient comfort and performance and should be accompanied with an appropriate rehabilitative program.

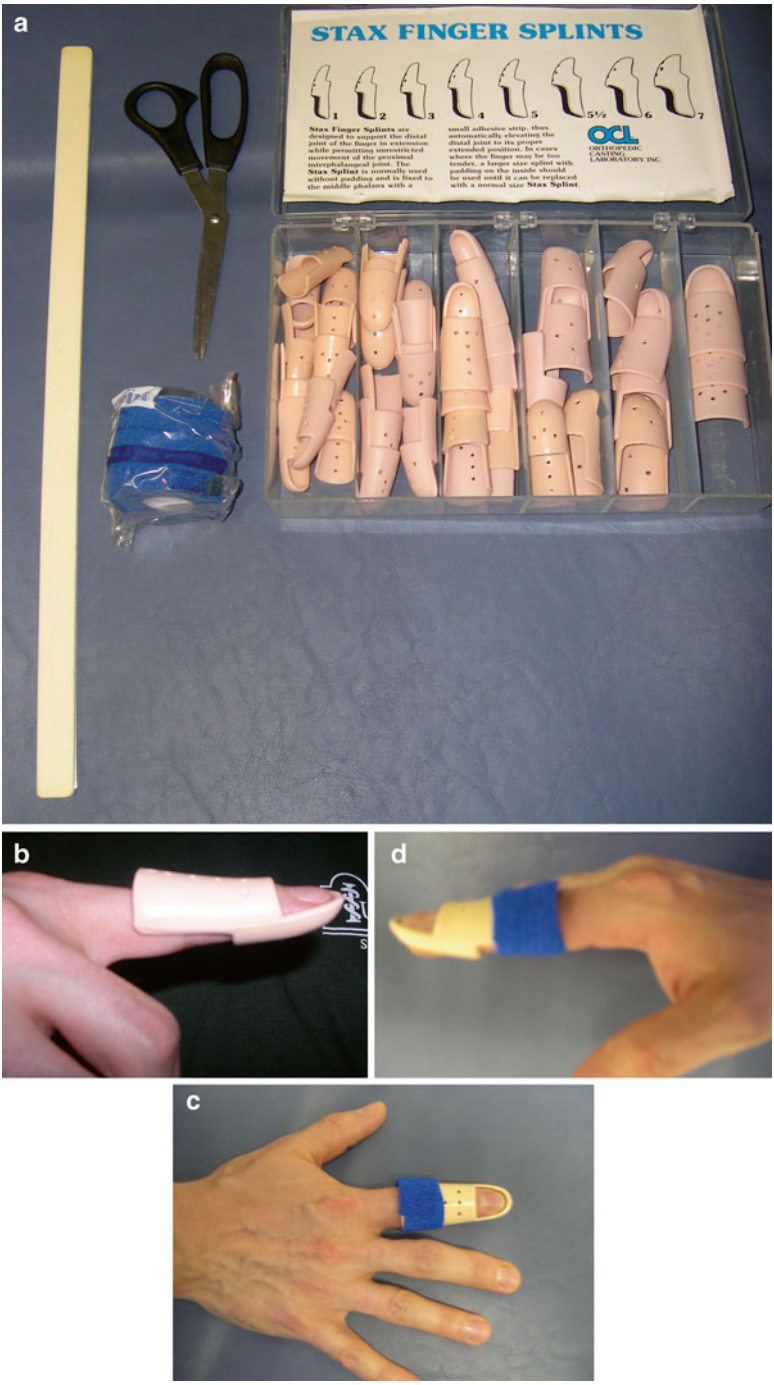

Fig. 15.4 (**a**) Application of mallet finger or stax splint. (**b**) Allow the patient to try on a number of splints on opposite, corresponding finger to get an idea of the size needed. The proper size should hold the DIP joint in slight extension without putting too much pressure on the skin. The PIP joint must be able to flex freely. (**c**) After the splint is applied, 1 in. wrap or cloth tape is used to "marry" the splint to the finger. The splint is *not removed to wash*, etc. This is the reason for the ventilation holes. (**d**) Proper application of a mallet finger splint – *medial view*

Table 15.5 Extensor block splint

Indications	Contraindications
Volar plate injury	Unstable fracture (fracture involves over 1/3 of the joint)
Displaced angulated rotated fracture of the proximal two phalanges	Open fracture
	Evidence of infection

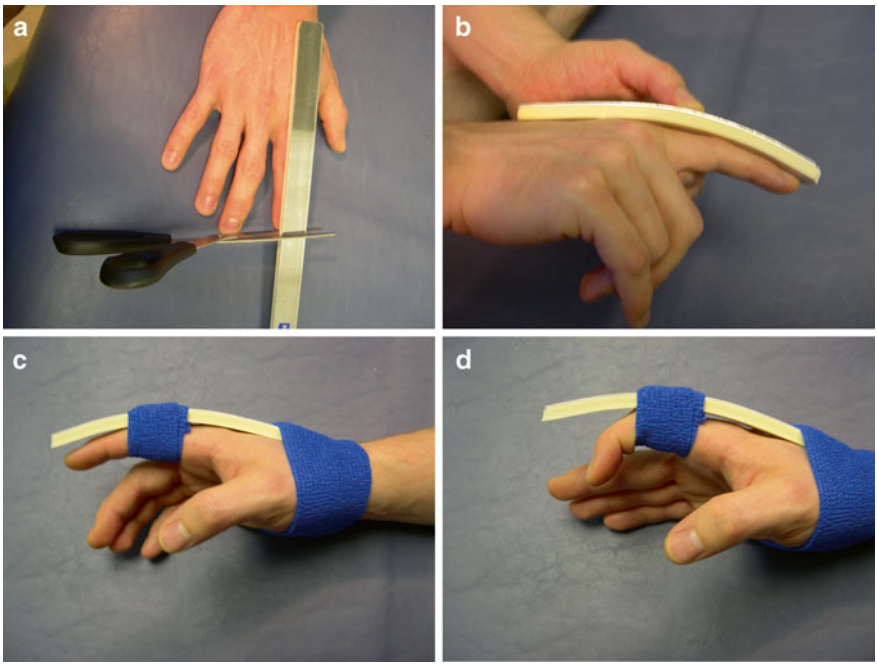

Fig. 15.5 Extension block splint. (**a**) Measure splint material from base of wrist to distal phalanx (the patient should be able to flex and extend wrist). (**b**) Mold dorsal splint to finger in "safe hand" position. (**c**) Apply 2 in. wrap to base of splint at wrist. Then apply 1 in. wrap to proximal phalanx of finger. (**d**) The extension block splint allows the patient to flex the PIP and DIP joint but blocks extension. If complete immobilization is desired, a 1 in. wrap is applied to distal phalanx and splint

Table 15.6 Knee immobilizer

Indications	Contraindications
Transport nondisplaced fracture	Long-term use over 1 week
Dislocated/relocated patella	Inability for the patient to follow-up
Temporary immobilization for suspected torn meniscus	Complex fracture
	Trauma
	Multiple ligament injuries suspected without consultation
	Vascular injury without consultation

Table 15.7 Knee sleeve

Indications	Contraindications
Dynamic splinting of the patella	Elastic, latex, neoprene allergy
Increase in proprioception of the knee after injury or rehabilitation	Dermatologic conditions such as eczema
	Skin infection

Table 15.8 Ankle sugar tong splint

Indications	Contraindications
Nondisplaced ankle fracture	Long-term use over 1–2 weeks
Transport of more serious fractures	Inability for the patient to follow-up
	Complex fracture
	Trauma
	Multiple ligament injuries suspected without consultation
	Vascular injury suspected without consultation

Ankle Sugar Tong Splint *(See Table 15.8 and Fig. 15.6a–d)*

A sugar tong splint is easily put in place with the patient in prone position and the knee flexed. The foreleg and ankle may be supported by the examiner or an assistant. The splint material is then put in place using the same technique discussed above for the upper extremity. Some clinicians prefer this splint over a posterior splint.

Ankle sprains are a common injury, usually involving the ligaments on the lateral aspect of the ankle. The typical mechanism is an inversion injury with plantar flexion, supination, and adduction of the foot relative to the ankle. The need for X-rays can be assessed using the Ottawa ankle rules (see Chap. 10). The immediate development of a hematoma on the ankle usually precludes an immediate return to full activity. If the person can bear weight and perform required duties, it is reasonable to attempt a quick return to activity with some form of protection. Taping and strapping are two common methods, and there are numerous off-the-shelf braces available for support. An important criterion is the symmetry of foot and ankle posture while weight bearing. If the patient is unable to keep the toes in front of the heel in a posture that mirrors the uninjured foot, then crutches are a consideration to unload the injured extremity.

Proper Use of Crutches

Patients should demonstrate the proper technique of crutch use before leaving the treatment area. Simply showing the patient how to use the crutch or providing them with written instructions alone is not adequate. The crutch should be adjusted to a position two to three finger breadths below the axilla. If the crutches press against

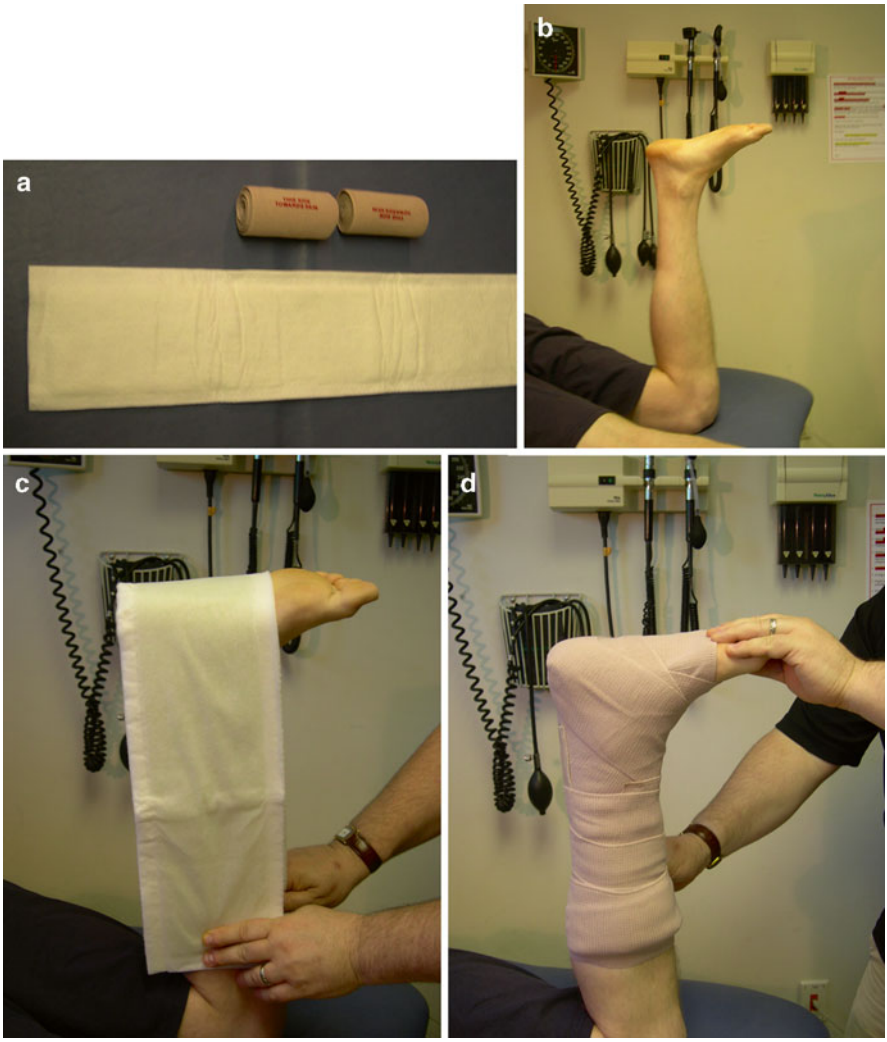

Fig. 15.6 Lower extremity sugar tong splint. (**a**) Four to six inch splint material and two 4 in. ace wraps or one 4 and 6 in. ace wrap (depending upon size of the patient). Splint material should be long enough to immobilize ankle and cover three-quarters of foreleg twice. If splint is not long enough, overlap two shorter splints. (**b**) Have the patient lie on table in prone position (*face down*) and flex the knee 90° and ankle 90°. (**c**) Apply the splint, padded side down, facing the patient. Notice that the splint covers the foot at least to midfoot and overhangs the heel just slightly. (**d**) Apply ace wrap proximal to distal, overlap bandage by one-half inch. The splint should keep the ankle at 90° and extend proximally to one-half to three-quarters of the foreleg

the brachial plexus of the axilla, the patient will experience paresthesia and pain. The patient should not "bear weight" using the axilla. The handles need to be adjusted so the elbow is completely extended so the patient's weight is supported by the palms of their hands. If the handles are too high, the patient's axilla will prematurely fatigue. Patients should not use crutches on escalators, slick surfaces, or stairs.

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Chapter 16
The Preparticipation Physical Exam

Merle H. Muller, Dae Hyoun Jeong, and Daniel M. Couri

The preparticipation evaluation (PPE) is a necessary, yet controversial and regulated, function that serves several purposes for athletic participants. At its core, the PPE is a screening tool used to identify potentially life-threatening or debilitating conditions that may manifest as a result of athletic participation. However, there are many other objectives of the PPE that are of great importance and less controversial. This chapter will discuss the pertinent details in performing an adequate PPE with special attention to the most common life-threatening conditions. Examples of medical history questions, exam techniques, and clearance issues will be provided.

An adequate screening tool has several characteristics. It should identify readily prevalent life-threatening or disabling conditions. It should also be simple to interpret, be cost effective, and allow for very few false negatives [1]. Currently, data supporting the efficacy of the PPE to meet these requirements is lacking. Nonetheless, a PPE is required by virtually all states for participation in school-sponsored athletics. Virtually all college institutions require a full PPE upon entrance to the program. Thus, in addition to being a screening tool, the PPE is felt to serve other important objectives. These objectives include identifying predisposition to injury, determining general health, providing an entry point for adolescents into the healthcare system, and initiating discussion on topics relevant to adolescent health [2].

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Musculoskeletal assessment during the PPE is an important opportunity for the provider to become familiar with past, present, and potential future problems the athlete encounters. Up to 90 % of athletes in one survey believe the PPE can help prevent injury [3]. This indicates many athletes may have questions regarding injury prevention. The PPE provides a gateway to identify and discuss acute, recurrent, or improperly rehabilitated injuries that may predispose the athlete to other injuries. While the purpose of the PPE is not to diagnose individual conditions, further assessment can be coordinated in order to properly address the athlete's concerns. In addition to providing a comprehensive musculoskeletal assessment, the PPE can serve as an assessment of general health. In fact, the PPE may serve as an entry point for many adolescents into the healthcare system. While data is again lacking on the effectiveness of this model, multiple organizations advocate routine health exams and preventive counseling for adolescents [4]. The PPE is not designed to take the place of these visits. However, its importance in providing a platform for discussion and introduction to the concept of establishing a medical home should not be underestimated.

The setting, structure, and qualification of examiners can play a major role in the effectiveness of the PPE. Multiple settings are used ranging from an individual office visit with the athlete's primary care provider (PCP) to "gymnasium" exams where athletes are herded from station to station. Ideally, the athlete's PCP will perform the exam and coordinate further assessment if necessary. Unfortunately, this scenario is rarely feasible. The responsibility of coordinating the PPE should then fall to the team physician. The team physician may coordinate with other qualified providers. State regulations and governing bodies vary with respect to which healthcare providers are qualified to perform the PPE. However, it is recommended the history and exam be performed by the same provider to ensure all components are reviewed. Noisy gymnasium settings with multiple stations for physical exam are considered inappropriate. These settings lack privacy and fail to meet the primary objectives of the PPE [2].

The appropriate frequency of the PPE can be quite variable. There is no evidence that more frequent PPEs reduce the risk of injury or death associated with athletic participation [2]. In general, younger athletes should have more frequent evaluations. Many states in fact require yearly exams for high school-age athletes and younger. For college athletes, a comprehensive PPE is recommended any time a new athlete enters an institution. Following the comprehensive evaluation, an annual update consisting of history, height, weight, blood pressure, and problem-focused physical exam is adequate [2].

Obtaining the Medical History

A thorough medical history is the most important portion of the PPE [2, 5]. Performing a complete history will identify 75 % of problems affecting athletes [2, 6, 19]. Ideally, parents and athletes will complete the history form together.

It is also imperative that the physician review the history with the athlete prior to the examination. Any abnormal response should prompt the physician to elicit further explanation.

An example PPE form is available for use at the American Medical Society for Sports Medicine website (www.amssm.org). It is important to know if the athlete has been previously disqualified. Any prior disqualification will require investigation including details of the diagnosis, review of medical records, and possible further subspecialty consultation before a clearance determination can be made.

Inquiring about medications, both prescription and over-the-counter, is imperative as it may provide the examiner information regarding medical conditions that the athlete failed to report. Assessment of the adequacy of prescription medications for control of chronic conditions is important. Specifically inquire about supplement use as many athletes do not report "natural" or ergogenic aids as medications. The PPE is an important time to counsel athletes on the use of such aids and possible performance expectations, as well as to assess the legality based on the sport's governing body [2].

Notation of environmental allergies may be important if the athlete is participating in an outdoor sport. Anaphylaxis to hymenoptera (e.g., bee, wasp, yellow jacket, and fire ant) envenomation should be noted and communicated with appropriate staff and coaches. The athlete with a history of anaphylaxis should be required to carry injectable epinephrine.

A primary objective of the PPE is to screen for life-threatening conditions. The estimated incidence of sudden cardiac death in high school and college athletes in the United States ranges from 1 in 83,000 (collegiate athletes only [2, 7]) to 1 in 200,000 (combine high school and college athletes; [2, 8]) per academic year. Any history of syncope or near syncope requires further, detailed, investigation. The actual historic details are the primary vehicle for separation of benign (neurocardiogenic) from malignant (ion channelopathies, structural heart disease) pathologies, with any history of exercise-induced syncope generally warranting subspecialty evaluation. Syncope after exercise is more likely related to exercise-associated collapse and carries a less ominous prognosis; however, further inquiry and potential cardiovascular evaluation may be required.

The pathology of chest pain in an athlete should be approached in an age-centered fashion. In younger athletes (ages 12–25 years), complaints of chest pain are often noncardiac in nature and may represent symptoms of exercise-induced asthma (EIA) or other noncardiac conditions. In athletes age 35–40 years, atherosclerotic disease becomes the most likely etiology [9]. Regardless of age, any athlete with complaints of chest pain in concert with syncope should undergo subspecialty evaluation.

Palpitations in athletes are often indicative of arrhythmias [2]. A history detailing the timing of the onset, heart rate, and frequency of episodes should be obtained. Use of caffeine, tobacco, illicit drugs, and supplements should also be investigated. Palpitations may be associated with syncope or presyncope. If they occur in association with exercise intolerance, lightheadedness, or chest discomfort, the athlete should be evaluated for a primary cardiac disorder.

The most common cardiac condition seen in participants of competitive athletics is hypertension. Correlating age, sex, height, and blood pressure to established percentiles is necessary to diagnose and establish severity of hypertension. Any athlete with a known or suspected history of hypertension requires further monitoring and counseling beyond the PPE to determine the safety of athletic participation.

Up to 50 % of children athletes will be diagnosed with an "innocent" murmur. Innocent murmurs are often of low grade (grade 1–2/6) and occur early in the cardiac cycle (early–mid systole). Pathologic auscultatory findings, i.e., third and fourth heart sounds (S3, S4), abnormal splitting of the 2nd heart sound, prominent (≥3/6) systolic murmurs, diastolic murmurs, etc., may be harbingers for underlying heart disease. Ejection murmurs may be accompanied by a click and are typically abnormal in any age athlete.

Eliciting a history of cardiac testing may reveal a suspected cardiac disorder that the athlete had not revealed. The examiner should obtain these medical records for review and documentation.

A detailed family cardiac history is very important. Identification of a first-degree relative that suffered sudden death prior to age 50 may place the athlete at increased risk for sudden death. It is imperative to inquire about the circumstances surrounding the relatives' death. If this history is present, the athlete should be considered for a basic workup, including EKG, echocardiogram, and lipid panel. Genetic causes of sudden cardiac death include connective tissue disorders (Marfan syndrome), ion channelopathies (long QT), and structural heart disease (hypertrophic cardiomyopathy, arrythmogenic right ventricular cardiomyopathy, anomalous coronary anatomy, and familial dilated cardiomyopathy) [2].

Controversy exists regarding the use of routine noninvasive cardiovascular screening such as ECG or echocardiography in athletes. Previously, the American Heart Association (AHA) recommended against cardiovascular screening of asymptomatic athletes with ECG or echocardiography due to the size of the athlete cohort, low prevalence of disease, limited resources, absence of a physician cadre to interpret the ECG, and the potential to create anxiety in athletes with false-positive test results [2, 9]. In a recent Scientific Statement, however, the American Heart Association recognized (with a class IIb recommendation, level of evidence C) that 12-lead ECG screening (or echocardiograms) in association with comprehensive history-taking and physical examination may be considered in relatively small cohorts of young people 12–25 years of age to identify or raise suspicion of genetic/congenital or other cardiovascular abnormalities, emphasizing *close physician involvement* and *sufficient quality control* [10]. Additionally, recognizing this need to advance integration of the cardiovascular specialist into the athlete healthcare team, the American College of Cardiology formed the Section of Sports and Exercise Cardiology in 2011, with over 4,000 current members [11].

The American College of Preventive Medicine (ACPM) position statement supports using a standardized history and physical exam (i.e., using standardized items as developed by the AHA [9, 20] to ensure uniformity and consistency in risk assessment); see Table 16.1 [11, 20]. ACPM recommends against routine screening for potential sudden cardiac death with ECG, echocardiography, and genetic testing in individuals without personal risk factors [11, 20].

Table 16.1 Standardized history and physical

Medical history
Personal history
1. Exertional chest pain/discomfort
2. Unexplained syncope/near-syncope
3. Excessive exertional and unexplained dyspnea/fatigue associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure
6. Prior restriction from participation in sports
7. Prior testing for the heart, ordered by a physician
Family history
8. Premature death (sudden and unexpected or otherwise) before age 50 years due to heart disease, in ≥1 relative
9. Disability from heart disease in a close relative aged <50 years
10. Specific knowledge of certain cardiac conditions in family member: hypertrophic or diluted cardiomyopathy, long QT syndrome or other ion channelopathies, Marfan syndrome, or clinically important arrhythmias
Physical examination
11. Heart murmur
12. Femoral pulses to exclude aortic coarctation
13. Physical stigmata or Marfan syndrome
14. Brachial artery blood pressure (sitting position)

Source: Adapted from Ref. [11]

Athletes with a significant neurological history, such as a seizure disorder, head injuries, concussions, stingers or burners, pinched nerves, or recurrent headaches will need a thorough history and will likely need further evaluation not possible at the PPE [2]. Preexistence of any of these conditions may indicate that the athlete is at risk for a future catastrophic neurologic injury [2]. Assessing for a history of concussions or prior head trauma allows the physician to discuss preventative strategies with the athlete as well as to counsel the athlete on the risk involved with collision sports and recurrent brain trauma.

A straightforward and easily understandable definition of concussion is "a traumatically induced transient disturbance of central neurologic function" [2]. It is important to remember that the loss of consciousness is not required to make the diagnosis of concussion, and in about 90 % of concussions, there will be no loss of consciousness [2]. Essentially, there are three main issues to consider when deciding whether it is reasonable to clear someone or return them to play after a concussion: second impact syndrome, postconcussion syndrome, and persistent neurologic deficit [2].

Stingers and burners are a common occurrence in collision sport athletes. Annually, 52 % of football athletes experience a stinger and, overall, 65 % will report at least one stinger in their career [2]. Evaluation of episodes of cervical cord neuropraxia (CCN) is also important. Athletes with CCN or recurrent stingers may benefit from a formal neurologic evaluation.

A thorough musculoskeletal history provides the examiner insight into an athlete's prior injury history and training methods. If the athlete has a history of stress fracture, further inquiry into training methods may be indicated to prevent recurrence of such injuries. Any workup that has been done on previous injuries also gives the examiner insight into the severity of the injury.

EIA is one of the most common encountered conditions of the PPE with a prevalence of 10–50 % in adolescents. In athletes who have been diagnosed with EIA, the PPE allows the physician to discuss timing and use of short-acting inhalers, avoidance of possible triggers, use of rescue inhalers during competition, and response to treatment. The physician must also maintain a high level of suspicion when the athlete complains of subtle symptoms, such as fatigue, being "out of shape," muscle cramps, and decreased stamina. Workup in such cases may be aided by performing spirometry in an exercise setting.

Heat edema, heat cramps, heat-related syncope, heat exhaustion, and heat stroke make up the spectrum of heat-related illnesses. Exertional hyperthermia is the leading cause of nontraumatic, noncardiac-related sports deaths [5]. Assessment of circumstances around the occurrence of heat illness in an athlete is important. Factors such as acclimatization, equipment, fluid intake, weight changes, medications and supplements, and history of heat illness are all important factors. Previous occurrence of heat illness does not prevent the athlete from being able to participate in sports. The importance of the PPE in these cases is to discuss prevention and treatment strategies.

Individuals with sickle cell disease should avoid highly strenuous activity and all contact and collision sports. Sudden death in athletes has been associated with sickle cell trait while doing strenuous activity in high environmental heat or altitude. Universal screening for sickle cell trait has been recommended [2]. Recommendations include asking the athlete if they have been screened for sickle cell trait. If positive for sickle cell trait, the athlete should acclimatize gradually and engage in year round training to maintain physical conditioning [2]. Education of the staff, coaches, and athletes concerning the condition and prevention of possible complications is the most important aspect [2]. The remainder of the PPE may focus on issues that are specific to the athlete. Questions concerning weight issues, menstrual history, and immunizations may be indicated based on concerns or observations of a specific athlete. Any affirmative responses on the history form should be an indicator to the examiner to obtain further information.

Performing the Physical Exam

The purpose of the physical exam portion of the PE is to identify athletes that may be at an increased risk of disability or death during athletic participation. Essential to the exam is a thorough cardiovascular assessment as well as evaluation of the musculoskeletal system. A focused exam should be performed based on findings from the history. Table 16.2 lists the components that should be included on the physical exam.

Measurement of height and weight allows the examiner to determine the athlete's body mass index (BMI). If an athlete is underweight, it may prompt further questioning by the examiner to assess for an eating disorder.

Table 16.2 Components of PPE

Height
Weight
Eyes
Visual acuity
Differences in pupil size
Oral cavity
Ears
Nose
Lungs
Cardiovascular system
Blood pressure
Pulses (radial, femoral)
Heart (rate, rhythm, murmurs)
Abdomen
Masses
Tenderness
Organomegaly
Genitalia (males only)
Single or undescended testicle
Testicular mass
Hernia
Skin
Rashes
Lesions
Musculoskeletal system
Contour, range of motion, stability
Symmetry of neck, back, shoulders/arms
Elbow/forearm, wrist/hand, hip/thigh
Knee, leg/ankle, foot

Evaluation of the head, eyes, ears, nose, and throat (HEENT) begins with visual acuity measurement using a Snellen eye chart. Visual acuity should be 20/40 or better in each eye with or without corrective lenses [2]. If best corrected vision is less than 20/40, the athlete has one eye missing, or a history of a significant eye injury, they should wear protective eye wear when participating in high-risk sports.

The remainder of the HEENT exam should focus on the general well-being. The examiner should note any oral ulcers or decreased enamel that may be evidence of an eating disorder. A high-arched palate is a minor diagnostic criterion for Marfan syndrome. Athletes with braces or other oral hardware may need a mouth guard to protect from laceration. Assessment of tympanic membranes for perforation is important in water sports athletes and may necessitate use of ear plugs [2].

When evaluating the lungs of an athlete, it is important to note wheezes, rub, prolonged expiratory phase, or significant cough with a forced expiration. These conditions may need further workup or may need referral to the appropriate specialist. It is important to note that athletes with EIA may have a normal exam during the PPE.

The cardiovascular exam should focus on the four major areas outlined in the 14-element American Heart Association Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes [9]. These include generalized inspection (with specific attention to the stigmata of Marfan syndrome [12]), blood pressure measurement, femoral artery palpation (palpation of radial and femoral pulses), and cardiovascular auscultation [9].

During generalized inspection, aside from casual assessment of carotid and venous wave forms, the examiner should pay particular attention to the thoracic anatomy. Pectus deformities, scoliosis, kyphosis, and increased arm/height ratio with reduced upper torso/lower torso dimension should all raise suspicion of potential Marfan syndrome [12]. At the discretion of the examiner, a more comprehensive assessment of the revised Ghent nosology should subsequently follow (with subspecialist referral as indicated) [9, 12].

Blood pressure should be taken using an appropriate-sized cuff for the athlete. Blood pressure elevation should be interpreted using charts based on the athlete's age, sex, and height. If the initial measurement is elevated, repeat the blood pressure measurement after the athlete has sat quietly for 5 min or reclined supine for 10–15 min [2].

Palpation should begin with characterization of the radial pulse, rate, and rhythm, progressing thereafter to simultaneous assessment of the radial and femoral arteries. Findings indicative of an arrhythmia or radial/femoral artery discrepancy should be further investigated. Thereafter, precordial palpation is completed with specific attention to the anterior precordium and the point of maximal impulse. A heave or thrill in the anterior precordium, as well as a displaced, sustained, or bifid apical impulse, should alert the examiner to potential nonphysiologic pathology and subsequently be correlated with auscultatory findings.

Cardiovascular auscultation allows the examiner to integrate observations from inspection and palpation and arrive at a unified opinion of the athlete's overall cardiovascular health. Auscultation should be completed in the supine, seated, and standing positions, with integration of the Valsalva maneuver when indicated. Careful notation of the intensity of the first and second heart sounds, as well as respiratory variation (i.e., splitting) of each heart sound, should be made. Diminished auscultatory intensity of the first heart sound, end-expiratory splitting of the second heart sound, and/or paradoxical splitting of the second heart sound all suggest pathology. The presence of additional heart sounds, i.e., third (S3) and fourth (S4) heart sounds, systolic clicks, and systolic/diastolic murmurs, requires additional diagnostic diligence on the part of the examiner.

Although an S3 may be physiologic in an athlete, it should occur in isolation of other cardiovascular abnormalities. An S4, on the other hand, is always pathologic. While provocative maneuvers may be performed to help clarify cardiac murmurs (Table 16.3), (1) any mid-peaking systolic murmur grade 3/6 or higher, (2) any holosystolic or late systolic murmur, (3) any diastolic or continuous murmur, and (4) any murmur associated with a systolic click or (5) radiating to the neck or back warrant echocardiographic evaluation [13]. Particular attention should be paid to the early–mid systolic murmur that accentuates with either the strain phase of Valsalva or when rising from a swatting position (i.e., dynamic outflow tract obstruction). Grade 1–2/6, early–mid systolic murmurs in an asymptomatic athlete with an otherwise normal examination, do not warrant further evaluation [13]. Abnormal noninvasive testing should be referred for subspecialty evaluation [9].

Table 16.3 Effects of physiologic maneuvers on auscultatory events

Maneuver	Major physiologic effects	Useful auscultatory changes
Respiration	↑Venous return with inspiration	↑Right heart murmurs (except PS) and gallops with inspiration, splitting of S2
Valsalva maneuver	↓BP, venous return, LV size	↑HCM (dynamic obstruction) ↓AS, MR MVP click earlier in systole, murmur prolongs
Standing	↓Venous return	↑HCM (dynamic obstruction); ↓AS, MR MVP click earlier in systole, murmur prolongs
Squatting	↑Venous return, systemic vascular resistance, LV size	↑AS, MR, AI; ↓HCM (dynamic obstruction) MVP click delayed, murmur shortens
Isometric exercise	↑Arterial pressure, cardiac output	↑MR, AI, MS, PS ↓AS, HCM (dynamic obstruction)

Source: Ref. [2, 13]

The abdominal exam should be performed with the athlete supine and the abdomen exposed to allow for sufficient inspection. Palpation of all four quadrants should be performed. Palpation of the liver and spleen should include an assessment of size. If there is any enlargement of the organs or any abdominal masses, these should be evaluated prior to clearance. In the female athlete, palpation of the lower abdomen to assess for any enlargement of the uterus may be indicated. A pelvic exam should be deferred to the athlete's primary care doctor.

Prior to performing a male genitourinary exam, the examiner should provide a brief description of and reasoning for the exam. This will help in establishing rapport with the athlete. The important aspects of this exam include presence of both testicles, testicular masses or irregularities, and inguinal hernias [2]. In an athlete with a single testicle or undescended testicle, the examiner should counsel the athlete on participation in collision sports.

Examination of the skin should include notation of acne, evidence of sun damage, rashes, infections, infestations, or evidence of intravenous drug use. Special attention should be paid to evidence of eczema, impetigo, furuncles, carbuncles, herpes simplex lesions, molluscum contagiosum, fungal infections, scabies, and louse infestations [2]. If an athlete appears to have a contagious rash or infection, clearance may be withheld until the infection clears, especially in sports that require close contact with other athletes.

The evaluation of the musculoskeletal system should focus on any areas of previous injury based on the history and on areas that may be at an increased risk of injury based on the sports. In athletes without a history of injury, the yield of a thorough musculoskeletal exam is low [2]. In these athletes, a screening exam may be performed.

Finally, assessment of the neurologic system should be performed. In general, a normal musculoskeletal exam implies normal motor function [2]. Athletes who indicate a history of recurrent stingers or burners should have an evaluation of their cervical spine as well as assessment of upper extremity strength. If a history of concussions is reported, evaluation of cranial nerves and motor, cerebellar, and cognitive function is indicated [2]. If any impairment is found on these examinations, referral for detailed neurologic testing is indicated.

Table 16.4 Classification of sports by contact level

Contact/collision sports	Limited contact sports	Noncontact sports
Basketball	Baseball	Archery
Boxing	Bicycling	Badminton
Diving	Cheerleading	Canoeing/kayaking (flat water)
Field hockey	Canoeing/kayaking (white water)	Crew/rowing
Football (flag or tackle)	Fencing	Curling
Ice hockey	Field events (high jump, pole vault)	Dancing
Lacrosse	Floor hockey	Golf
Martial arts	Gymnastics	Race walking
Rodeo	Handball	Riflery
Rugby	Horseback riding	Rope jumping
Ski jumping	Racquetball	Running
Soccer	Skating (ice, inline, roller)	Sailing
Team handball	Skiing (cross-country, downhill, water)	Scuba diving
Water polo	Softball	Swimming
Wrestling	Squash	Table tennis
	Ultimate frisbee	Tennis
	Volleyball	Track and field
	Windsurfing/surfing	Weight lifting

Adapted from Ref. [9]

Clearance Determination

The act of determining clearance for sports participation must take several questions into account. The examiner must consider if the problem places the athlete – or other athletes – at risk for injury or health problems. In addition, the examiner must consider if there are viable treatment options or other participation options for the athlete. Sports can be classified on the basis of contact or intensity (static and dynamic activity; see Tables 16.4 and 16.5). Should an issue arise as part of the PPE, the examiner has several options for clearance ranging from cleared without restrictions, cleared with follow-up, not cleared pending further evaluation, and not cleared for certain activities.

As recognized in the 2007 American Heart Association Scientific Statement on Preparticipation [11], it is not possible to achieve a "zero-risk" circumstance in competitive sports [9]. In all clearance determination issues, communication with the athlete and family regarding potential workup, treatment, and participation consequences is paramount. Communication with the athletic training staff, coaching staff, and school officials is also critical. However, patient confidentiality must be respected at all times. A release of information waiver may be signed by the athlete (or parents) allowing communication with other school personnel regarding the athlete's condition. The remainder of this section will discuss specific clearance determination issues by system.

Table 16.5 Classification of sports by intensity level

High-moderate dynamic	High-moderate dynamic	Low dynamic
High-moderate static	Low static	High-moderate static
Boxing	Badminton	Archery
Crew/rowing	Baseball	Auto racing
Cross-country skiing	Basketball	Diving
Cycling	Field hockey	Equestrian
Downhill skiing	Lacrosse	Field events
Fencing	Orienteering	Gymnastics
Football	Table tennis	Karate or judo
Ice hockey	Race walking	Motorcycling
Rugby	Racquetball	Rodeo
Running (sprinting)	Soccer	Sailing
Speed skating	Squash	Ski jumping
Water polo	Swimming	Water skiing
Wrestling	Tennis Volleyball	Weight lifting

Adapted from Ref. [9]

Cardiovascular

Clearance for cardiovascular conditions has been established by the guidelines set forth by the 36th Bethesda Conference [9]. Any physician determining preparticipation clearance for an athlete should be familiar with these guidelines. A positive response or finding in any 1 or more of the 14 items in the recommended AHA Preparticipation Cardiovascular Screening potentially warrants a formal cardiovascular consultation [9]. An athlete should not be cleared for participation until that evaluation is completed. Refer to the Bethesda guidelines for clearance issues regarding specific cardiovascular diagnoses.

Elevated blood pressure is one of the most common abnormalities found during the PPE. The use of appropriate-sized cuffs and maintaining a quiet environment for accurate measurement are a must in all settings. For those athletes younger than 18, established blood pressure values based on height, weight, age, and gender should be used for comparison. Values between the 90th and 99th percentile are classified as stage 1 hypertension, while values greater than the 99th percentile are classified as stage 2 hypertension [10]. Athletes 18 years and older can be classified according to JNC8 guidelines [14]. An athlete with stage 1 hypertension and no evidence of end-organ damage is free to participate in all sports categories provided a physician is supervising their condition. Athletes with stage 2 hypertension or who have findings of end-organ damage require further evaluation and treatment prior to full clearance. These situations require assessment on an individual basis with respect to participation risk, severity of disease, and sport [2].

The presence of a murmur found during the PPE does not necessarily preclude clearance. The physical exam section aids in delineating potential causes – both benign

and pathologic – of such murmurs. A positive response or finding, however, in any 1 or more of the 14 items in the recommended AHA Preparticipation Cardiovascular Screening may be sufficient to warrant a formal cardiovascular referral [9]. An athlete should not be cleared for participation until that evaluation is completed. Refer to the Bethesda guidelines for clearance issues regarding specific cardiovascular diagnoses.

Another common cardiovascular condition encountered during the PPE includes arrhythmias. The presence of symptoms such as syncope and chest pain as outlined in the physical exam section should prompt further workup of a potential arrhythmia or other cardiovascular disorder. Again, reference to the Bethesda guidelines and cardiology consultation is required prior to the clearance in any athlete presenting with an arrhythmia.

Neurologic

Several neurologic issues may present as part of the PPE. One of the most common involves a history of concussion. Any athlete with recent history of concussion should be fully evaluated to assess resolution of symptoms prior to return to activity. A remote history of concussion in an otherwise asymptomatic athlete should not preclude participation [2]. Utilization of baseline neuropsych testing remains a controversial subject in regard to its role in the PPE. At this time, neuropsych testing is not necessary, but may be considered as part of the PPE.

An athlete presenting for PPE clearance with a history or transient quadriplegia or CCN requires evaluation and ultimate clearance from a specialist familiar with such issues, usually a neurologist or neurosurgeon. Return-to-play issues for athletes with this history and no identifiable structural or pathological abnormalities are controversial and require assessment on an individual basis [11]. Any athlete with identified instability or progressive lesions presenting with such a history should be excluded from contact sports.

"Burners" or "stingers" on the other hand would not preclude an athlete from participation providing a detailed examination at the time of PPE is normal. Athletes with a history of recurrent episodes or prolonged symptoms, however, require diagnostic imaging to rule out a pathologic cause. Such cases would then require individual assessment and specialist evaluation prior to clearance for contact sports.

Athletes with a history of seizure disorder that is stable and well controlled can participate in virtually all sports. If the seizure disorder is new or poorly controlled, clearance should be deferred for the majority of sports. Conditioning and limited participation that do not pose increased risk to the athlete or others may be considered until the process is considered stable.

Musculoskeletal

Clearance determination for athletes with musculoskeletal injuries can have many facets. Obviously review of every musculoskeletal injury is beyond the scope of this chapter. The situation surrounding the injury and the athlete's clearance will

determine how best to proceed. These factors can include whether the athlete is new or returning, the acuity of the injury, current rehabilitation status, fracture care, and postsurgical care.

Acute injuries should be evaluated for the presence of joint effusion, loss of range of motion, strength deficit, and inability to perform sports-specific skills. Full clearance will depend upon resolution of these issues. The athlete may, however, have limited participation that does not pose increased injury risk while they continue to rehabilitate. Fracture clearance and postsurgical clearance should be deferred to the treating physician.

Chronic injuries and developmental conditions must be addressed on an individual basis. The deficit, sport, and risk of injury must all be factored into the decision. Ideally, the patient's primary care physician and/or treating physician are involved in the decision-making process for clearance determination. If questions or controversy exists regarding the clearance determination, consultation with a sports medicine specialist familiar with the athlete's condition is suggested.

Pulmonary

The most prevalent pulmonary disorder encountered as part of the PPE is exercise-induced bronchoconstriction. Accurate diagnosis of this disorder, however, can be quite challenging. Rarely will a complaint of exercise-induced bronchoconstriction or asthma result in a restriction of participation at the time of PPE. The physician's objective at the time of PPE should be to assess accuracy of diagnosis, severity of disease, and adequacy of treatment. Based upon these historical, clinical, and physical factors, the physician and athlete can develop a plan for further workup and intervention if needed.

Abnormal Vision and Eye Disorders

One of the most common abnormalities encountered as part of the PPE is poor vision. The visual acuity test functions as the "vital sign" of the eyes. An athlete with best corrected vision of less than 20/40 in one eye is considered monocular or a functionally one-eyed athlete. The importance of this classification stems from the fact that loss of vision in the athlete's adequate eye would result in significant impairment for the athlete. Because of this, functionally one-eyed athletes are contraindicated from participation in very high-risk sports or sports where no adequate eye protection can be provided [12]. Participation in other sports is dependent upon the use of adequate eye protection during all participation including practice. Table 16.6 classifies sports based upon risk of eye injury.

Many other eye disorders may present as part of the PPE. These may include but are not limited to retinal detachment, severe myopia, history of infection, and history of surgery. When such conditions are present, consultation with the ophthalmologist is necessary to determine the level of safe participation.

Table 16.6 Eye risk classification

High risk	Moderate risk	Low risk
Shooting sports	Badminton	Bicycling
Boxing	Fishing	Diving
Full-contact martial arts	Football	Noncontact martial arts
Baseball/softball	Golf	Skiing
Basketball	Soccer	Swimming
Cricket	Tennis	Wrestling
Fencing	Volleyball	Gymnastics
Hockey Lacrosse Racquetball Squash	Water polo	Track and field

Adapted from Ref. [2], Table 24 page 70

Abnormalities of Abdominal Organs

There are various conditions involving abdominal organs (i.e., liver, kidney, spleen) that may place the athlete at increased risk. Review of all such conditions is outside the scope of this chapter. The presence of hepatomegaly or splenomegaly identified on PPE should prompt further evaluation and clearance should be deferred pending evaluation. Splenomegaly is most commonly associated with acute mononucleosis. Established guidelines for participation should be strictly followed for any athlete diagnosed with mononucleosis [13]. Athletes presenting with kidney abnormalities should be cleared by a nephrologist for safe levels of participation.

An athlete with a solitary kidney has been the subject of controversy over recent years. Injury to a solitary functioning kidney would produce a dramatic change in lifestyle for any athlete. For this reason, these athletes are occasionally not cleared to participate in high-risk collision sports. These disqualifications seem to be unwarranted based on research analyzing the risk of kidney injury in sports [14, 15]. Nevertheless, the athlete, parents/guardians, and coaches should all be informed of the potential consequences of kidney injury in these athletes.

Gender-Specific Issues

Female athletes with menstrual abnormalities should be evaluated by a physician familiar with the unique characteristics of the female athlete triad. If continued sports participation is determined to place the athlete at an unnecessary health risk, clearance may be denied pending further evaluation and treatment. Otherwise, most athletes with menstrual irregularities can be cleared pending further workup. Female athletes with a solitary ovary may participate without restrictions [2].

The presence of a solitary or undescended testicle in males should not disqualify the athlete from participation provided they are willing to wear protective equipment such as a protective cup [15]. An undescended testicle that has not been treated should be referred to urology for evaluation.

Diabetes

The diabetic athlete poses unique challenges given the increased risk of complications including coronary artery disease, retinopathy, nephropathy, neuropathy, and gastroparesis. Athletes with such complications will need individual assessment depending upon the severity of disease and sports-specific risks. The diabetic athlete with excellent glucose control and no complications may be allowed participation without restriction. Activities such as rock climbing, skydiving, scuba diving, endurance activities, and motor sports may be considered high risk for such athletes [2].

Heat Illness

The athlete with a history of heat illness or severe cramping requires special monitoring and should be identified during the course of the PPE. Detailed review of the circumstances surrounding prior issues with heat illness can help both the physician and athletic training staff to prevent future occurrences. A special consideration is the athlete with sickle cell trait. These athletes are believed to be at increased risk for exertional rhabdomyolysis and sudden death [16]. Factors such as altitude, dehydration, and heat may predispose sickle cell trait athletes to such events. Recent publications from organizations including the NCAA recommend screening for sickle cell trait if the athlete's status is not already known [2].

Transmissible Illness

The risk of transmitting a blood-borne pathogen such as HIV, hepatitis B, and hepatitis C has been difficult to quantify. Given the likelihood of transmission during sports activity – while not impossible – appears incredibly remote, the presence of such illness does not warrant disqualification from participation. The health of the infected athlete, however, must be considered when determining clearance, and regular monitoring of disease progression is recommended as it would be for any member of the general population [2].

CA-MRSA poses a greater challenge due to its nearly ubiquitous presence, high degree of transmissibility with skin-to-skin contact, virulence, and potential morbidity and mortality. A history of such infection should be noted during the

history portion of the PPE. Concerning lesions or open wounds found during the exam should be covered and treated appropriately. An athlete with active infection at the time of PPE may have clearance deferred pending resolution of the infection. NCAA guidelines exist regarding participation for athletes in high-risk sports such as wrestling [18]. Return-to-activity decisions following treatment should be made by the treating physician and/or team physician based upon risk to the infected athlete as well as other competing athletes.

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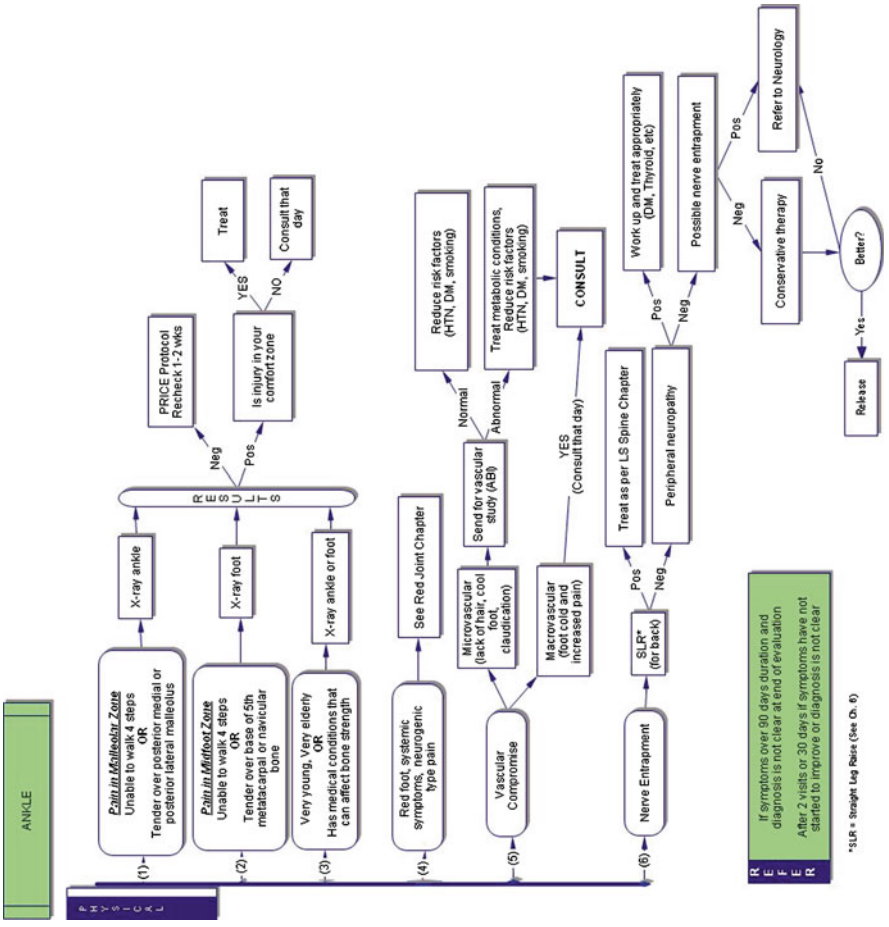
Appendix



J.M. Daniels (ed.), *Common Musculoskeletal Problems: A Handbook*,
DOI 10.1007/978-3-319-16157-0

ANKLE T-SHEET

CC: Ankle Pain R ☐ L ☐ Both ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: _____
Radiation: Yes ☐ No ☐ Where: _____
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____
Pain at Rest ☐ Swelling after Activity ☐ _____

PMHx: Meds: _____
Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

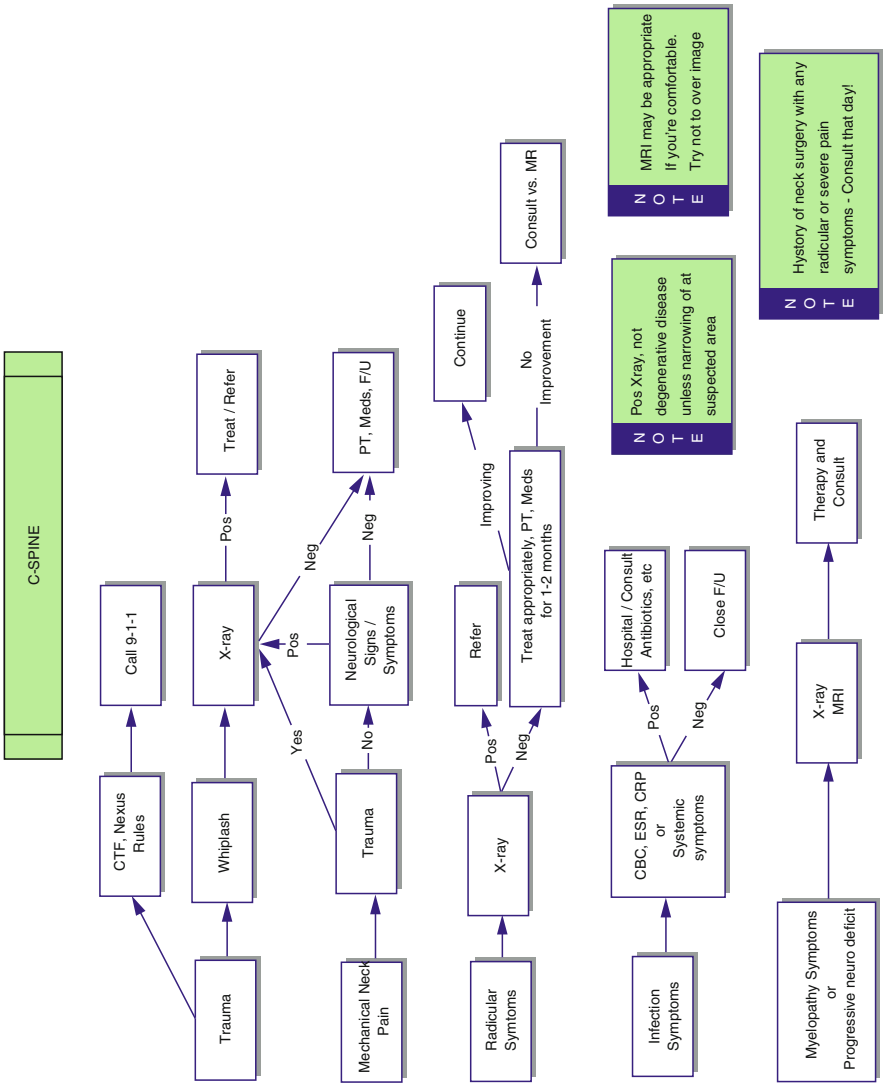
PE: Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____
Gait: Normal ☐ Limp ☐ Assist ☐ _____ Unable to bear weight ☐
Skin: Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

		Right	Left
Vascular:	Dorsalis Pedis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Post Tibialis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Capillary Refill:	Normal ☐ Slow ☐	Normal ☐ Slow ☐
Neuro:	Toe Raise (peroneal):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Distal Sensation:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
ROM:	Dorsiflexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Plantar Flexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	1st MP Joint:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
Active Eval:	Anterior Drawer Sign (Neutral):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Anterior Drawer Sign (Plantar):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Thompson (Squeeze):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
Ottawa Rules:	Navicular tender:	Yes ☐ No ☐	Yes ☐ No ☐
	Medial Malleolus tender:	Yes ☐ No ☐	Yes ☐ No ☐
	Lateral Malleolus tender:	Yes ☐ No ☐	Yes ☐ No ☐
	Base of 5th metatarsal tender:	Yes ☐ No ☐	Yes ☐ No ☐

TREAT APPROPRIATELY	Ankle/Foot Pain..... 719.47 Achilles tendonitis..... 726.71 Ankle Sprain ..... 845.00 Tendonitis ..... 726.79 Foot Sprain/Strain..... 845.10
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Unable to bear weight with negative X-ray findings Cellulitis of Foot/Ankle
CALL CONSULTANT THAT DAY	Uncertain X-ray findings Fracture Cold/Avascular Foot Diagnosis uncertain/perplexing
CONSULT OR REFER	Septic joint Nerve entrapment Fractures, if not comfortable treating Torn Achilles Vascular disease needing surgical treatment

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


C-SPINE
CTF, Nexus Rules
Call 9-1-1
Trauma
Whiplash
X-ray
Treat / Refer
Pos
Yes
Pos
Neg
Trauma
Neurological Signs / Symptoms
PT, Meds, F/U
No
Neg
Mechanical Neck Pain
Radicular Symtoms
X-ray
Pos
Neg
Refer
Treat appropriately, PT, Meds for 1-2 months
Improving
Continue
No Improvement
Consult vs. MR
Infection Symptoms
CBC, ESR, CRP or Systemic symptoms
Pos
Neg
Hospital / Consult Antibiotics, etc
Close F/U
Myelopathy Symptoms or Progressive neuro deficit
X-ray MRI
Therapy and Consult
NOTE
Pos Xray, not degenerative disease unless narrowing of at suspected area
NOTE
MRI may be appropriate If you're comfortable. Try not to over image
NOTE
Hystory of neck surgery with any radicular or severe pain symptoms - Consult that day!

C-SPINE T-SHEET

CC: Neck Pain R ☐ L ☐ Both ☐
Upper Extremity Pain R ☐ L ☐ Both ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: _____
Radiation: Yes ☐ No ☐ Where: _____
Pain at Rest: Yes ☐ No ☐ Where: _____
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx: Meds: _____
Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

PE: Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____

Skin:
Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

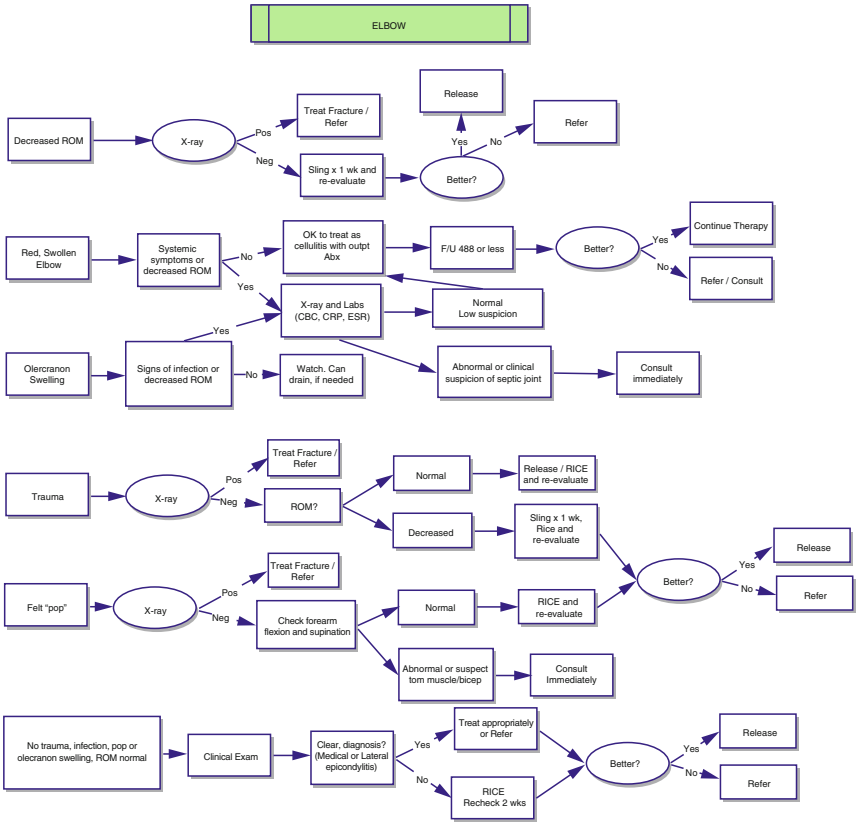
		Right	Left
Vascular:	Capillary Refill:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Radial Pulse:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
Neuro:	Spurling's Maneuver:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Brachioradialis Reflex (C5):	Nl ☐ Absent ☐ ↓ ☐ ↑ ☐	Nl ☐ Absent ☐ ↓ ☐ ↑ ☐
	Bicep Reflex (C6):	Nl ☐ Absent ☐ ↓ ☐ ↑ ☐	Nl ☐ Absent ☐ ↓ ☐ ↑ ☐
	Tricep Reflex (C7):	Nl ☐ Absent ☐ ↓ ☐ ↑ ☐	Nl ☐ Absent ☐ ↓ ☐ ↑ ☐
	Hoffman Test:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Babinski Reflex:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Position Sense:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
ROM:	Rotation:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Flexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Extension:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐

Soft Tissue (Palpation): Tenderness: Yes ☐ No ☐ Location: _____
Vertebral Tenderness: Yes ☐ No ☐ Location: _____
Cervical Lymphadenopathy: Yes ☐ No ☐ Location: _____

TREAT APPROPRIATELY	Cervical Myelopathy ..... 721.1 Degenerative Disc Disease ..... 722.4 Mechanical Pain/Benign Neck Pain ..... 723.1 Mild Radicular Symptoms ..... 723.4 Whiplash Associated Disorder 847.0
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Severe pain Narcotics prescribed
CALL CONSULTANT THAT DAY	Fracture X-ray negative, but tender bony prominence or neurologic signs Meningitis
CONSULT OR REFER	Suspect myelopathy Other positive X-ray findings History of C-spine surgery with recurrent symptoms

Plan:
- ☐ Xray / imaging _____
- ☐ Laboratory eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / work up initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


ELBOW
Decreased ROM
X-ray
Pos
Neg
Treat Fracture / Refer
Sling x 1 wk and re-evaluate
Better?
Yes
No
Release
Refer
Red, Swollen Elbow
Systemic symptoms or decreased ROM
No
Yes
OK to treat as cellulitis with outpt Abx
F/U 488 or less
Better?
Yes
No
Continue Therapy
Refer / Consult
X-ray and Labs (CBC, CRP, ESR)
Normal
Low suspicion
Olercranon Swelling
Signs of infection or decreased ROM
Yes
No
Watch. Can drain, if needed
Abnormal or clinical suspicion of septic joint
Consult immediately
Trauma
X-ray
Pos
Neg
Treat Fracture / Refer
ROM?
Normal
Release / RICE and re-evaluate
Decreased
Sling x 1 wk, Rice and re-evaluate
Felt "pop"
X-ray
Pos
Neg
Treat Fracture / Refer
Check forearm flexion and supination
Normal
RICE and re-evaluate
Abnormal or suspect torn muscle/bicep
Consult Immediately
Better?
Yes
No
Release
Refer
No trauma, infection, pop or olecranon swelling, ROM normal
Clinical Exam
Clear, diagnosis? (Medical or Lateral epicondylitis)
Yes
No
Treat appropriately or Refer
RICE Recheck 2 wks
Better?
Yes
No
Release
Refer

ELBOW T-SHEET

CC: Elbow Pain R ☐ L ☐ Both ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: _____
Radiation: Yes ☐ No ☐ Where: _____
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx: Meds: _____
Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

PE: Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____

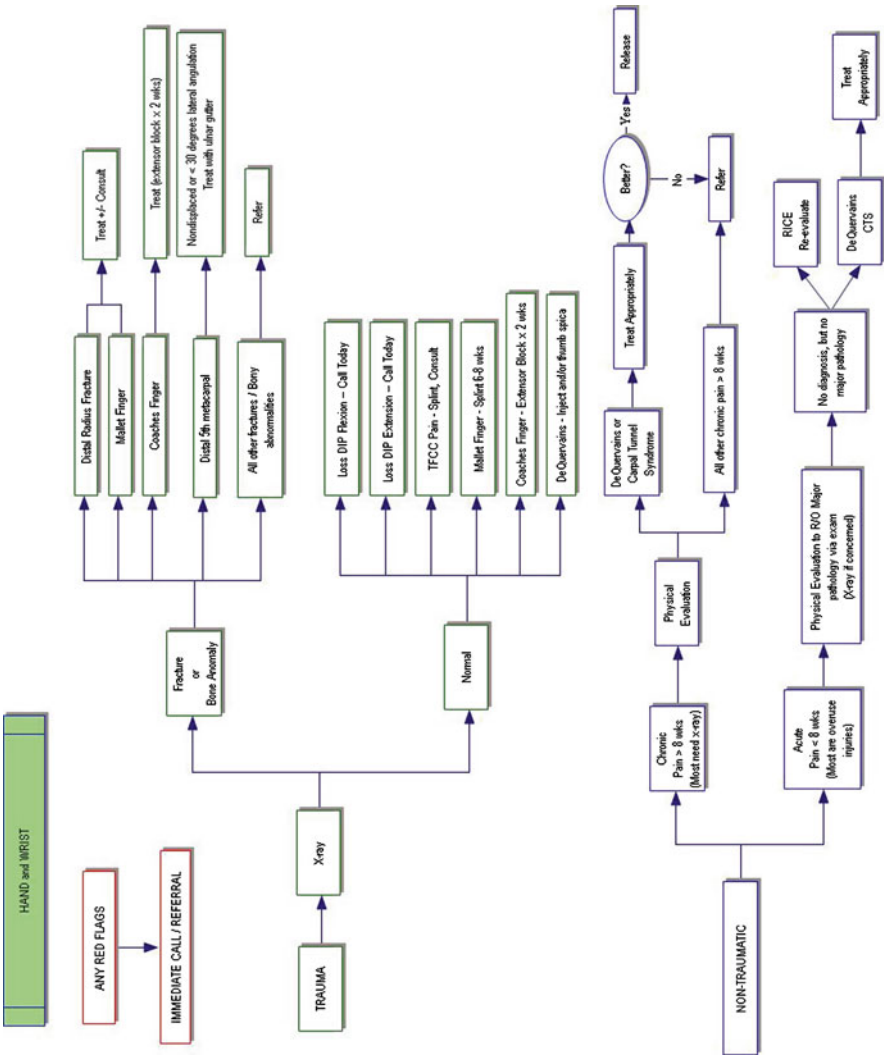
Skin:
Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

		Right	Left
Vascular:	Radial Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Capillary Refill:	Normal ☐ Slow ☐	Normal ☐ Slow ☐
Neuro:	Spurling's Maneuver:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
	C6 Biceps:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
	Sensory Exam:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
ROM:	Supination:	Nl ☐ Abn ☐ Painful ☐	Nl ☐ Abn ☐ Painful ☐
	Pronation:	Nl ☐ Abn ☐ Painful ☐	Nl ☐ Abn ☐ Painful ☐
	Flexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Extension:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
Soft Tissue (Palpation):	Olecranon Effusion:	Yes ☐ No ☐	Yes ☐ No ☐
	Olecranon (tender):	Yes ☐ No ☐	Yes ☐ No ☐
	Lateral Epicondyle (tender):	Yes ☐ No ☐	Yes ☐ No ☐
	Biceps insertion tendon (tender - distally):	Yes ☐ No ☐	Yes ☐ No ☐

TREAT APPROPRIATELY	Olecranon Bursitis ..... 726.33 Lateral Epicondylitis ..... 726.32 Medical Epicondylitis ..... 726.31 Pain in Elbow ..... 719.42 Osteoarthritis ..... 715.92 Contusion ..... 923.11 Cubital Tunnel Syndrome 354.2
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Cellulitis Patients with decreased ROM Patients with Normal X-ray
CALL CONSULTANT THAT DAY	Distal biceps rupture Suspected septic arthritis
CONSULT OR REFER	Fracture Limited ROM with no improvement over 1 week Undiagnosed pain

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


HAND and WRIST
ANY RED FLAGS
IMMEDIATE CALL / REFERRAL
TRAUMA
X-ray
Fracture or Bone Anomaly
Normal
Distal Radius Fracture
Mallet Finger
Coaches Finger
Distal 5th metacarpal
All other fractures / Bony abnormalities
Treat +/- Consult
Treat (extensor block x 2 wks)
Nondisplaced or < 30 degrees lateral angulation Treat with ulnar gutter
Refer
Loss DIP Flexion – Call Today
Loss DIP Extension – Call Today
TFCC Pain - Splint, Consult
Mallet Finger - Splint 6-8 wks
Coaches Finger - Extensor Block x 2 wks
DeQuervains - inject and/or thumb spica
NON-TRAUMATIC
Chronic Pain > 8 wks (Most need x-ray)
Acute Pain < 8 wks (Most are overuse injuries)
Physical Evaluation
Physical Evaluation to R/O Major pathology via exam (X-ray if concerned)
DeQuervains or Carpal Tunnel Syndrome
All other chronic pain > 8 wks
No diagnosis, but no major pathology
Treat Appropriately
Refer
RICE Re-evaluate
DeQuervains CTS
Better?
Yes
No
Release
Treat Appropriately

HAND and WRIST T-SHEET

CC:
Hand Pain R ☐ L ☐ Both ☐ Location: _____
Wrist Pain R ☐ L ☐ Both ☐ Location: _____
Finger Pain R ☐ L ☐ Both ☐ Location: _____

HPI:
Onset: _____
Mechanism of injury: _____
Location: _____
Radiation: Yes ☐ No ☐ Where: _____
Exacerbating factors: _____
Relieving factors: _____

ROS:
Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx:
Meds: _____
Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx:
Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

PE:
Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____
Handshake: Nl ☐ ↓ ☐ Painful ☐

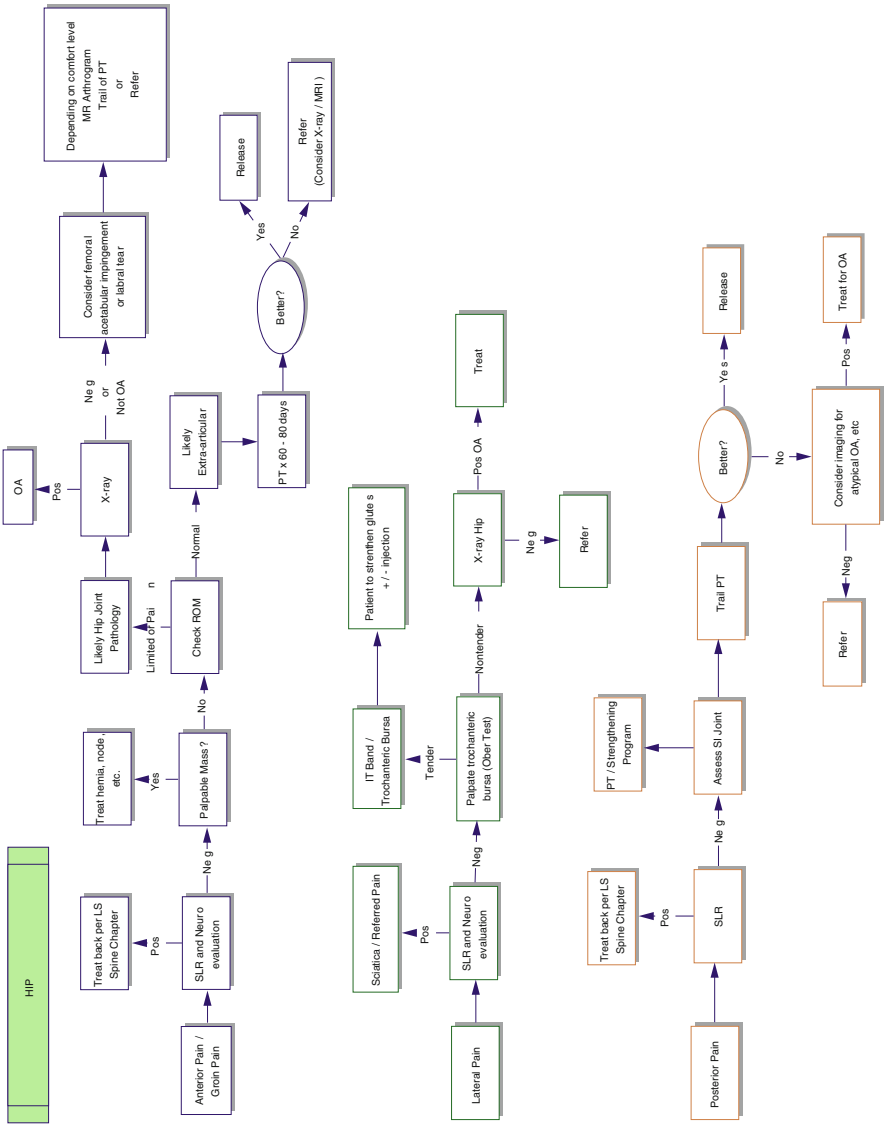
Skin:
Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

		Right	Left
Vascular:	2 pt discrimination:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Capillary Refill:	Normal ☐ Slow ☐	Normal ☐ Slow ☐
ROM:	DIP Flexion:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
	DIP Extension:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
	PIP Flexion:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
	PIP Extension:	Nl ☐ Abn ☐ _____	Nl ☐ Abn ☐ _____
Soft Tissue:	Pisiform:	Tender ☐ Nontender ☐	Tender ☐ Nontender ☐
(Palpation)	Hook of Hamate:	Tender ☐ Nontender ☐	Tender ☐ Nontender ☐
	Navicular:	Tender ☐ Nontender ☐	Tender ☐ Nontender ☐
	Lunate:	Tender ☐ Nontender ☐	Tender ☐ Nontender ☐
	Anatomical snuffbox:	Tender ☐ Nontender ☐	Tender ☐ Nontender ☐
	Watson's Test: (scaphoid tender with radial deviation)	Tender ☐ Nontender ☐	Tender ☐ Nontender ☐
	Finkelstein's Test:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐

TREAT APPROPRIATELY	Hand/Finger Pain ..... 719.44 Forearm/Wrist Pain ..... 719.43 Wrist Sprain/Strain ..... 842.00 Finger or Hand Sprain/Strain ..... 842.10 DeQuervain's Tenosynovitis ..... 727.04 Carpal Tunnel Syndrome..... 354.0 Cubital Tunnel Syndrome..... 354.2 Fracture, Finger..... 816.00 Coach's Finger..... 834.02 Mallet Finger..... 736.1
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Tender Anatomical Snuffbox with normal x-ray Decreased ROM of wrist with normal x-ray
CALL CONSULTANT THAT DAY	Fight bite High pressure injury Palmar burn Compound fracture Flexor tendon disruption Suspected joint infection
CONSULT OR REFER	Extensor tendon disruption (splint, consult) Distal radius fracture Scaphoid fracture Gamekeeper's thumb Pain in wrist >8wks Persistent anatomic snuffbox tenderness after 2 wks with neg x-ray

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


HIP
Anterior Pain / Groin Pain
SLR and Neuro evaluation
Neg
Pos
Treat back per LS Spine Chapter
Palpable Mass ?
No
Yes
Treat hernia, node, etc.
Check ROM
Normal
Limited or Pain
Likely Hip Joint Pathology
X-ray
Pos
OA
Neg or Not OA
Consider femoral acetabular impingement or labral tear
Depending on comfort level MR Arthrogram Trail of PT or Refer
Likely Extra-articular
PT x 60 - 80 days
Better?
Yes
Release
No
Refer (Consider X-ray / MRI)
Lateral Pain
SLR and Neuro evaluation
Neg
Pos
Sciatica / Referred Pain
Palpate trochanteric bursa (Ober Test)
Nontender
Tender
IT Band / Trochanteric Bursa
Patient to strenthen glute s + / - injection
X-ray Hip
Pos OA
Treat
Neg
Refer
Posterior Pain
SLR
Neg
Pos
Treat back per LS Spine Chapter
Assess SI Joint
PT / Strengthening Program
Trail PT
Better?
Yes
Release
No
Consider imaging for atypical OA, etc
Pos
Treat for OA
Neg
Refer

HIP T-SHEET

CC: Hip Pain R ☐ L ☐ Both ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: Groin ☐ Posterior ☐ Lateral ☐
Radiation: Yes ☐ No ☐ Where: _____
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx: Prior malignancy: Yes ☐ No ☐ Meds: _____
Hx of back problems: Yes ☐ No ☐ Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

PE: General Appearance: _____

Gait: Normal ☐ Antalgic ☐ Unable to bear weight ☐

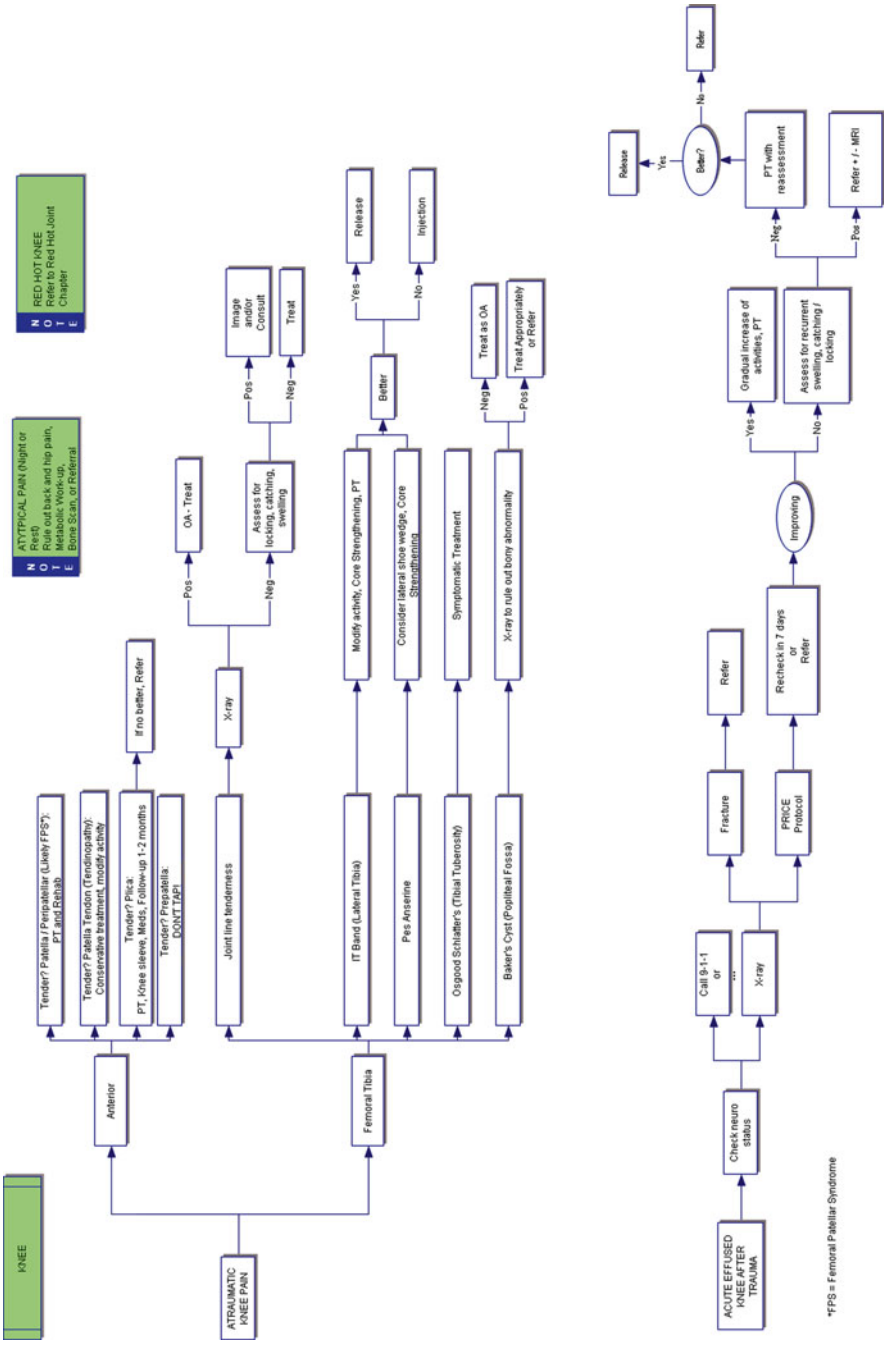
Skin: Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

		Right	Left
Vascular:	Femoral Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Dorsalis Pedis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Post Tibialis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Capillary Refill:	Normal ☐ Slow ☐	Normal ☐ Slow ☐
Neuro:	Straight Leg Raise:		
	Knee Jerk Reflex (L4):		
	Toe Raise (L5):		
	Ankle Jerk (S1):		
	2-point discrimination:		
ROM:	Internal Rotation:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	External Rotation:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Flexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Extension:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
Active Eval:	SI Joint (FABER):	Nl ☐ Painful ☐	Nl ☐ Painful ☐
	Impingement (McCarthy):	Nl ☐ Painful ☐	Nl ☐ Painful ☐
Soft Tissue: (Palpation)	Palpable Lymph Nodes:	Yes ☐ No ☐	Yes ☐ No ☐
	Lateral Hip (tender):	Yes ☐ No ☐	Yes ☐ No ☐
	Hernia:	Yes ☐ No ☐	Yes ☐ No ☐
	Testicular Exam:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐

TREAT APPROPRIATELY	Trochanteric Bursitis ..... 726.5 Osteoarthritis ..... 715.95 ITB Syndrome ..... 728.89 SI Joint Pain ..... 719.45 Sprain/Strain ..... 843.x Low Back Pain 724.2
TREAT WITH CLOSE FOLLOW-UP	Soft Tissue
CALL CONSULTATNT THAT DAY	Can't walk AVN Fracture
CONSULT OR REFER	OA, failed conservative treatment Suspected fracture Diagnosis unknown

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


KNEE
ATRAUMATIC KNEE PAIN
Anterior
Femoral Tibia
Tender? Patella / Peripatellar (Likely FPS*): PT and Rehab
Tender? Patella Tendon (Tendinopathy): Conservative treatment, modify activity
Tender? Plica: PT, knee sleeve, Meds, Follow-up 1-2 months
Tender? Prepatella: DONT TAP!
If no better, Refer
Joint line tenderness
X-ray
Pos
Neg
OA - Treat
Assess for locking, catching, swelling
Pos
Neg
Image and/or Consult
Treat
IT Band (Lateral Tibia)
Pes Anserine
Osgood Schlatter's (Tibial Tuberosity)
Baker's Cyst (Popliteal Fossa)
Modify activity, Core Strengthening, PT
Consider lateral shoe wedge, Core Strengthening
Symptomatic Treatment
X-ray to rule out bony abnormality
Better
Yes
No
Release
Injection
Neg
Pos
Treat as OA
Treat Appropriately or Refer
NOTE ATYPICAL PAIN (Night or Rest) Rule out back and hip pain, Metabolic Work-up, Bone Scan, or Referral
NOTE RED HOT KNEE Refer to Red Hot Joint Chapter
ACUTE EFFUSED KNEE AFTER TRAUMA
Check neuro status
Call 9-1-1 or ...
X-ray
Fracture
PRICE Protocol
Refer
Recheck in 7 days or Refer
Improving
Yes
No
Gradual increase of activities, PT
Assess for recurrent swelling, catching / locking
Neg
Pos
PT with reassessment
Refer + / - MRI
Better?
Yes
No
Release
Refer
*FPS = Femoral Patellar Syndrome

KNEE T-SHEET

CC: Knee Pain R ☐ L ☐ Both ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: _____
Radiation: Yes ☐ No ☐ Where:
Locking: Yes ☐ No ☐ _____
Catching: Yes ☐ No ☐ _____
Giving Out: Yes ☐ No ☐ _____
Recurrent Swelling: Yes ☐ No ☐ _____
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx: Meds: _____
Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

PE: Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____
Gait: Normal ☐ Limp ☐ Assist ☐ _____ Unable to bear weight ☐
Skin: Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

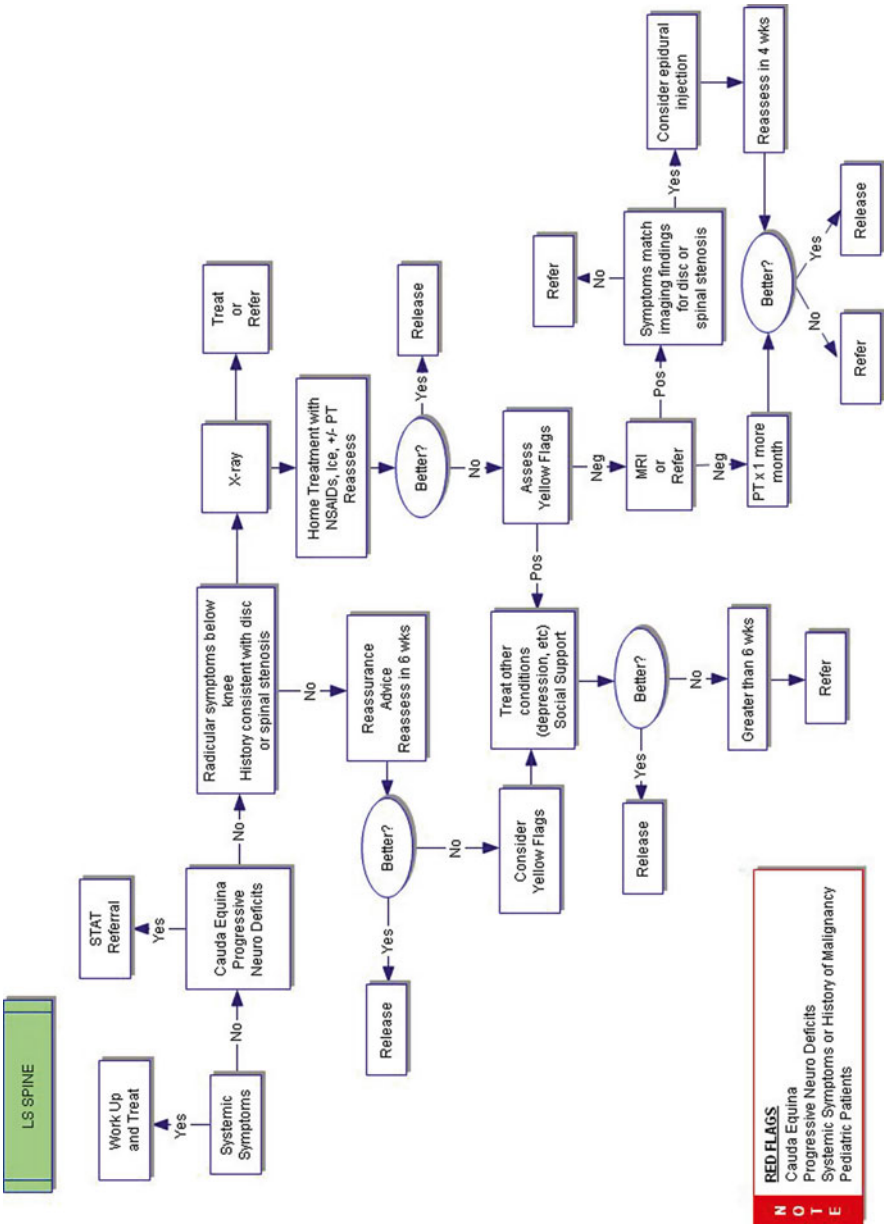
		Right	Left
Vascular:	Dorsalis Pedis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Post Tibialis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Capillary Refill:	Normal ☐ Slow ☐	Normal ☐ Slow ☐
Neuro:	Straight Leg Raise:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Toe Raise:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Knee Jerk Reflex:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
ROM:	Internal Rotation:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	External Rotation:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Flexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Extension:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
Active Eval:	Lachman (ACL):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	McMurray (Med meniscus):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐

PE: (cont)	Soft Tissue: (Palpation)		Right	Left
		Effusion:	Yes ☐ No ☐	Yes ☐ No ☐
		Medial Joint Line:	Tender☐ Nontender ☐	Tender☐ Nontender ☐
		Lateral Joint Line:	Tender☐ Nontender ☐	Tender☐ Nontender ☐
		Patella:	Tender☐ Nontender ☐	Tender☐ Nontender ☐
		Patellar Tendon:	Tender☐ Nontender ☐	Tender☐ Nontender ☐
		Quad Tendon:	Tender☐ Nontender ☐	Tender☐ Nontender ☐
		Tibial Plateau:	Tender☐ Nontender ☐	Tender☐ Nontender ☐

TREAT APPROPRIATELY	Osteoarthritis ..... 715.96 Knee Pain ..... 719.46 IT Band Syndrome ..... 728.89 Patellofemoral Pain Syndrome ..... 719.46 Patellar Bursitis ..... 726.65 Meniscal Injury ..... 836.2 Sprain/Tear Cruciate Ligament ..... 844.2 Sprain/Tear Medical Collateral Ligament ..... 844.1 Soft Tissue Pain 719.56
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Cellulitis Acute effusion with negative x-ray Crystal deposition disease
CALL CONSULTANT THAT DAY	Fracture Dislocation Impaired Neurovascular Status Septic Joint
CONSULT OR REFER	Acutely effused knee, if not comfortable with close f/u Atypical knee pain Failure of conservative therapy Recurrent effusion Recurrent locking or catching Vascular disease requiring intervention

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


LS SPINE
Systemic Symptoms
Yes
Work Up and Treat
No
Cauda Equina Progressive Neuro Deficits
Yes
STAT Referral
No
Radicular symptoms below knee
History consistent with disc or spinal stenosis
X-ray
Treat or Refer
Home Treatment with NSAIDs, Ice, +/- PT
Reassess
Better?
Yes
Release
No
Assess Yellow Flags
Neg
MRI or Refer
Neg
PT x 1 more month
Better?
Yes
Release
No
Refer
Pos
Symptoms match imaging findings for disc or spinal stenosis
Yes
Consider epidural injection
Reassess in 4 wks
No
Refer
Yes
Release
Pos
Treat other conditions (depression, etc) Social Support
Better?
Yes
Release
No
Greater than 6 wks
Refer
No
Consider Yellow Flags
Better?
Yes
Release
No
Reassurance Advice Reassess in 6 wks
NOTE
RED FLAGS
Cauda Equina
Progressive Neuro Deficits
Systemic Symptoms or History of Malignancy
Pediatric Patients

LUMBOSACRAL SPINE T-SHEET

CC: LS Spine Pain R ☐ L ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: _____
Radiation: Yes ☐ No ☐ Where:
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx: Meds: _____
Allergies: _____
Chronic medical conditions: _____
Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

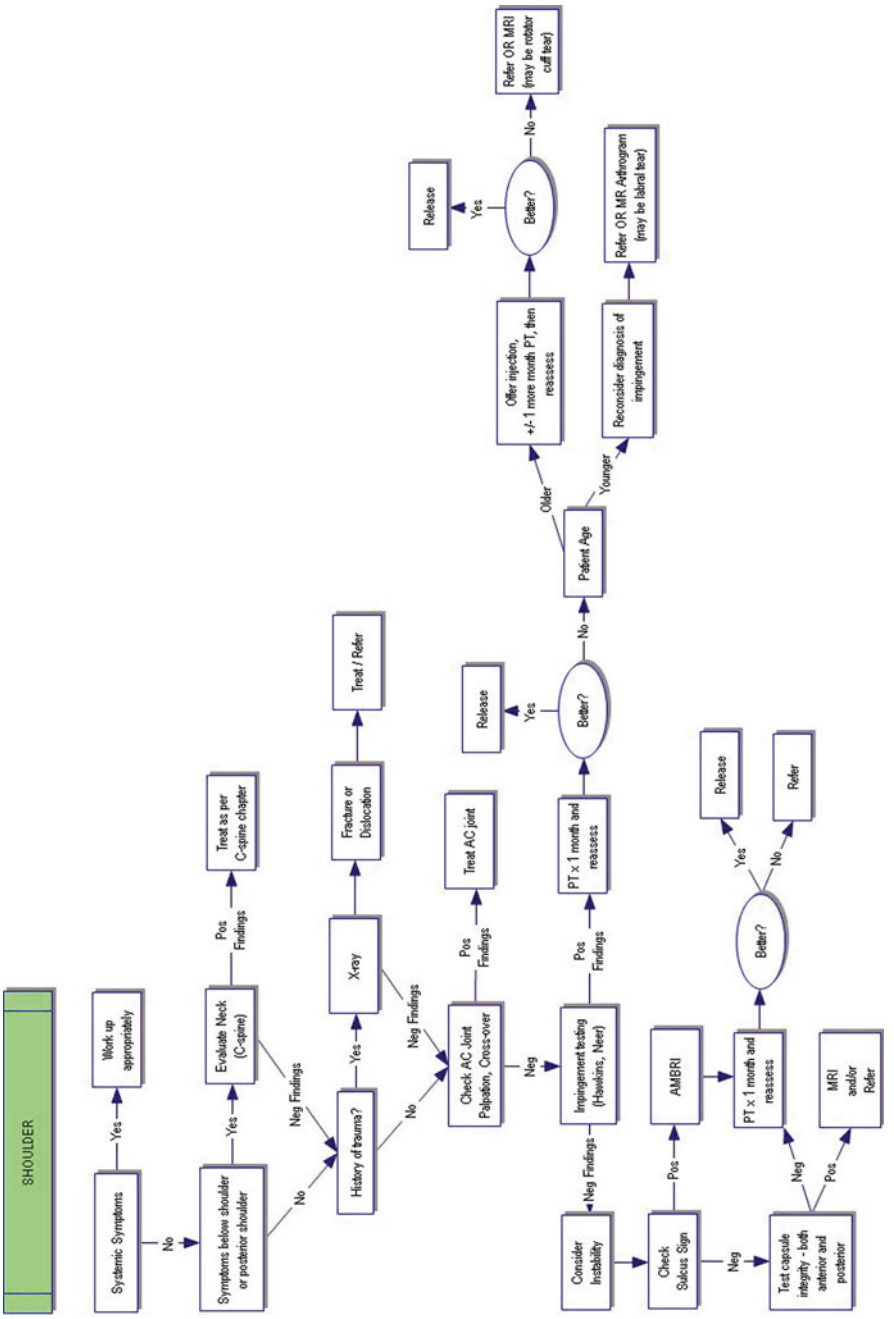
PE: Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____
Gait: Normal ☐ Limp ☐ Assist ☐ _____ Unable to bear weight ☐
Skin: Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

		Right	Left
Vascular:	Dorsalis Pedis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Post Tibialis Pulse:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Capillary Refill:	Normal ☐ Slow ☐	Normal ☐ Slow ☐
Neuro:	Straight Leg Raise:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Toe Raise:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Walk on Toes:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Walk on Heels:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Knee Jerk Reflex:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Ankle Jerk Reflex:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
	Distal Sensation:	Nl ☐ ↓ ☐ Absent ☐	Nl ☐ ↓ ☐ Absent ☐
ROM:	Flexion:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
	Extension:	Nl ☐ ↓ ☐ Painful ☐	Nl ☐ ↓ ☐ Painful ☐
Active Eval:	Lachman (ACL):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	McMurray (Med meniscus):	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
Soft Tissue: (Palpation)	Vertebral Tenderness:	Yes ☐ No ☐	Yes ☐ No ☐

TREAT APPROPRIATELY	Mechanical Back Pain .....724.2 Lumbar degenerative disc disease.....722.52 Disc herniation .....722.2 Low Back Pain .....724.2 Lumbar radiculopathy.....724.4 Lumbar sprain/strain .....846.0 SI Joint strain.....846.1 Nonspecific low back pain with negative evaluation.....724.2 Spinal stenosis with mild symptoms.....724.02
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Atypical pain with negative findings
CALL CONSULTANT THAT DAY	Severe symptoms Cauda equine Significant motor symptoms
CONSULT OR REFER	Failure of conservative therapy Abnormal x-ray findings Spinal stenosis (severe or not responding to conservative management)

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
- ☐ Consultation initiated with Dr. _____
- ☐ Referral to Dr. _____


SHOULDER
Systemic Symptoms
Yes
Work up appropriately
No
Symptoms below shoulder or posterior shoulder
Yes
Evaluate Neck (C-spine)
Pos Findings
Treat as per C-spine chapter
Neg Findings
No
History of trauma?
Yes
X-ray
Fracture or Dislocation
Treat / Refer
Neg Findings
No
Check AC Joint Palpation, Cross-over
Pos Findings
Treat AC joint
Neg
Impingement testing (Hawkins, Neer)
Pos Findings
PT x 1 month and reassess
Better?
Yes
Release
No
Patient Age
Older
Offer injection, +/- 1 more month PT, then reassess
Better?
Yes
Release
No
Refer OR MRI (may be rotator cuff tear)
Younger
Reconsider diagnosis of impingement
Refer OR MR Arthrogram (may be labral tear)
Neg Findings
Consider Instability
Neg
Check Sulcus Sign
Pos
AMBRI
PT x 1 month and reassess
Better?
Yes
Release
No
Refer
Neg
Test capsule integrity - both anterior and posterior
Pos
MRI and/or Refer

SHOULDER T-SHEET

CC: Shoulder Pain R ☐ L ☐ Both ☐

HPI: Onset: _____
Mechanism of injury: _____
Location: _____
Pain below elbow: Yes ☐ No ☐ Where: _____
Pain in posterior shoulder: Yes ☐ No ☐ Where: _____
Radiation: Yes ☐ No ☐ Where: _____
Exacerbating factors: _____
Relieving factors: _____

ROS: Fever ☐ Chills ☐ Numbness ☐ Paresthesias ☐
Weakness ☐ Night Pain ☐ Weight Loss ☐ Amount_____

PMHx: Meds: _____
Allergies: _____
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Immunizations Current: Yes ☐ No ☐

Soc Hx: Occupation and/or Activities: _____
Smoking status: Current ☐ Past ☐ Never ☐
IV Drug Use: Yes ☐ No ☐

PE: Vital Signs: BP: _____ P: _____ Wt: _____ BMI: _____ RR: _____
General Appearance: _____

Skin:
Redness Yes ☐ No ☐ Location: _____
Warmth Yes ☐ No ☐ Location: _____
Ecchymosis Yes ☐ No ☐ Location: _____
Deformity Yes ☐ No ☐ Location: _____
Ulcers Yes ☐ No ☐ Location: _____
Distal Hair pattern: Normal ☐ Decreased ☐

		Right	Left
Neuro:	ROM of Neck:	Nl ☐ Abnl ☐ _____	Nl ☐ Abnl ☐ _____
	Spurling's Maneuver:	Nl ☐ Abnl ☐ _____	Nl ☐ Abnl ☐ _____
ROM:	Abduct 180°:	Yes ☐ No ☐ Painful ☐	Yes ☐ No ☐ Painful ☐
	Extension:	Nl ☐ Abnl ☐ Painful ☐	Nl ☐ Abnl ☐ Painful ☐
	Internal Rotation:	Nl ☐ Abnl ☐ Painful ☐	Nl ☐ Abnl ☐ Painful ☐
Active Eval:	Sulcus:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Apprehension:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Infraspinatus Strength:	Nl ☐ Reduced ☐	Nl ☐ Reduced ☐
	Supraspinatus Strength:	Nl ☐ Reduced ☐	Nl ☐ Reduced ☐
	Crossover Test/AC Joint Pain:	Yes ☐ No ☐	Yes ☐ No ☐
	Impingement Test: Neer:	Nl ☐ Painful ☐	Nl ☐ Painful ☐
	Hawkins:	Nl ☐ Painful ☐	Nl ☐ Painful ☐
	Posterior capsule/dislocation:	Nl ☐ Abnormal ☐	Nl ☐ Abnormal ☐
	Labrum – Click or Clunk: (circumduction in abduction)	Yes ☐ No ☐ Painful ☐	Yes ☐ No ☐ Painful ☐
Soft Tissue: (Palpation)	SC Joint:	Nl ☐ Tender ☐ Effusion ☐	Nl ☐ Tender ☐ Effusion ☐
	AC Joint:	Nl ☐ Tender ☐ Effusion ☐	Nl ☐ Tender ☐ Effusion ☐
	Clavicle:	Nl ☐ Tender ☐ Deformity ☐	Nl ☐ Tender ☐ Deformity ☐

TREAT APPROPRIATELY	Shoulder Instability (AMBRI) ..... 718.81 Impingement ..... 726.2 Osteoarthritis ..... 715.91 Rotator Cuff Tear ..... 840.4 Dislocation/Subluxation ..... 831.00 AC Joint Separation ..... 831.04 Rotator Cuff Tendinitis (supraspinatus) ..... 726.10 Rotator Cuff Tendinitis (infraspinatus) ..... 726.19 Shoulder pain, nonspecific with negative exam 719.41
TREAT WITH CLOSE FOLLOW-UP (< 1 week f/u)	Status Post dislocation
CALL CONSULTANT THAT DAY	Dislocation Fracture Major Trauma
CONSULT OR REFER	Suspected or Confirmed rotator cuff tear with no response to PT Recurrent dislocations Suspected labral tear Radiculopathy Young/Active patient with no response to 4 wks of PT or treatment TUBS instability

Plan:
- ☐ Xray / Imaging _____
- ☐ Laboratory Eval _____
- ☐ NSAIDs _____
- ☐ Acetaminophen _____
- ☐ Other _____
- ☐ PRICE Protocol
- ☐ Physical Therapy

Disposition:
- ☐ Treatment initiated: Follow-up _____ weeks
- ☐ Treatment / Work up Initiated: Follow-up ≤ 1 week _____ days
- ☐ Immediate call to Dr. _____
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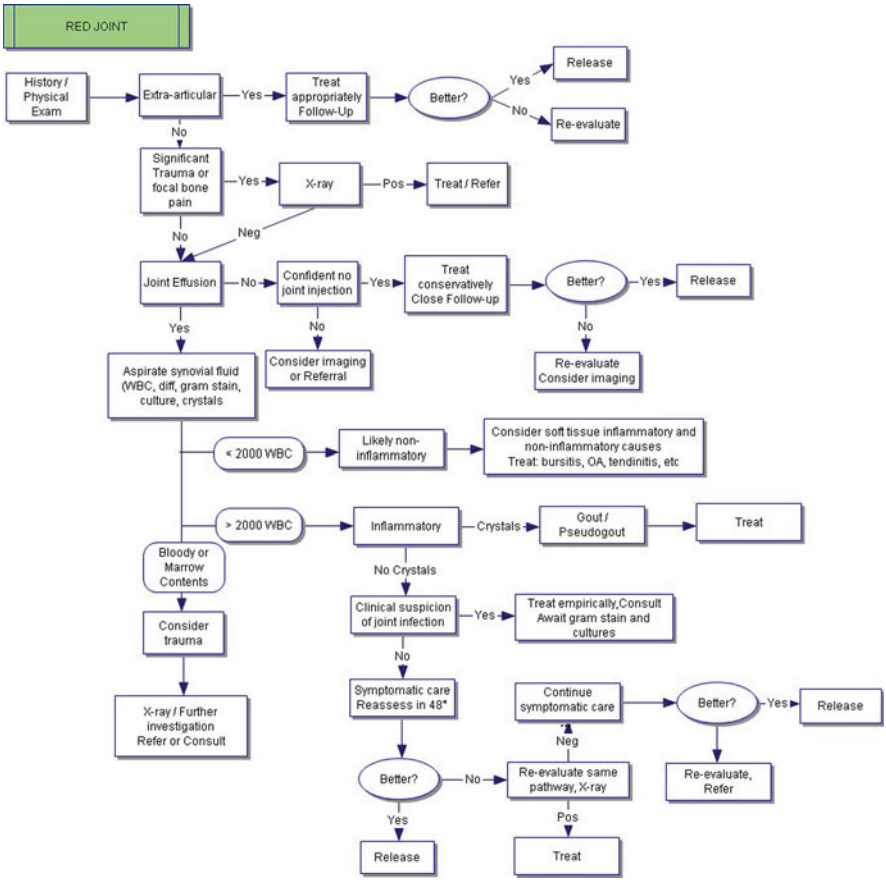
RED JOINT
History / Physical Exam
Extra-articular
Yes
Treat appropriately Follow-Up
Better?
Yes
Release
No
Re-evaluate
No
Significant Trauma or focal bone pain
Yes
X-ray
Pos
Treat / Refer
No
Neg
Joint Effusion
No
Confident no joint injection
Yes
Treat conservatively Close Follow-up
Better?
Yes
Release
Yes
No
Aspirate synovial fluid (WBC, diff, gram stain, culture, crystals
Consider imaging or Referral
Re-evaluate Consider imaging
< 2000 WBC
Likely non-inflammatory
Consider soft tissue inflammatory and non-inflammatory causes Treat: bursitis, OA, tendinitis, etc
> 2000 WBC
Inflammatory
Crystals
Gout / Pseudogout
Treat
Bloody or Marrow Contents
No Crystals
Clinical suspicion of joint infection
Yes
Treat empirically,Consult Await gram stain and cultures
Consider trauma
No
Symptomatic care Reassess in 48*
Continue symptomatic care
Better?
Yes
Release
Neg
X-ray / Further investigation Refer or Consult
Better?
No
Re-evaluate same pathway, X-ray
Re-evaluate, Refer
Yes
Pos
Release
Treat

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