Essential Orthopedics for Global Surgery

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Introduction

Treatment of musculoskeletal conditions and bone and joint trauma in developing countries is often done by general surgeons at the district and provincial level or by traditional bonesetters, while specialist orthopedic facilities are available only at central, military, training, or NGO hospitals, making the level of care highly variable.

The burden of orthopedic conditions has become a World Health Organization (WHO) priority, but the reality seems quite different on the ground. Injury prevention, having a large behavioral component, doesn't neatly fall into the realm of health but requires coordinated programs crossing many fields as well as the will, organization, and funds to address the problems. The recent, rapid, partial motorization of transport using roads that are inadequate for high speeds and the wide mix of

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road users has created an epidemic of road traffic injuries, leaving millions permanently disabled from extremity and spinal injuries.

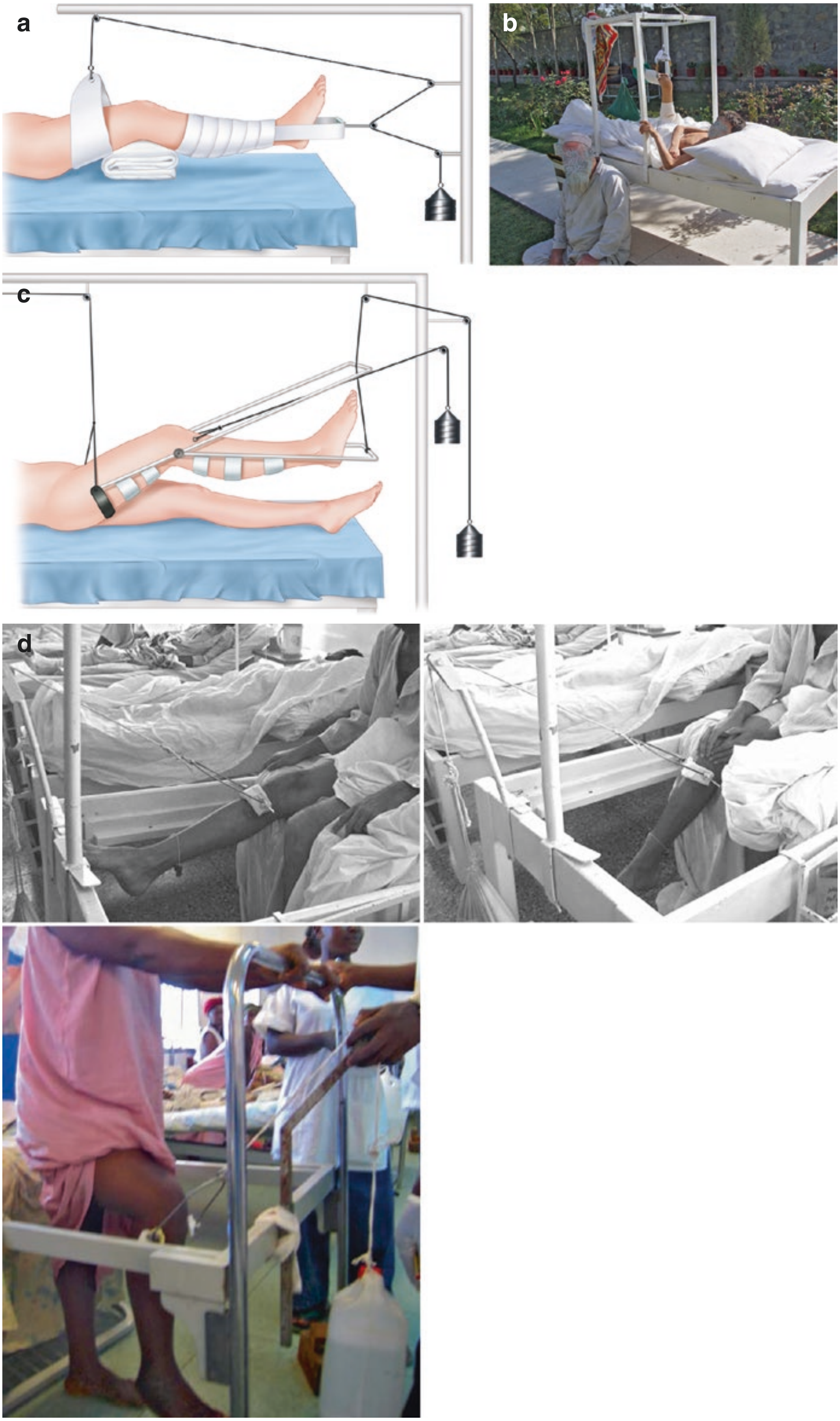
Surgical treatment of orthopedic injuries and end-stage arthritic conditions has long been thought to be too demanding and expensive for the limited human resources and health budgets of most LMICs. Orthopedic training is long and highly specialized; the materials are costly and constantly changing as techniques improve and new therapies evolve. Rehabilitation requires another layer of care, which, if absent, will result in continued disability despite adequate surgical or nonoperative treatment. Even where trauma care is taken seriously, extremity injuries especially of the hands and feet—the small, non-life-threatening, "insignificant parts"—are often overlooked or inadequately treated, resulting in long-term disability. Lengthening life spans and Western lifestyles have added to the orthopedic burden through increased incidence of disabling arthritis with advanced age and the musculoskeletal consequences of chronic diseases such as diabetes.

Neglected or poorly treated trauma is common in austere settings, presenting as chronic dislocation, malunion, non-union, infection, and functional limitation. Taking a useful history can be time consuming, but needs to include an accurate idea of chronicity, the cause of the injury, the specific reason the patient and family have come for consultation, and the results expected after treatment. The latter are not always self-evident and a sympathetic translator needs to be available. A complete exam, including demonstration of activities of daily living, will show functional limitations. Before suggesting surgery, a course of physical therapy and/or serial casting may be suggested as the surgical management of many untreated or poorly treated injuries is prone to complications, and it is often difficult to achieve the desired functional result. A detailed informed consent is mandatory when embarking on these reconstructive cases.

Nonsurgical management of extremity injuries primarily involves external immobilization via plaster of Paris (POP) circumferential casts, plaster slabs, or traction. Fiberglass materials and prefabricated braces are expensive and rare. Plaster supplies and cast padding may be of poor quality, making application cumbersome, inelegant, and often ineffective. Even if dedicated staff are charged with application of POP, patients and possibly x-rays must be checked to ensure proper fit before discharge from the hospital or outpatient department. Though considered safer than surgery, improper splinting or poorly applied casts can cause major problems. Any complaints related to external immobilization must be addressed immediately.

The use of traction is highly dependent on the familiarity of nursing and/or physio staff with the principles of traction and the use of the available devices (Fig. 16.1a–d).

Fig. 16.1 Different forms of traction may be useful in the treatment of upper and lower extremity fractures. For lower extremity fractures, longitudinal traction may be employed through the skin, for example, Russel's traction (**a**). 90–90 traction involves 90° of flexion at the hip and the knee and can be accomplished by distal femoral pin (**b**). Longitudinal traction may also be accomplished using a proximal tibial traction pin and a Thomas-Pearson splint, but care must be taken to avoid damaging the tibial tuberosity in skeletally immature patients, as this may cause recurvatum deformity from growth disturbance (**c**). In the Perkin's traction, the lower portion of the bed is removed so that the patient may work on knee range of motion and strengthening exercises while still in traction (**d**) [1] (Reprinted from Fisher et al. [1], with permission of Springer)


a
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The skin can tolerate up to 3–4 kg of skin traction and is primarily used in children or in adults to initially keep an extremity comfortable. Skeletal traction may require weights up to 10 % of the patient's weight. Traction pins should be placed using a hand drill as power can thermally necrose the skin and bone. Typical pin sites are the proximal tibia at the level of the tibial tuberosity for the femur, hip, and pelvis injury, distal femur at the level of the proximal pole of the patella for hip and pelvis, and calcaneus for tibia, and olecranon for supracondylar humerus. Avoid proximal tibial pins in children as they can damage the adjacent physis, resulting in recurvatum deformity. Lower extremity traction is used most often with the leg straight or on a padded frame to control rotation. Poorly made or improperly sized traction frames can cause serious pressure sores. Protocols for pin care vary, but should not include deep cleaning with astringent solutions or vigorous digging around the pins.

In this chapter the authors will present some of the more common orthopedic problems found in developing countries and approaches to deal with them; few will involve surgery. When faced with unfamiliar problems, ask for help from your medical, surgical, and nursing colleagues. They can advise on the available equipment, supplies, and local resources.

Adult Orthopedic Trauma

Fractures should be evaluated for associated deformity, swelling, bruising or abrasions, bleeding, fracture blisters, evidence of superficial and deep degloving, vascular injury, and/or neurologic injury. Evaluation of the severity of soft tissue damage in extremity trauma is key to treatment along with knowledge of available treatments and the staff's experience in their use.

Long-bone open fractures are usefully described by the Gustilo classification (Fig. 16.2) and are best left open after tetanus prophylaxis and thorough debridement of all nonviable tissue, including bone fragments without soft tissue attachment, followed by elevation and immobilization in plaster splints or traction with delayed

Gustilo and Anderson Classification of Open Fractures

Type I

Clean wound smaller than 1 cm in size. Assumes a simple fracture pattern

Type II

Soft tissue injury >1 cm but <10 cm without extensive soft tissue damage. Assumes minimal degloving and periosteal stripping and not more than moderate contamination or comminution

Type III

High-energy injuries, with substantial soft tissue injury, periosteal stripping, and/or some degree of crush. Segmental fractures, bone loss, farmyard injuries, high velocity GSW

Type IIIA

Large soft tissue injury or flap, though usually less than 10 cm. Adequate soft tissue remains to cover the bone

Type IIIB

Extensive soft tissue injury, bone loss, devascularization, and/or massive contamination. Inadequate soft tissue to cover bone without a flap

Type IIIC

Fractures with major arterial injury requiring repair

Fig. 16.2 The Gustilo classification [2] (Reprinted from Foltz et al. [2], with permission of Springer) primary closure (DPC), split skin graft (SSG), or flap in 3–5 days. An alternative to plaster or traction management is external fixation (ex-fix), which combines the benefits of easy access to the wound and early mobilization of the patient. It should be viewed as a tool for wound management not for bone healing. While an easy technical procedure in skilled and experienced hands, external fixation can appear daunting to the neophyte, who should not embark on its use without careful consideration of potential harm. Appropriate pin placement is crucial to avoid neurovascular injuries or jeopardize future surgical procedures such as grafting or flaps. In general, the ex-fix should be removed and replaced with splints/POP soon after the wound has healed.

When the presentation is acute, antibiotic prophylaxis for 24 h is appropriate if available. Compartment syndrome can occur in open or closed fractures and in high- or low-energy injuries and is most commonly seen in leg and forearm injuries. The earliest sign is increased narcotic requirements and pain out of proportion to the injury and with passive stretch of the muscle. These are more reliable signs than waiting until pulselessness, pallor, parasthesias, and paralysis have set in, at which point irreversible damage is likely. All bandages, including cotton, should be released while maintaining fracture stability. If the symptoms are not significantly improved, fasciotomies must be considered (Fig. 16.3). In the leg a longitudinal medial incision placed about 2 cm posterior to the medial border of the tibia allows access to both the superficial and deep posterior compartments, each of which must be released. A second anterolateral longitudinal incision placed halfway between the tibial crest and the fibula allows release of the anterior extensor and peroneal muscle compartments. All four compartments must be completely released of constricting fascia. Any muscle that is discolored, of poor consistency, fails to contract when irritated, or does not bleed is nonviable and should be removed. In the forearm both the volar and dorsal

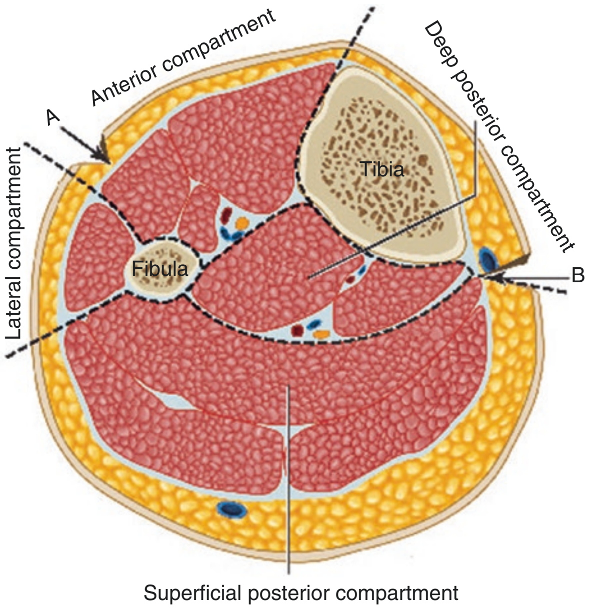


Fig. 16.3 Lower extremity muscle compartments and their release. A–skin incision for release of anterior and lateral compartments. B–skin incision for release of superficial and deep posterior compartments [2] (Reprinted from Foltz et al. [2], with permission of Springer)

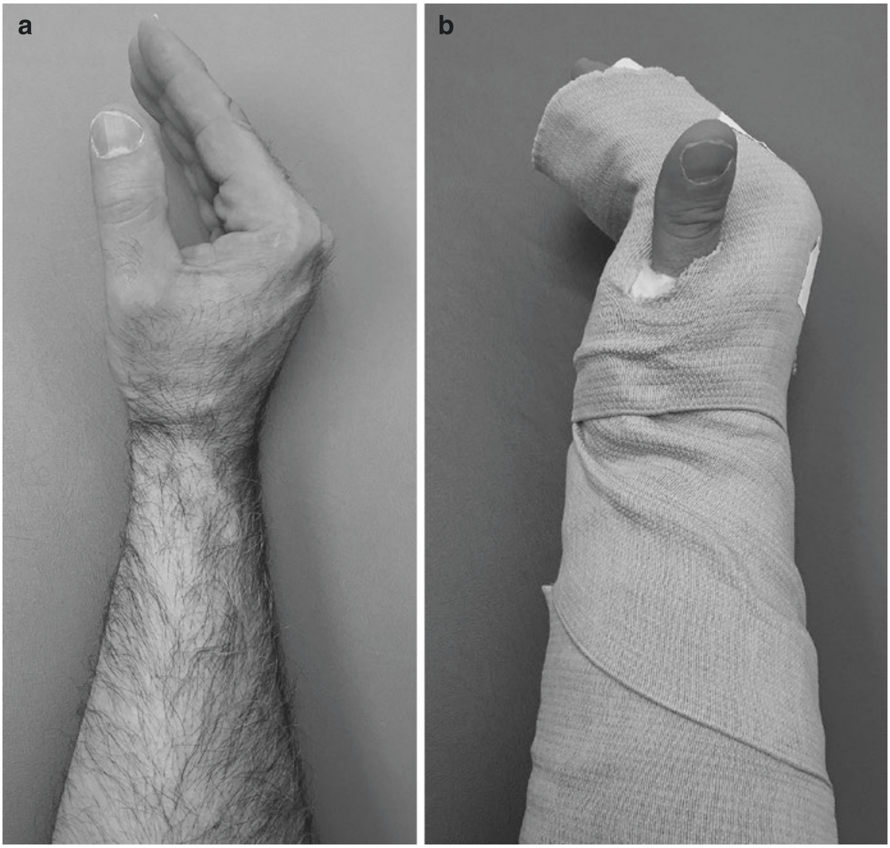


Fig. 16.4 The functional position for splinting the hand involves 30° dorsiflexion at the wrist, 90° flexion at the MCP joints, and full extension at the IP joints

compartments need to be released through separate incisions. Fasciotomy wounds are left open and the extremities stabilized in a bulky dressing with plaster splints and moderate elevation. The wounds are re-evaluated in 3–5 days to determine additional treatment options: further debridement, DPC, or SSG.

Compartment syndromes from injuries that have occurred more than 24 h before admission, such as in crush injuries in natural disasters, should not undergo surgical decompression. By that time ischemia is irreversible and the surgical wounds will likely become infected, often leading to amputation. It is better to splint the extremity in a functional position, accept the residual deficit, and plan for delayed reconstruction. For the hand, the functional position involves extension at the interphalangeal joints, 90° flexion at the metacarpophalangeal joints, and 30° dorsiflexion at the wrist (Fig. 16.4a, b). Long arm splints typically keep the forearm at the midrange of pronation/supination, and the elbow flexed 90°.

No matter the method of treatment, the primary goals are prevention of complications, especially infection, the reestablishment of stability in fractures and motion in joint injury, and the restoration of useful function.

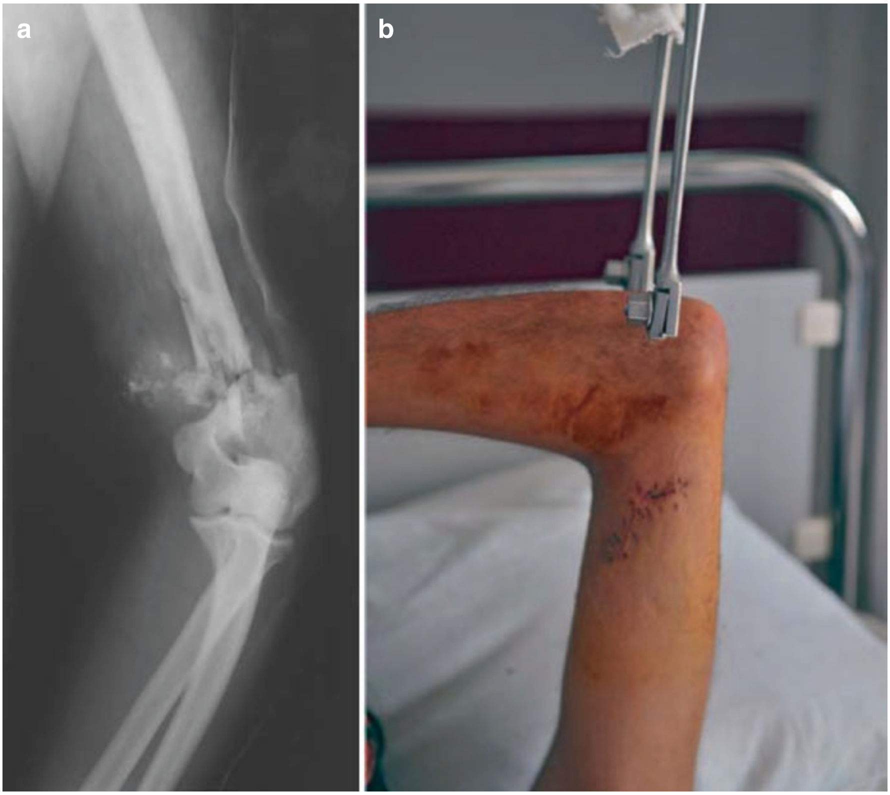


Fig. 16.5 Olecranon traction. Olecranon traction may be used to treat distal humerus fractures, for example, this unstable fracture from a gunshot wound [1] (Reprinted from Fisher et al. [1], with permission of Springer)

Upper Extremity Injuries

Acute anterior shoulder dislocations can usually be reduced with sedation in the emergency department (ED). Those of 2–3 weeks duration may require general anesthesia with relaxation or reduction using the prone position on a trolley and strapping a weight to the wrist. Associated tuberosity fractures usually reduce with the joint relocation and will heal with the shoulder immobilized in a sling for 2–3 weeks. A 3–4 week old dislocation often requires open reduction. Proximal humerus fractures are more common in the elderly and can be treated with a collar and cuff. Humeral shaft fractures heal well in lightweight U-slabs of POP that are changed and tightened every 10–14 days as the edema and swelling decrease. Shaft fractures heal in 6–10 weeks.

Supracondylar humerus fractures in adults are often intra-articular. Unless familiar with the demanding open techniques and with proper equipment and time, these are best treated with olecranon traction until the fracture has demonstrated early healing (no pain with clinical examination) (Fig. 16.5a, b), followed by

Fig. 16.6 Long arm cast

casting or treated with early motion in a removable back slab. Opening such fractures without obtaining adequate stability that allows early motion is not recommended. If elbow dislocations are stable after reduction, apply a back slab for 7–10 days followed by early motion. In general elbows are notorious for loss of motion, even after minor injuries, and any surgical procedures need to be well thought out.

To regain full function, both bone forearm diaphyseal fractures are best treated with plates and screws crossing at least six cortices on each side of the fracture. If this is not possible, a well-molded above elbow cast in neutral rotation will allow healing, though with loss of rotation and probably limited elbow range of motion (ROM) (Fig. 16.6). Monteggia fractures—proximal ulna fracture with radial head dislocation and Galleazi fractures—distal third radius fracture and ulnar head dislocation require open reduction and internal fixation of the fracture to reduce the dislocation. In children these fracture/dislocations can usually be treated closed, without surgery.

Distal radius and ulnar fractures are due to falls on the outstretched arm and can usually be reduced in the ED and splinted. Edema is controlled with elevation of the injured segment above heart level and active finger ROM exercises; an arm sling is not an elevation. While lying down, the shoulder can be externally rotated and pillows placed under the humerus posteriorly to keep the hand and wrist above the heart. In osteoporotic bone, the reduction is often lost, leaving the ulna prominent, but this rarely adversely affects function. Fractures of the hand and fingers are reduced to maintain alignment, length, and rotation and splinted with front slab, back slab, or both that includes the wrist. The functional position for splinting common hand injuries is 20–30° wrist dorsiflexion, 90° metacarpal-phalangeal joint flexion, and interphalangeal joint extension (Fig. 16.4). Buddy taping the noninjured digit(s) to the injured one(s), with gauze or cotton between fingers to prevent maceration, helps maintain the reduction in which the semi-flexed fingertips point to the scaphoid bone. Three- to four weeks splinting is usually sufficient. Mangled hands are difficult to sort out what parts are viable as opposed to what parts will be useful. Seek your colleagues' advice as cultural factors often affect the decisions.

Lower Extremity Injuries

Pelvic fractures are generally high-energy injuries, for example, motor vehicle crashes, and involve a variety of mechanisms including lateral compression and shear forces. They generally heal with nonoperative management, allowing activity and weight bearing as tolerated. In general, shortening of more than 2 cm and angulation greater than 10° in the lower extremity are poorly tolerated. Displaced intra- and periarticular fractures and non-unions lead to significant functional limitations, pain, weakness, and potential compensatory arthritis in adjacent joints.

Hip dislocations usually involve axial loading, and most commonly the hip is flexed at the time of impact, and the dislocation will be posterior. Those that are stable and congruent after a closed reduction can be treated symptomatically; unstable fractures benefit from 2 to 3 weeks of traction in extension and external rotation. Unstable dislocations with large acetabular fractures can be treated with open reduction and internal fixation or prolonged traction to allow the fragments to heal. Femoral neck fractures often progress to non-union and even undisplaced fractures may fail to unite. Low demand patients may be able to get by using a walking aid. Otherwise, replacing the head with a hemi-replacement or complex reconstructive procedures are the options.

Intertrochanteric fractures involving metaphyseal bone can heal with prolonged traction, though older patients may poorly tolerate this. Sub-trochanteric fractures are usually high-energy injuries and like diaphyseal femur fractures can be treated with traction, although shortening and malunion are common. Hip spica casts for adults are cumbersome and are rarely the first line of treatment, but occasionally they can be useful after traction or when biding time between procedures. These casts incorporate the abdomen/pelvis as well as one or both lower extremities and are most commonly used to treat femur fractures in children less than 5–6 years of age.

Unless implants and professional expertise are available for surgery and rehabilitation, injuries about the knee, whether bony or ligamentous, are better treated with 4–6 weeks immobilization, generally in a position of 30° flexion. This results in a stiff, but hopefully stable and pain-free joint.

Tibial shaft fractures can result from either a direct blow or an indirect mechanism involving torsion or lateral bending and can often be reduced and treated in a non-weight-bearing above-knee cast with the knee in 20–25° flexion after the initial swelling has subsided. At 6–10 weeks, when the fracture is "sticky" and painless, the long leg cast is converted to a patellar tendon bearing cast (Fig. 16.7) or

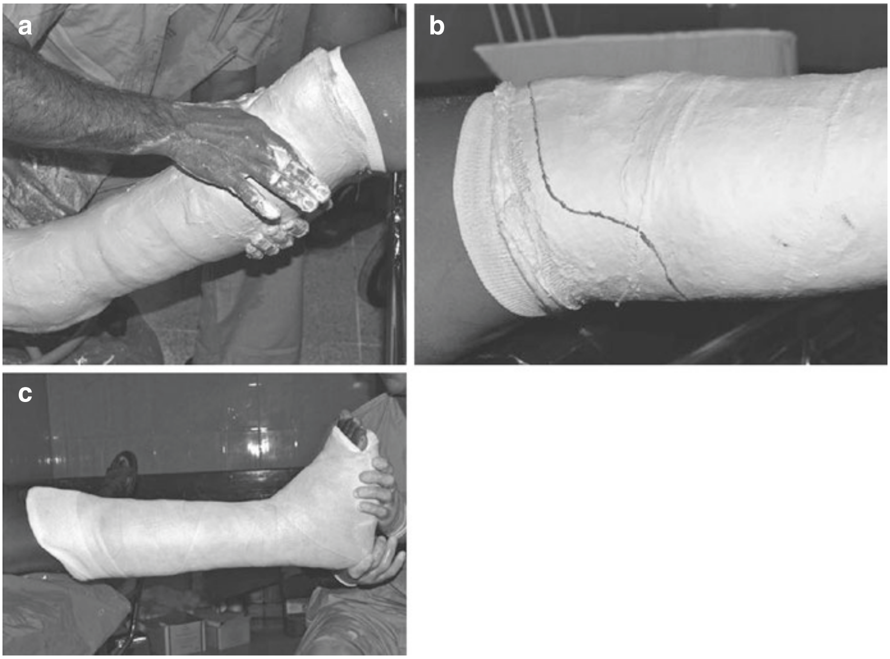


Fig. 16.7 A patellar tendon bearing cast is a variant of a short leg cast in which the initial cast is placed just above the superior pole of the patella and then trimmed down distal to the popliteal flexion crease [1] (Reprinted from Fisher et al. [1], with permission of Springer)

below-knee walking cast. Unstable fractures, and those at or above the level of the proximal third of the tibia, should not be placed in short leg casts that leave the knee free for fear of angulation and non-union due to loss of proximal support. Determining fracture consolidation is subjective. The presence of solid, bridging callus on x-ray, pain-free deep palpation and stress at the fracture site, and pain-free normal gait without limp are good indications of fracture healing.

In many parts of the developing world, the introduction of SIGN nails (Sign Fracture Care International) has revolutionized the treatment of open and closed long bone injuries, allowing dependable and predictable fixation of femur (Fig. 16.8a, b), tibia, and humerus fractures with acceptably low rates of infection, using a solid, locked stainless steel intramedullary nail that requires neither C-arm control or fracture table reduction. A technique manual is freely available at https://signfracturecare.org.

Outcomes for ankle and foot injuries are highly dependent on early reduction to relieve the swollen and deformed soft tissue envelop, while the injured extremity is held with a well-padded back slab, U-slab, or bivalved cast and kept elevated. The goal is a plantigrade or flat foot without excessive inward (varus) or outward (valgus) tilt and full range of dorsiflexion. Fractures and fracture-dislocations of the

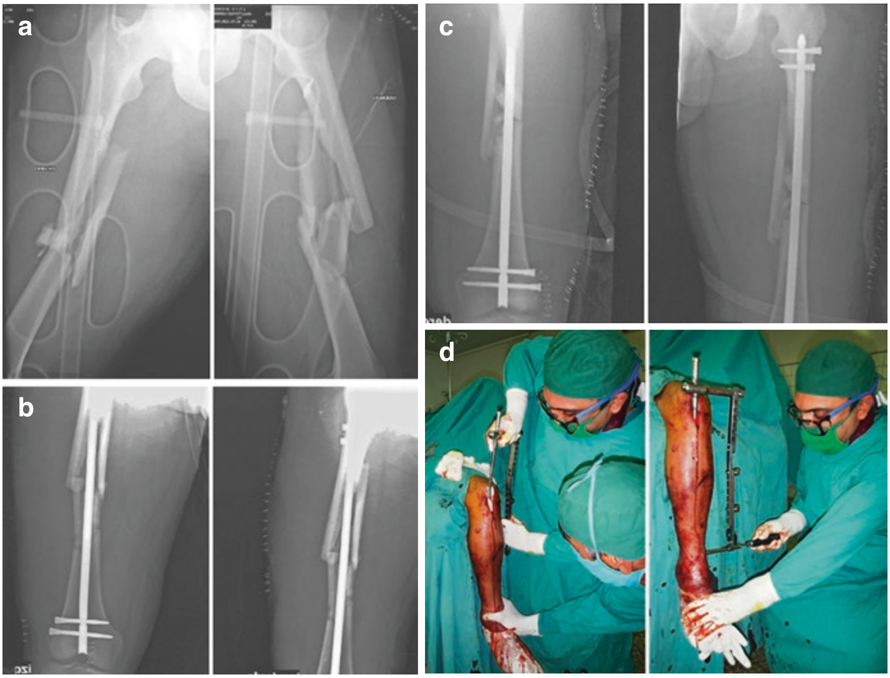


Fig. 16.8 Closed, comminuted femur fracture treated with a retrograde SIGN nail. (**a**, **b**) [3]. A tibial fracture treated by SIGN nailing (**c**, **d**) [4] (**a**, **b** Reprinted from Gosselin et al. [3], with permission of Springer. **c**, **d** Reprinted from Gosselin and Oloruntoba [4], with permission of Springer)

foot are inherently unstable and difficult to hold in plaster. Percutaneous fixation using a K-wire may be needed to hold the reduction. In cultures where shoe wear is optional or minimal, crushed, degloved, and mangled feet often present to the (ED). Thorough debridement with or without pin fixation while allowing the tissues to demarcate may allow useful salvage with only partial foot amputation and avoid higher amputations that would require a prosthesis.

Spinal Cord and Spine Injuries

Spinal cord injury is assessed clinically with a thorough motor and sensory exam including a rectal exam. Inspection and palpation of the back and neck can reveal pain, tenderness, bruising, or step-off to help direct the x-ray exam. Lateral C-spine films should adequately show C7-T1. Key determinants of potential function depend on the neurologic level of the cord injury and the stability of the spine. In resource-poor areas, treatment is usually nonoperative with prolonged bedrest, precautions to prevent pressure sores, and bowel and bladder training.

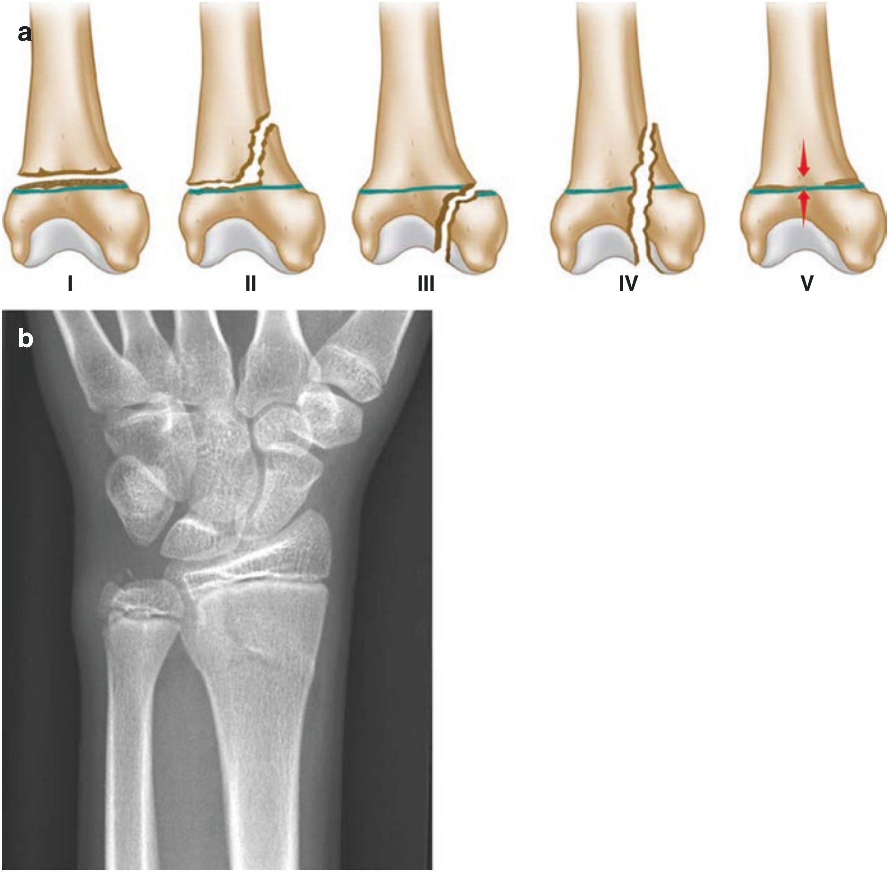


Fig. 16.9 The Salter-Harris classification of pediatric fractures. The Type I fractures go through the physis, while the Type II fractures extend through the physis and then exit out of the metaphysis, leaving a metaphyseal fragment called the "Thurston-Holland" fragment. Type III fractures extend through the physis and then into the joint, while Type IV fractures extend from the metaphysis through the physis and epiphysis, exiting into the joint. Type III and IV are especially at risk for growth disturbance, and joint incongruency can result in arthritis. The Type V fracture is due to compression and is not identified on initial plain radiographs but may present as growth disturbance later. (b) [5] (Reprinted from Spiegel and Banskota [5], with permission of Springer)

Pediatric Orthopedic Injuries

Children make up a disproportionately large population in most developing countries. The majority of extremity injuries can be treated nonoperatively with good outcomes, and as long as rotation and axial alignment are preserved, overriding of fracture fragments is acceptable in most pediatric fractures.

The Salter-Harris classification (Fig. 16.9) is both descriptive and prescriptive for fractures around the physis. Growth plate and metaphyseal fractures have a greater ability to remodel than diaphyseal fractures, especially if the deformity is in line with the adjacent joint's ROM and when significant growth remains. The areas with the greatest remodeling potential are, in descending order, distal femur, proximal tibia, proximal humerus, and distal radius. Remodeling occurs through both physeal growth and new bone formation on the concave or compression side of the bone and resorption on the convex or tension side. Fractures around the growth plates can be problematic, especially in the lower extremities where asymmetric growth can lead to deformity and/or leg length discrepancy. Intra-articular fractures with displacement and/or significant step-off can lead to early arthritis.

Pediatric supracondylar humerus fractures have a bad reputation due to their association with neurovascular injuries (up to 20 % of widely displaced fractures) and compartment syndrome with Volkmann's ischemic contracture (Fig. 16.10). They are the most common pediatric fracture about the elbow, are caused by a fall on the outstretched arm with impact at the hand/wrist (elbow extends and the olecranon causes the fracture), and are usually treated on an emergent basis with closed reduction and percutaneous pinning. Internally stabilizing the fracture allows the elbow to be held in less flexion and less fear of vascular compromise. A long arm splint is usually applied with the elbow in 60–70° of flexion after pinning, and this can be converted to a cast with the elbow at 90° flexion after the swelling has diminished, usually in 3–5 days. Without C-arm, pinning is difficult, and it is better to accept an "improved" closed reduction that maintains general alignment rather than a perfect reduction that might require excessive flexion and vascular compromise.

Patients presenting with a supracondylar fracture with no radial pulse, but whose hand and fingers are pink rarely need vascular exploration. The fracture should be reduced emergently and the vascular status reassessed. An exploration of the vessel is only required if perfusion is felt to be compromised, while close observation can be continued for the pink and well-perfused extremity. Pre- and postreduction neuro assessment is necessary. The anterior interosseous nerve, giving distal interphalangeal flexion to the index and interphalangeal flexion to the thumb, is most commonly involved and usually recovers without further treatment. Fractures that cannot be reduced or adequately held or are highly comminuted may be better treated with overhead olecranon traction. Children with supracondylar fractures often arrive late after treatment by local healers. Treatment depends on extent of deformity and time from the fracture. A moderate deformity with full ROM of the elbow is more acceptable than a well-reduced fracture but an immobile elbow joint. Malunited fractures can be referred for corrective osteotomy if they are symptomatic and/or cosmetically objectionable.

Pediatric femoral shaft fractures may result from low-energy injuries (twisting, falls) or high-energy injuries such as motor vehicle crashes. The fracture patterns reflect the mechanism (torsion, bending axial loading) and the amount of energy. Fractures with comminution or multiple pieces are due to higher energy injuries. The treatment of pediatric femoral shaft fractures depends on

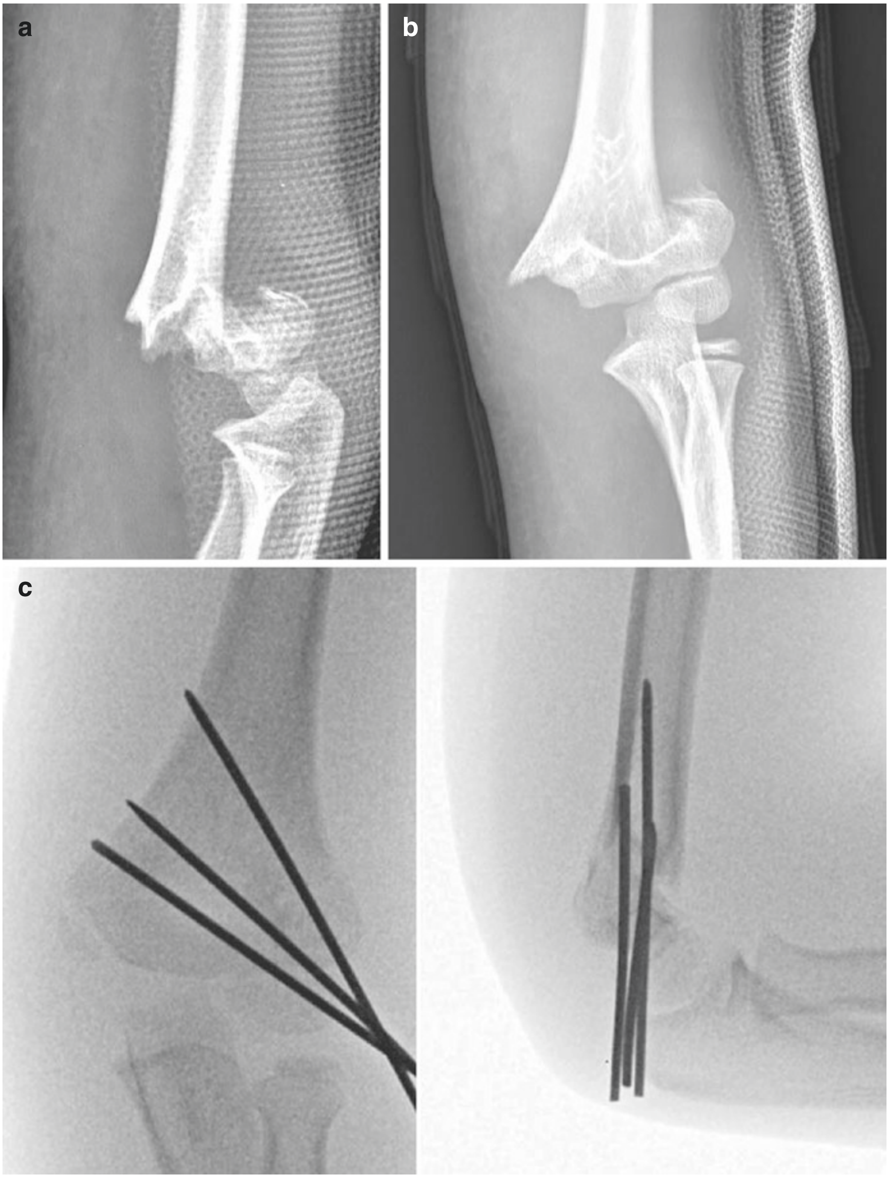


Fig. 16.10 Supracondylar humerus fracture. Supracondylar fractures may be treated by closed versus open reduction and percutaneous pinning (**a**–**c**) or by traction (**d**) [6] (Reprinted from Spiegel et al. [8], with permission of Springer)

Fig. 16.10 (continued)

the age of the patient and local preferences. Between 3 and 8 years, an average 9 mm overgrowth is common and up to 2 cm shortening is acceptable. For patients under 6 years, immediate spica casting or traction followed by spica are the most common treatments with various fixation methods reserved for selected circumstances. Length-stable fractures can be treated in an immediate single-leg or a double-leg spica cast with the foot and ankle free. Mid-shaft fractures are generally immobilized in 45° of flexion of the hip and knee, while proximal fractures may require a greater amount of hip flexion, up to 90°. Fractures that are length unstable (comminuted or with more than 2–3 cm shortening) require traction for 10–21 days prior to applying a spica. Unstable proximal fractures are treated in traction in 90° flexion at the hip and the knee. Older children can be treated as adults with care to preserve growth plates.

Amputations

In low- and middle income countries, amputation for tumors, trauma, infections, and chronic diseases is often the best or only option. Amputation surgery is a process—not a procedure—and needs to address the range of physical, psychological, social, and rehabilitation issues. In some cultures, obtaining consent for an amputation is extremely difficult. No matter the circumstances, a visiting surgeon should request a second opinion from a colleague before proceeding with amputation. Digital photos may also help families make the decision.

An upper extremity amputation should preserve as much distal function as possible, even if limited. The wounds should be healed, and the stump should be painless, sensate, and able to assist as a paddle or claw. Stump length is less of a concern than function, i.e., there is no advantage to preserve the carpal bones that have no muscle padding and add no function while making a cosmetic prosthesis ungainly long. A lower extremity amputation should ideally have a stump that is painless, well padded, and balanced. Disarticulations are end bearing while through-bone amputations bear weight through contact of muscles and various tendons and tuberosities. Before doing any amputation, the surgeon should be aware of the rehabilitation resources available. The prosthetic constraints of a knee disarticulation, for example, may dictate that a less efficient above-knee amputation be performed. Postoperative prevention of hip and knee flexion contractures by prone lying and knee extension exercises is an important step in preparing the patient for prosthetic fitting.

Infections

Musculoskeletal infections are a common cause of disability in economically underdeveloped regions. Early treatment is preferable, although this is unrealistic in most austere environments where patients present with established disease and/or sequelae of sepsis. Besides eradicating the infection, managing the complications of joint destruction, bone loss, pathological fracture, and deformities are long-term projects. Nutritional supplements are important adjuncts in managing all infections.

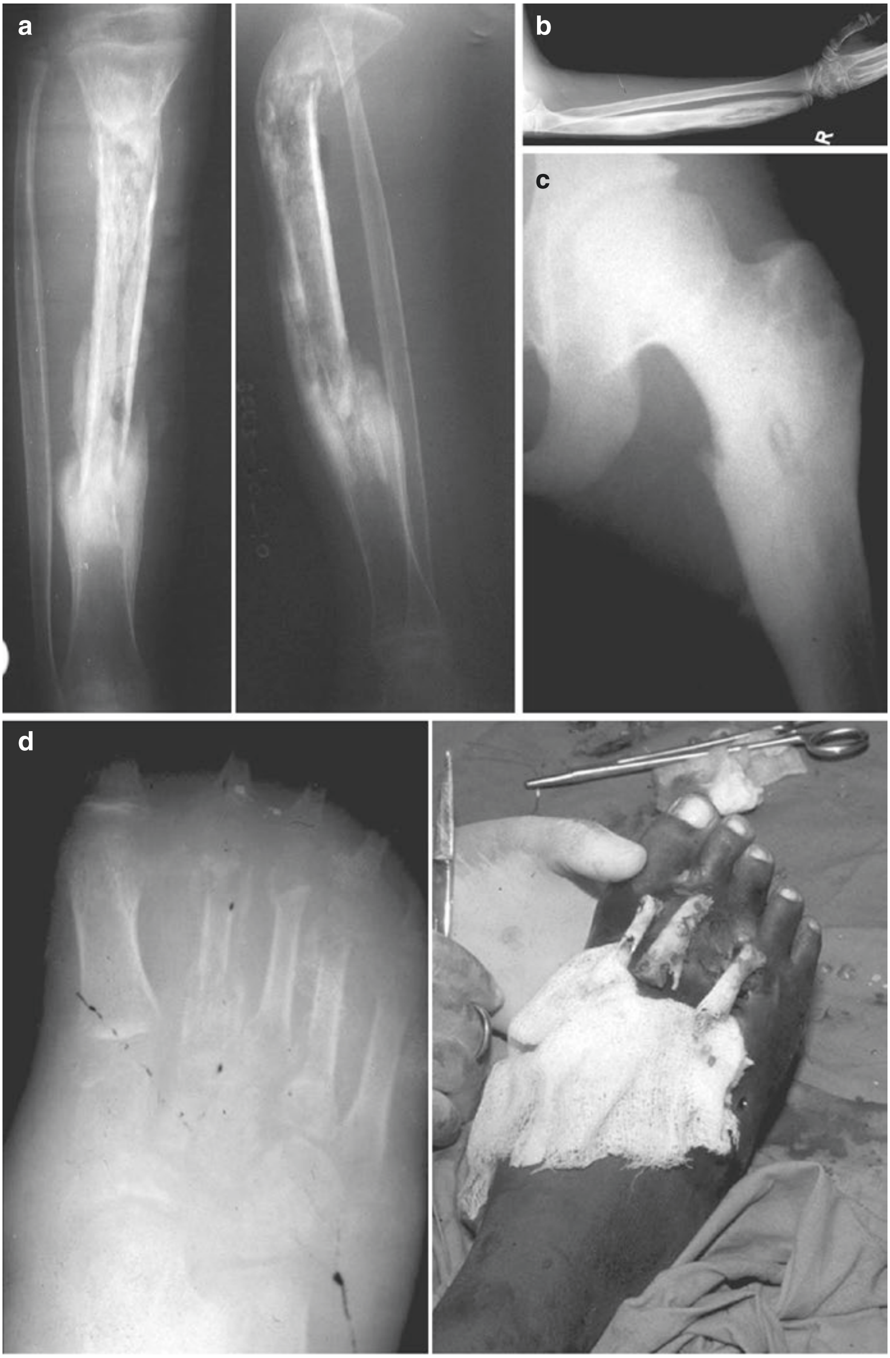
The etiology of most septic arthritis is hematogenous, extension of metaphyseal osteomyelitis, or following surgery. Patients present with joint pain (hip and knee are most common), especially pain with motion, limp, fever, and often a history of other infection. A high index of suspicion leading to prompt surgical drainage and antibiotics should give good results. Damage to the joint surface begins within 18–24 h, and irreversible changes can be present by 4 days, making early diagnosis crucial to prevent permanent damage. While smaller joints may be managed by repeated aspirations and antibiotics, open drainage for larger joints is recommended. Emergent drainage of hip sepsis in children is preferred as there is risk of femoral head avascular necrosis due to vascular tamponade from a tense effusion. Sequelae of septic arthritis are variable and depend on time of presentation thoroughness of treatment, nutritional status of patient, and the ability to prevent of complications.

Acute hematogenous osteomyelitis is commonly a disease of children and presents with localized pain, fever, malaise, and limp. The metaphyses, especially those around the knee, are usual sites of infection with local swelling, warmth, erythema, metaphyseal tenderness, and often a sympathetic effusion, making differentiation between bone and joint infection difficult. Early recognition of infection with surgical drainage and antibiotics gives better outcomes; however, the diagnosis may be masked as there is often a vague history of trauma, and x-rays rarely show bony changes until 10–14 days.

Subacute osteomyelitis involves infection of bone, usually the metaphysis, with an indolent organism in the face of strong host defenses. Patients present with intermittent bone pain, usually at night, and exacerbated by activity with few systemic signs or symptoms. Local discomfort to palpation and mild soft tissue swelling can be present for up to 2 weeks before presentation. The most common radiographic presentation is a Brodie's abscess, a well-circumscribed lytic lesion with a thin sclerotic rim. These lesions may cross the growth plate. Empiric antibiotics are appropriate when the classic radiographic and clinical features are present, but a biopsy should be considered when more aggressive features are present—bone destruction or subperiosteal new bone formation.

Chronic osteomyelitis evolves over months to years from acute osteomyelitis, when organisms become embedded within devitalized material and dead bone (sequestrum), against the body's attempt to resorb these devascularized tissues and retain stability through the formation of new bone (involucrum). Patients present with intermittent bone pain, local tenderness, often a draining sinus, and typical x-ray findings (Fig. 16.11a–d). Treatment is complex, requiring a correct diagnosis, debridement of all infected material, dead space management, and treatment of complications, e.g., pathologic fracture and deformity. Unless there are systemic symptoms, antibiotics are unnecessary; robust nutrition is mandatory for any success. Biopsy may be required as some cases of malignancy can be confused with chronic osteomyelitis, especially when a good history is unobtainable.

Tuberculosis (TB) is still highly prevalent around the world and now kills as many people every year as HIV-AIDS. It should always be in the differential diagnosis of presumed infections or tumors. Ten percent of TB cases involve the musculoskeletal system; 50 % of these involve the spine. TB bone and joint infections require a high index of suspicion as they are usually indolent and slowly progressive with nonspecific constitutional symptoms of low-grade fever, night sweats, weight loss, anorexia, anemia, and malaise. Chemotherapy is effective in 90 % of cases with surgery indicated to establish the diagnosis and treat complications. If a biopsy is not possible, and the clinical signs/symptoms are suggestive and the patient comes from an endemic area, empiric chemotherapy should be started.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Bone and Soft Tissue Tumors

Features suggestive of malignancy include nonmechanical pain, rapid growth, fever, malaise, and weight loss. Prognosis depends on the specific tumor, its grade, size, depth, patient age, medical comorbidities, nutritional status, and available resources for treatment. Patients often present late. In the face of limited imaging, laboratory, chemotherapy, or radiation, palliative amputation may be the only option. If an open biopsy is considered, make a longitudinal incision, cut directly to the lesion to avoid tumor contamination of surrounding tissues, insure adequate hemostasis, and place any drains in line with the skin incision. Specimens from the soft tissue component or extension from an osseous lesion are more likely to be diagnostic. Detailed clinical information must accompany the biopsy when sent to pathology.

Congenital and Developmental Conditions

Clubfoot, congenital talipes equinovarus, affects about 1/1,000 live births. It is most commonly idiopathic, but severe forms are seen in neuromuscular conditions such as myelomeningocele and in arthrogryposis and constriction band syndrome. Pathology is primarily found in the hind foot involving malalignment of the relationships between the calcaneus, talus, and navicular, with associated contractures of the posterior and medial tendons, ligaments, and joint capsules. The basic clinical findings are (1) midfoot cavus, (2) forefoot adductus, (3) hindfoot varus, and (4) hindfoot equinus (Fig. 16.12).

Worldwide treatment of clubfoot is primarily nonoperative using the minimally invasive Ponseti technique, which includes manipulation, serial casting, and usually a percutaneous tenotomy of the Achilles tendon to obtain correction, followed by night bracing for 4 years to maintain the correction. Regional clinics supported by government health services or NGOs are becoming common as the method is disseminated globally, and patients should be referred to these. Older children and adolescents may present with neglected clubfoot or recurrent deformity. They should be referred to specialist centers.

Developmental dysplasia of the hip (DDH) encompasses a spectrum of physical and imaging findings from mild hip instability to frank dislocation. Cultures in which children are swaddled have an increased incidence, while it is little known in Africa, where children are carried with their hips abducted. The instability may be

Fig. 16.11 Chronic osteomyelitis is a sequelae of acute hematogenous osteomyelitis, open fractures, or postoperative infections, in which there are organisms embedded within and around devitalized tissues, giving rise to recurrent episodes of clinical sepsis. An entire segment of a long bone may be sequestered in children (**a**, **b**) [7, 8]. The treatment involves debridement of all devitalized tissues and reconstruction of any bony and soft tissue defects (**c**, **d**) [9] (**a** Reprinted from D'Astous and Harrison [7], with permission of Springer. **b** Reprinted from Penny and Spiegel [8], with permission of Springer. **c**, **d** Reprinted from Harrison [9], with permission of Springer)

Fig. 16.12 Congenital talipes equinovarus (Clubfoot) [10] (Reprinted from Aroojis et al. [10], with permission of Springer)

masked until a limp is found when the child starts to walk. Early treatment by surgeons specialized in DDH treatment offers the best results, as the treatment is technically demanding, and outcomes following a failed reconstruction are worse than no treatment at all.

Angular deformities of the lower extremities can be physiologic (within expected range for age in a growing child), post-traumatic, associated with inflammatory diseases or systemic conditions (malnutrition, rickets), congenital conditions or limb deficiencies, and generalized bone disorders (osteogenesis imperfecta, skeletal dysplasias) (Fig. 16.13). Most will require referral to an orthopedic specialist. The first step is to determine whether the alignment is appropriate for age, and if not where the deformity originates (femur, tibia, foot). Correction is typically by osteotomy with or without fixation. Angular deformities are commonly due to nutritional deficiencies, generalized bone dysplasias, and/or metabolic diseases, and relapse is more likely in the presence of these generalized conditions. Adequate nutritional supplementation is required in most cases.

Fig. 16.13 Angular deformities [11] (Reprinted from Sabharwal and Schwend [11], with permission of Springer)

Neurologic Conditions and Postinjection Injuries

A variety of syndromes and neuromuscular diseases can be encountered with variable influence on the musculoskeletal system, and these are best referred to a center for a diagnosis and orthopedic management to improve function and/or ease of care.

Cerebral palsy is a nonprogressive disorder of movement and posture stemming from damage to the immature brain. The incidence worldwide is 1–2.5 per 1,000 live births. In developing countries the common associations are difficult deliveries at home, jaundice, encephalitis, and meningitis. Musculoskeletal manifestations often progress throughout growth and development in the setting of spasticity and chronic muscle imbalance. Realistic goals must be set for each patient, and treatment will depend on the degree of involvement and local facilities. Handicap International and the International Committee of the Red Cross (ICRC) have family centered rehabilitation programs that can help address some of the challenges in caring for these patients. In selected patients surgery to lengthen or transfer muscles or realignment osteotomies to restore anatomy and maximize function may play a role.

Postinjection paralysis often presents like polio with lower motor neuron signs of foot drop or equinovarus deformity of the foot. The typical history is of a febrile child receiving a quinine injection in the buttock or quadriceps for suspected malaria. Loss of sensation in the first dorsal web space differentiates this from polio, which is strictly a motor disease. Other sequelae of injection injuries include buttock abscess, gluteal fibrosis, and quadriceps fibrosis. Early presentation may respond to splinting and physio; referral to an orthopedic center is recommended. The surgical treatment of equinus contracture is heel cord lengthening, while equinovarus deformity requires heel cord lengthening and a tendon transfer. Gluteal fibrosis is treated by surgical release of the gluteus maximus.

Summary

The world's burden of musculoskeletal diseases is enormous and mostly due to traumatic injuries and infections. Degenerative conditions are emerging as populations age. A majority of the world's population lacks access to an orthopedic surgeon, and when available services are delivered by general surgeons, non-surgeon medical doctors, paraprofessionals, and traditional healers. This chapter briefly covers principles of management for a spectrum of pathology in a setting of limited resources, assuming that an orthopedic surgeon is not available.

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Suggested Reading

Global help (global-help.org) makes available free downloads of books, monographs, and materials which are appropriate for the surgeon working in an austere setting.

Global orthopedics—caring for musculoskeletal conditions and injuries in austere settings. Springer; 2014. Ed. Gosselin, Spiegel, and Foltz. Available as e-book. The text is aimed to give useful advice on orthopedic conditions and treatments for surgeons wanting to work or volunteer in developing countries.

HINARI (www.who.int/hinari/) through HINARI many hospitals and teaching institutions in LMIC have access to a wide selection of journals.

https://signfracturecare.org

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Primary surgery 2 volumes ed. by Maurice King and Peter Bewes. Oxford medical publication, 1987. Available as free down load (https://www.ghdonline.org/surgery/.../primary-surgery-trauma-volume-2). Though almost 30 years old, this text book provides valuable information that remains pertinent in austere settings.

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The closed treatment of common fractures by Sir John Charnley. This text is difficult to find and expensive. It contains a wealth of information on the principles of closed fracture treatment.

War surgery, International Committee of the Red Cross. https://www.icrc.org/.../icrc-002. Available as free down load. Contains useful information not just on orthopedics, but on all war surgery, much of which is pertinent to work in disaster situations.

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