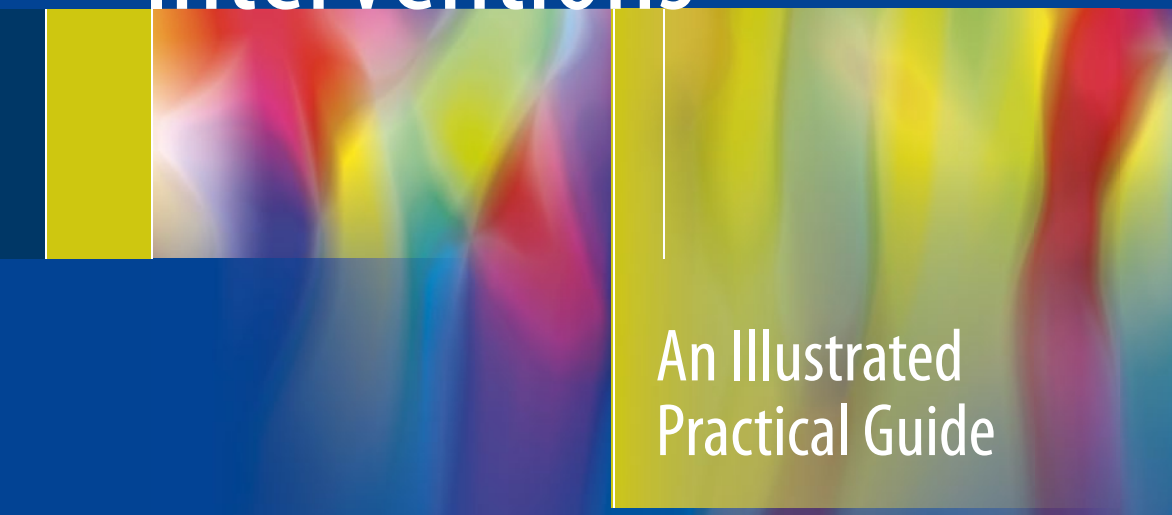
Image-guided Intra- and Extra-articular Musculoskeletal Interventions



An Illustrated Practical Guide

Marina Obradov
Jan L.M.A. Gielen
Editors

Springer

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To strong, loving, and precious women who inspired me for all this, but at the same time probably shall never read it—to Vjera, Tamara, and Jelena.

—Marina Obradov

I dedicate this work to my inspiring daughters Sofie, Soetkin, Hadewych, Janne, and Josefien, my son Seppe, and my grandchildren Anna, Lauren✞, and Jolan.

—Jan Gielen

Foreword

Imaging-guided musculoskeletal injection procedures rapidly expanded in the last two decades supported by the development of imaging technology. The introduction of CT countered the major drawback of X-ray-guided interventions, that is, its lack of three-dimensional anatomy. Once the increasing spatial resolution of US made it suitable for musculoskeletal diagnosis, it countered the major drawback of CT, that is, its lack of real-time imaging.

Imaging-guided interventional procedures require additional training and expertise which is not always available in residency training programs.

This comprehensive book addresses diagnostic and therapeutic intra- and extra-articular injection procedures. It describes the procedures for all major joints and musculoskeletal regions individually. Each procedure is explained step by step beginning with the anatomy of the region, radiological equipment (conventional X-ray, US, CT), pre- and post-procedure medications and needles, different approaches, and possible problems and ending with tips and tricks and aftercare. It is illustrated with drawings, model images, and radiological images: US, CT, and X-ray.

The aim of the book is to help beginners to start with interventions by reading the entire instruction, making a "mental" game plan, using a time-out procedure, with the right equipment and medication. We hope that while using this book the reader will feel that the authors are standing right next to him/her ready to answer questions that may arise along the way. It is only when one feels confident and ready to make his/her own small adjustments that the umbilical band with this book is ready to be cut.

Acknowledgments

Editing this book was a long journey with a lot of unexpected experiences, sometimes less good days but mostly with great professional and personal satisfaction.

We wish to thank ESSR intervention subcommittee members who were generous with their expertise and precious time invested in the creation of this book.

Tijana Lukovic deserves a hearty thank you for her skillful artwork of relevant anatomy and patient readiness for all repeated corrections.

Abbreviations

AC	Acromioclavicular
A-P	Anteroposterior
APB	Abductor pollicis brevis tendon
APL	Abductor pollicis longus tendon
BMI	Body mass index
CMC	Carpometacarpal
CT	Computed tomography
CTS	Carpal tunnel syndrome
DRU	Distal radioulnar
ECRB	Extensor carpi radialis brevis tendon
ECRL	Extensor carpi radialis longus tendon
ECU	Extensor carpi ulnaris tendon
EDC	Extensor digitorum communis tendon
EDQ	Extensor digiti quinti tendon
EIP	Extensor indicis proprius tendon
EPB	Extensor pollicis brevis tendon
EPL	Extensor pollicis longus tendon
G	Gauge
IV	Intravenous
LE	Lateral epicondyle
ML	Milliliters
MM	Millimeters
MR(I)	Magnetic resonance (imaging)
NSAID	Nonsteroidal anti-inflammatory drug
P-A	Posteroanterior
PNT	Percutaneous needle tenotomy
PRP	Platelet-rich plasma
Rab	Rectus abdominis
RC	Radiocarpal
RF	Radio frequency
SIJ	Sacroiliac joint
SP	Symphysis pubis
US	Ultrasound

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General Introduction On Imaging Guided Interventions

1

Jan L.M.A. Gielen

Abbreviations

CT	Computed tomography
MRI	Magnetic resonance imaging
NSAID	Non-steroidal anti-inflammatory drug
PNT	Percutaneous needle tenotomy
PRP	Platelet-rich plasma treatment
ROI	Region of interest
US	Ultrasound
VAS	Visual analog scale

1.1 Indications: Intraarticular

Blind injections for shoulder pain are successful only in minority of the cases, 42% of glenohumeral joint injections and even less (29%) of subacromiosubdeltoid bursa injections are in situ. In suspected joint effusions, blind aspirations only returned fluid in only 32% of cases compared to 97% if performed under US guidance. A minor resis tance loss might be felt when entering the joint. Even in the knee sonographically guided injections show more accuracy than blind injections [22]. These numbers are substantial evidence to use ultrasound-guided techniques in articular and bursal procedures.

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– *Diagnostic and Therapeutic Aspiration*
– Diagnostic aspiration is performed in suspected crystal arthropathy or septic arthritis for respectively microscopic and microbiological examination. In suspected septic arthritis, intraarticular injection of local anaesthetic is avoided as the bacteriostatic action of this medication may contribute to the false-negative microbiology result. The best result is expected after complete aspiration of joint effusion; US is effective in demonstration of the completeness of the aspiration.
– *Diagnostic Injection*
– Diagnostic block is useful in differential diagnostic situations to confirm or rule out a specific joint as source of pain. It is performed by injecting a small amount of local anaesthetic into the joint followed by 24-h clinical assessment with VAS pain registration whether the patient's symptoms improved. Injection should be terminated if the patient complains of discomfort. Large amounts of local anaesthetic are avoided to reduce the chondrotoxic effect of lidocaine and bupivacaine. Overuse of the joint because of pain relief should be avoided.
– *Therapeutic Injection*
– Most often local anaesthetics and corticosteroid are used. See Sect. 1.5 for details and other preparations. In adhesive capsulitis expansion of the joint with saline mixed with local anaesthetic and corticosteroid is performed.

1.2 Indications: Extra-Articular

- *Calcific Tendon Disorders and Non-calcific Tendinopathy*
- Calcific tendon disorders and non-calcific tendinopathy are self-limiting disorders and potentially symptomatic with pain and functional impairment. They might be refractory to conservative management in which US-guided treatment options might be used. These treatment options are PNT, PRP, prolotherapy and barbotage [1, 2, 6]
  – PNT (percutaneous needle tenotomy, needling)
  – PRP (platelet-rich plasma) treatment
  – Prolotherapy
  – Barbotage/needle aspiration of calcific deposit

These procedures are only performed in symptomatic patients. In the mechanical symptomatic phase, the calcium deposits are typically firm. Removal of the deposits is difficult and often incomplete. In the resorptive (inflammatory) phase, the calcium is liquefied and shedded into the peritendinous tissues (peritenon, tendon sheath, bursa or subbursal) with acute inflammation for 2 weeks or longer. This inflammation will dissolve the calcific deposits. Anti-inflammatory drugs are avoided; aspiration of the soft consistency deposits under US guidance shortens the recovery time.

No conclusive evidence exists that intralesional steroid injection, acetic acid iontophoresis or pulsed ultrasound therapy is effective [7, 20].

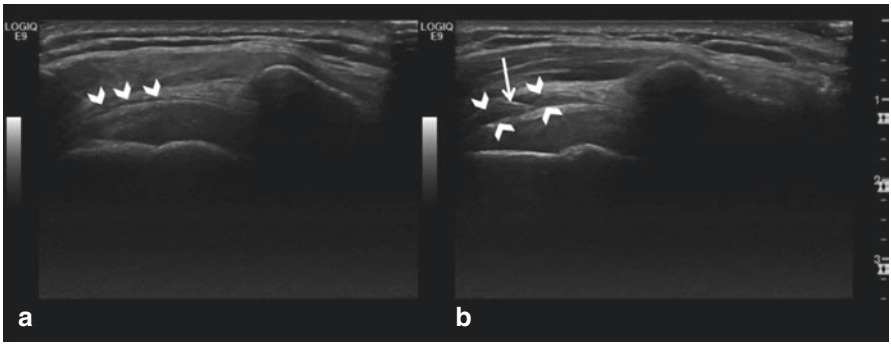

Fig. 1.1 US-guided bursal injection at the subacromiosubdeltoid bursa in a 38-year-old female patient with complaints of subacromial impingement. US examination revealed no rotator cuff tear. US-guided infiltration with Depo-Medrol and Marcaine of the subacromiosubdeltoid bursa is performed. (**a**) US view before infiltration. Subacromiosubdeltoid bursa is not expanded (*arrowheads*). (**b**) US view during infiltration. Intrabursal needle position (*arrow*) with expansion of the subacromiosubdeltoid bursa (*arrowheads*)

- *Bursitis and Tendon Sheath Injection*
- Increased accuracy of US-guided tendon sheath or bursal injection therapy is related to specific locations, deep bursa location or in obese patients [15]. Blind superficial intrabursal injection is verified by aspiration of bursal content prior to the injection. (Fig. 1.1) Ultrasound-guided bursal injection definitely is more accurate in subacromiosubdeltoid, iliopsoas and trochanteric bursa (Fig. 1.1).

- *Nerve Intervention*
- US-guided peripheral nerve blocks for surgical regional anaesthesia gained interest related to the increased spatial resolution of US and subsequent use in diagnosis of peripheral nerve lesions. Ultrasound nerve blocks are common practice for surgical anaesthesia. Specific US-guided diagnostic nerve blocks (saphenous nerve in entrapment at the adductor canal, piriformis syndrome, superficial peroneal nerve injury) and US-guided nerve block or US-pulsed radiofrequency (carpal tunnel, shoulder adhesive capsulitis, facet joints) for pain control are accurate techniques [11, 12, 13, 25].

- *Biopsy of Soft Tissue and Bone Masses*
- Imaging-guided core needle biopsy of soft tissue and bone masses is highly accurate and common practice in radiology departments. Depending on the specific location and imaging characteristics of the lesion, (PET/SPECT)CT-, US- or (PET)MRI-guided technique is preferred. In suspected malignancy, MRI should be performed before the biopsy procedure. Biopsy trajectory should be discussed with the surgeon that will remove the tumour as in case of malignancy, the biopsy trajectory has to be removed.

1.3 Contraindication

- Coagulation pathology
- Local or systemic infection
- Patient unwilling to consent to the procedure
- Pregnancy for CT- and MRI-guided procedures

1.4 Pre-Procedures

Review of previous examinations and/or repetition of diagnostic (ultrasound) examination to confirm the indication of the procedure is mandatory. Critical structures to be avoided during the procedure, i.e. nerves, vessels and joint spaces are defined. Safe needle trajectory is planned. In case of suspected tumour or malignancy, MRI should be performed before the interventional procedure (biopsy). The needle trajectory should be discussed with the surgeon that will remove the lesion with the needle route.

Sterile skin preparation and aseptic technique regarding the use of sterile coupling gel (US guided procedures) and sterile drapes are not generally accepted. In US guided procedures standoff pads are never used. In extra-articular procedures, thorough cleansing of the skin and probe is advised. In intraarticular procedures, disposable plastic probe covers minimize the risk of septic arthritis.

Local anaesthesia at the puncture site is optional.

1.5 Medication

- *Local Anaesthetics*
  - Local anaesthetics are used for immediate pain relief and diagnostic feedback in the elucidation of pain; this is referred to as "marcainization". Amides (lignocaine, lidocaine, bupivacaine) water-soluble local anaesthetics are generally used; allergic reaction is not common in these products. Use local anaesthetics free of paraben or phenol in order to avoid steroid flocculation. Lidocaine hydrochloride 2% (Xylocaine® or Linisol) has a rapid onset with a duration of action of up to 5 h. Bupivacaine hydrochloride 0.25–0.5% (Sensorcaine® or Marcaine) has a slower onset (10–15 min) but can last up to 12 h. For extra-articular use, a mix of both products with slow and rapid onset can be used to combine the advantage of rapid onset with long duration. Intraarticular and intravascular use is avoided in large quantities. Severe CNS and cardiovascular adverse effects are published in intravascular use in large quantities. In intraarticular use, significant chondrolysis is described especially in lidocaine hydrochloride in combination with vasoconstrictors [17].
- *Corticosteroids*
  - Corticosteroids are used for their anti-inflammatory action providing medium-term relief of symptoms.

- Particulate corticosteroid preparations (non-water-soluble esters) are potential embolic agents in case of intravascular injection; avoid intravascular injection by verifying proper needle positioning by means of water soluble contrast medium injection. Never use these non-water-soluble products in neuroforamina to avoid spinal cord infarction [18].
- Corticosteroids are grouped in **four classes** (Table 1.1). Intraclass allergy is described; supraclass allergy is most often not the case. Water-soluble and water-insoluble products are used. Most preparations are insoluble in water, among them the corticosteroid esters; they form microcrystalline suspensions. Water-insoluble products should not be used for transforaminal injections. Serious adverse effects are reported if accidentally injected intravascularly with embolization and potential cerebral and spinal cord infarction. Dexamethasone preparations are typical water-soluble non-particulate (dexamethasone sodium phosphate) used for transforaminal injections that are not associated with CNS embolic type sequels. A drawback is that these water-soluble corticosteroids have a shorter-lived anti-inflammatory effect. Commonly prescribed corticosteroids for injection into soft tissues are triamcinolone acetonide (Kenalog®) and methylprednisolone acetate (Depo-Medrol®). They are long-acting corticosteroids. A suspension mixed before injection might be used for extra-articular-extravascular use with 1 part lidocaine 2%, 1 part bupivacaine 0.25% and 2 parts 40 mg/mL corticosteroid (Depo-Medrol®).
- **Side effects** of corticosteroids. Biomechanical properties of **tendons** are adversely affected. Moreover currently there is no good evidence to substantiate the use of corticosteroids in treatment of chronic tendon lesions. Multiple case reports of tendon rupture after intratendinous corticosteroid injection are published. Intra- and repeated peritendinous injection should be avoided especially in loaded tendons of the lower limb (Achilles tendon and patellar tendon). **Cartilage** breakdown when injected into synovial joints particularly weight-bearing articulations is described. Articular surfaces develop multiple cystic defects, which become filled with necrotic debris. Such lesions appear not to develop in similarly injected non-weight-bearing joints. A postinjection **flare** with a local increase in inflammation is described

Table 1.1 Corticosteroid classes

A. *Hydrocortisone type (cortisol)*: Methylprednisolone acetate (Depo-Medrol, Medralone)
B. *Acetonide type*: Triamcinolone acetonide (Kenalog)
C. *Betamethasone type*:
(a) Betamethasone acetate/sodium phosphate (Celestone Soluspan, Betaject)
(b) Dexamethasone sodium phosphate (Decadron phosphate, Adrenocot, Decaject)
D. *Corticosteroid esters*: (D1) halogenated and (D2) prodrug esters

in 2–25% of injections. This develops within hours and may last up to 3 days and is not a predictor of poor corticosteroid therapy response. Topical, intradermal or subcutaneous application may lead to **skin atrophy, fat necrosis and skin depigmentation**. Methylprednisolone (Depo-Medrol®) is less prone to causing skin atrophy than triamcinolone (Kenalog® or Aristopan) and thus is preferred when injecting lesions near the skin surface. Triamcinolone is very effective in intraarticular use; extra-articular use should be avoided. **Increased blood glucose level in insulin-dependent diabetes** can be seen in 1% of patients from 2 to 5 days after injection. It is less prominent with intraarticular injections, more with tendon sheath injections. Injections may be less effective in patients with diabetes. **Facial flushing** is described in about 15% of patients. It is likely secondary to a histamine-mediated response to the drug 2–30 h after injection and can last 36 h. Chilliness, shaking and headaches can accompany the facial flushing. Facial flushing is always self-limiting. It is more common after triamcinolone injection. If symptoms persist, administer antihistaminicum diphenhydramine (Benadryl®).

  - **Contraindications** of corticosteroids. Absolute contraindications are local or intraarticular sepsis, bacteraemia, intraarticular fracture and joint instability. Relative contraindications are severe juxta-articular osteopenia, coagulopathy if INR is over two and three previous intraarticular injections in the same year or previous injection within a period of 6 weeks.
  - **Recommendations** for corticosteroid use in soft tissues and joints. Use methylprednisolone (Depo-Medrol®) when injecting superficial lesions or superficial joints. Mix the corticosteroid with local anaesthetic solution to provide immediate but short-term pain relief. Avoid intratendinous injections and peritendinous injections, especially when the adjacent tendon is heavily loaded (patellar and Achilles) or is torn. Avoid intraarticular injections unless there is a specific indication, such as end-stage osteoarthritis. Advise at least 2 weeks of rest and avoid heavy loading for 6 weeks. Allow adequate time between injections to assess its effects, a minimum of 6 weeks. Be cautious in using more than three injections at any one site. Do not repeat if at least 4 weeks of symptomatic relief was not achieved after two injections [9, 14, 21].

- *Prolotherapy*
  - Prolotherapy is the administration of a small volume of a local irritant substance that is injected around a ligament or tendon insertion to initiate a local inflammatory response. Typical products are hyperosmolar dextrose, phenol glycerine glucose (P2 G) and sodium morrhuate [5, 16, 19]. No randomized controlled trials regarding its efficacy have been published.

- *Botulinum Toxin Type A*
  - Botulinum toxin type A is use for spasticity and muscle contractures. No randomized controlled trials regarding its efficacy have been published.
- *Traumeel*
  - Traumeel is a homoeopathic preparation with fixed combination of diluted plant and mineral extracts. Traumeel has shown comparable effectiveness to NSAIDs in terms of reducing symptoms of inflammation, accelerating recovery and improving mobility, with a favourable safety profile. Current information suggests that Traumeel may be considered as an anti-inflammatory agent that is at least as effective and appears to be better tolerated than NSAIDs [23].
  - Traumeel is injected for injuries and degenerative and inflammatory conditions (osteoarthritis, sprains, epicondylitis, tenovaginitis). In cases of traumatic knee haemarthrosis, three 2 mL intraarticular injections were given over a period of 8 days.
- *Hyaluronic Acid*
  - Hyaluronic acid is a carbohydrate polymer that is part of the extracellular matrix. It is a major component of the synovial fluid and cartilage. It increases the viscosity of the fluid. Along with lubricin, it is one of the fluid's main lubricating components. Hyaluronic acid is in the cartilage present as a coat around each chondrocyte. The aggregates of hyaluronan with aggrecan monomers in the presence of hyaluronic acid and proteoglycan link protein imbibe water and are responsible for the resistance of cartilage to compression.
  - Hyaluronic acid injections in joints, especially the knee joint, are used to treat osteoarthritis in patients that are no longer able to control pain associated with osteoarthritis with NSAID and/or corticosteroids or have a contraindication for the latter. Many patients appear to get at least some pain relief with improvement to perform daily activities, reducing the pain levels by 28–54%. It has not been proven, however, to generate significant benefit and has potentially severe adverse effects.
  - The treatment regimen for hyaluronic acid usually involves one injection in the affected joint per week for 3–5 weeks. It takes about 5 weeks before a patient experiences the maximal benefits of hyaluronic acid; these benefits persist at peak levels for about 3 months. By contrast, NSAIDs and corticosteroid are short-acting medications with pain relief within a few days that diminishes within a month.
  - Injected mixture for diagnostic purpose might be mixed with 5 mL local anaesthetic.
  - Injected mixture for therapeutic purpose might be mixed with 1–1.5 mL long-acting corticosteroid and 1–1.5 mL local anaesthetic.

1.6 Equipment

- *Needles*
  - Larger needles (18–20 G) are generally needed for aspiration of thick material (ganglion, hematoma and pus). Smaller needles (22–27 G) suffice for most injections. Trucut biopsy side loading needles are easily manipulated with one hand. Spirotome® end loading biopsy needle needs a two-hand manipulation and is not easily used under US guidance. The advantage of Spirotome needle is the full control of the needle tip position.

- *Syringes*
  - 2.5–5 mL Luer Lock syringe for injected mixture
  - 2.5–5 mL Luer Lock syringe for iodinate contrast medium
  - 5–10 mL syringe for local anaesthesia (optional)
  - 22 G, 70–90 mm spinal needle with Quincke type point
  - Extension set with three cocks connecting the needle and syringes

1.7 Complications and Adverse Effects

For adverse effects of medications, see medications Sect. 1.5.
For complications of individual procedures, see the dedicated chapter.

1.8 Aftercare

- Adhesive tape at the puncture site.
- Patient should be observed for 15–30 min (prior to discharge, perform motor strength and sensory evaluation).
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post infiltration because they might experience temporary weakness or delayed reflexes due to the local anaesthetic action.
- Follow-up reschedule within 7–10 days.
- Temporary pain or pain exacerbation (2.5% of the cases) could be treated with oral analgesics.

1.9 Fluoroscopy-Guided Procedures

- The patient is positioned, and fluoroscopy beam is angulated to provide axial view in joint procedures.

- With a course parallel to the fluoroscopy beam, advance the needle aiming towards a target point.
- Proper intraarticular needle positioning is verified fluoroscopically with injection of 1–3 mL of water-soluble iodinated contrast medium which will be dispersed inside the joint either lining its margins or being collected at the joint's dependent part.
- Solution to be injected depends on the indication of the procedure.

1.10 Ultrasound-Guided Procedures

- High-frequency linear array ultrasound transducers with compound scanning are routinely used. These are less prone to anisotropic artefact and deformation of anatomy [17].
- Lower-frequency curvilinear probes are used in specific situations: deep structures (hip in large patients).

1.10.1 Puncture with Direct US Guidance (Freehand Technique)

- Perform diagnostic US examination. Compose a safe needle route as parallel to the long axis of the surface of the transducer as possible. Mark the entry point on the skin and orientation of the probe on the skin (Fig. 1.2a, b).
- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Local anaesthesia at the puncture site is optional but advised in complex procedures (PNT, PRP, prolotherapy, etc.)
- Reposition and align the probe along the marks on the skin, and advance the needle along the composed needle route under constant US dynamic visualization of the needle and tip with the long axis of the needle parallel with the long axis of the transducer (Fig. 1.2c, d). Reverberation artefact helps in identification of the needle (Fig. 1.3). Injecting a small amount of fluid (anaesthetic of physiologic solution) helps to localize the needle tip.
- The diagnostic or therapeutic procedure depends on the indication; the same needle is used for aspiration or injection to avoid puncturing multiple times.

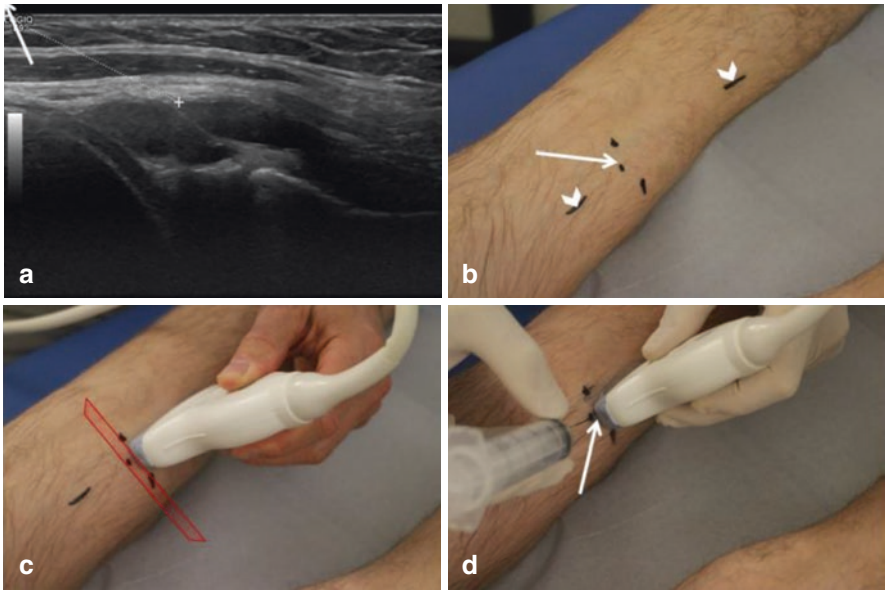

Fig. 1.2 US-guided bursal injection at the semimembranosus bursa in a 27-year-old male patient (**a**) US examination in sagittal imaging plane with mark of the puncture trajectory (*dotted line*), skin puncture location is defined at the centre of the short axis of the probe (*arrow*). Angle relative to the skin surface is memorized (*curved line*). (**b**) Skin puncture location is marked on the skin (*arrow*); orientation of the long axis of the probe is marked on the skin (*arrowheads*). (**c**) After skin and probe disinfection, the probe is repositioned with usage of the skin markings. (**d**): Needle is positioned on the skin with memorized angulation and punctured at the skin marking (*arrow*) and transgressed in the body under direct US guidance

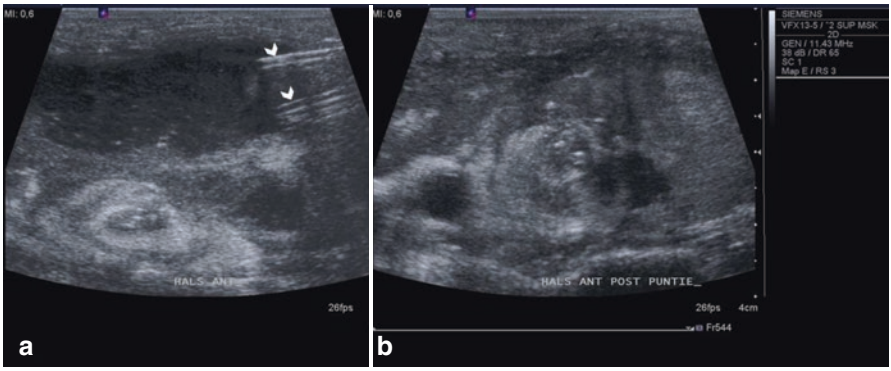

Fig. 1.3 Reverberation artefact. US guided aspiration and evacuation of neck abscess. (**a**) US image illustrating reverberation artefact of needle tip (*arrowheads*) with needle tip in the hyposonant abscess area. (**b**) US image after evacuation demonstrating absence of collection

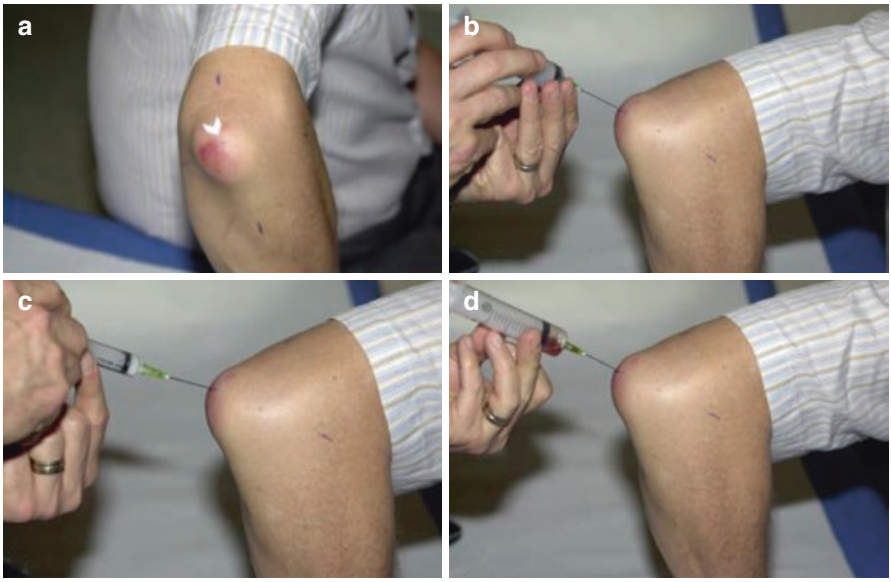

Fig. 1.4 Evacuation and infiltration of traumatic bursitis olecrani in a 68-year-old male patient. (**a**) Entry point with skin marking (*arrowhead*) at the central and major bursal thickening is made. Skin disinfection is performed. (**b**) Needle with empty syringe is positioned at the skin marking. (**c**) Needle is advanced under constant traction of the syringe plunger for aspiration of bursal content. Bloody aspirate is evident. (**d**) Depo-Medrol is injected post aspiration. Intrabursal injection is confirmed with US copy

1.10.2 Puncture Without Direct US Guidance

The procedure without direct US guidance is used for aspiration of superficial cyst-like lesions. This procedure is less time-consuming and requires no special sterile preparation (Fig. 1.4).

- High-frequency linear array ultrasound transducers with compound scanning are routinely used. These are less prone to anisotropic artefact and deformation of anatomy.
- Lower-frequency curvilinear probes are used in specific situations with deep structures like the hip in large patients.
- Perform diagnostic US examination in axial and longitudinal orientation, and mark the margins of the lesion on the skin with a central entry point on the cross hair of these markings on the skin (Fig. 1.4a). Calculate the depth of the centre of the lesion relative to the skin surface.
- Prepare the sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Local anaesthesia at the puncture site is not used.

- Insert a thick 18 G needle at the cross hair at right angles to the original planes and to the skin surface to the predetermined depth. Aspire the contents for laboratory evaluation (culture, crystal, pathology), and eventually inject corticosteroid on indication (Fig. 1.4b–d).
- Post-procedure US examination to confirm volume reduction of the cyst and/or injected steroid (reflective suspension).

1.11 Computed Tomography (Fig. 1.5)

- Patient positioning is dependent on the location of the lesion.
- Adjust radiopaque catheter with plaster on the skin in the suggested ROI in perpendicular orientation relative to the axial scanning plane.
- In case of biopsy, intravenous iodine contrast enhancement is used. The biopsy ROI is defined in area's with increased vascularity (angiogenesis) in the tumor as defined by the jodine enhancement on CT and/or in comparrison with previously performed MRI (gadolinium enhanced area's) or hybrid PET imaging (area's with increased PET avidity).
- Perform scans with 3–5 mm axial images, covering the target area.
- Define and mark entry point at the skin with non-water-soluble marker.
- Define the needle path avoiding nerves and vascular structures joint in extra-articular procedures; in case of biopsy, discuss the needle path with the surgeon.
- Define the angle of the path relative to the horizontal or vertical axis.

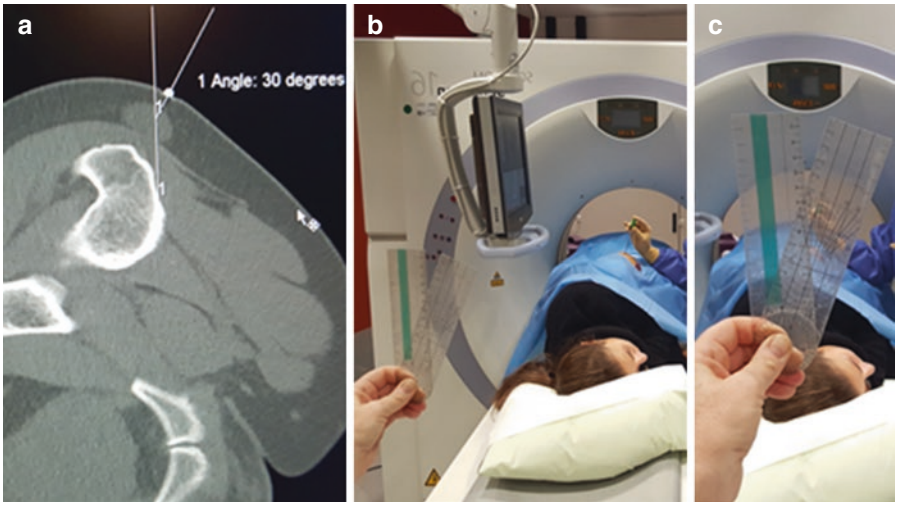

Fig. 1.5 (**a**–**c**) Female patient, 38-year-old. Painful mass lesions at the subcutaneous tissue of the left trochanteric area. (**a**–**c**) Pre-biopsy scan for location and planning of biopsy trajectory and angulation relative to vertical axis (**a**). Thirty-degree angulation relative to the vertical axis is transferred to the needle using transparent triangle (**b**, **c**)

- Define the depth of the target.
- Prepare the sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Local anaesthesia at the puncture site is optional in aspirations and injections and mandatory in biopsy procedures.
- Advance the (biopsy) needle along the projected trajectory at the defined angle and depth.
- Perform the intended procedure (aspiration, injection, biopsy).

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Shoulder Procedures: Intra-Articular

2

Marina Obradov

Abbreviations

AC Acromio-clavicular
G Gauge
US Ultrasound

2.1 Glenohumeral Joint

2.1.1 X-Ray Guidance

2.1.1.1 X-Ray Guidance: Anterior Approach

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

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Pre- and post-procedural medications:

- No medication

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 1–2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinate contrast
- Pre-packed 20 mL Artirem® syringe
- Pre-packed 2 mL hyaluronans® syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol® (methylprednisolone acetate) 40 mg/mL or 1 mL Kenacort® (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis® 5 mg/mL
- Hyaluronas: 2 mL Synvisc® Hylan G-F 20
- Contrast: 1 mL–10 mL Xenetix® 300
- 10 mL Artirem® 0.0025 mmol/mL

Anatomy of the region (Fig. 2.1):

- Anterior glenohumeral capsule inserts at the anatomic neck of the humerus
- In the neutral position of the patient, coracoid process is located medially which allows direct access to the humeral head, while in oblique position, the coracoid process covers laterally over the humeral head and could be an obstacle for direct intra-articular puncture

Patient positioning (Fig. 2.2):

- Patient is lying in supine position on the fluoroscopy table, with the arm in external rotation and supination of the forearm and hand; a sandbag could be placed on the hand to obtain relaxation of the shoulder musculature. External rotation of the arm moves the anterior humeral capsular insertion laterally and promotes intra-articular injection

Technique (Fig. 2.3):

- Position the metallic pointer in the caudo-medial quadrant of the humeral head that is marked on the patient skin using indelible marker
- Sterile preparation of the region of the marker

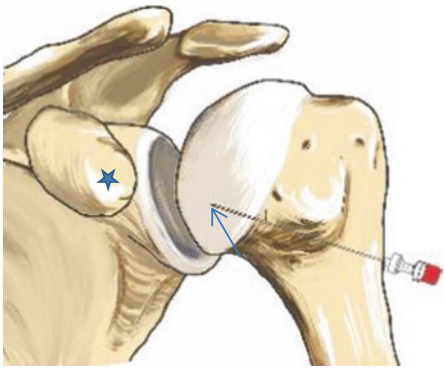

Fig. 2.1 Normal anatomy of the anterior aspect of the shoulder. In neutral position of the patient, coracoid process (*asterisk*) is located medially allowing direct access to the humeral head. Area of interest is the caudo-medial quadrant of the humeral head (*arrow*)

Fig. 2.2 Patient position. Patient is lying in supine position on the fluoroscopy table, with the arm in external rotation and supination of the forearm and hand

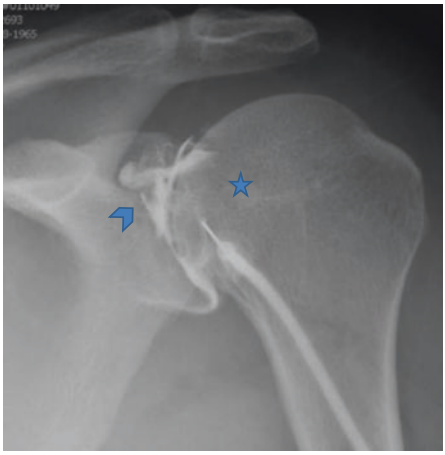

Fig. 2.3 X-ray of glenohumeral injection technique, anterior approach. The needle is positioned in the caudo-medial quadrant of the humeral head (*asterisk*). A small amount of injected contrast has to flow away from the tip of the needle with demonstration of a sharp contour of the hyaline cartilage as a sign of good intra-articular position of the needle (*arrowhead*)

- Connect the needle and appropriate syringe with extension set
- Insert needle in a vertical direction intra-articularly, control position using fluoroscopy with light visor collimation
- Inject a small amount of contrast which has to flow away from the tip of the needle with demonstration of a sharp contour of the cartilage as a sign of good intra-articular position of the needle
- Inject solution depending on the indication of the procedure
- Joint volume capacity is 12 mL (care is taken not to over distend the joint to avoid artificial leakage of the contrast)
- Put pressure on the needle tract when withdrawing the needle to prevent solution reflux

Aftercare:

- Adhesive tape at the puncture site
- Patient should be observed for 15 min
- Information brochure with information on procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression
- Feeling of the fullness of the shoulder joint could be treated with 1-day relative rest of the shoulder[1]

Tip:

- Palpate position of the coracoid process to avoid inadequate extra-articular injection due to over projection of the coracoid process

2.1.1.2 X-Ray Guidance: Posterior Approach

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:
- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 12 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinate contrast
- Pre-packed 20 mL Artirem syringe
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate) 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis 5 mg/mL
- Hyaluronas: 2 mL Synvisc Hylan G-F 20
- Contrast: 1–10 mL Xenetix 30
- 5–10 mL Artirem 0.0025 mmol/mL

Anatomy of the region (Fig. 2.4):

- The infraspinatus tendon arises from the infraspinatus fossa of the scapula coursing deep to the deltoideus muscle and superficial to the glenoid cortex inserts onto the great tuberosity of the humerus
- The posterior glenohumeral capsule should always insert to the glenoid rim [2]
- External rotation of the arm makes the posterior glenohumeral capsule lax
- The normal labrum can vary in width and thickness from 2 to 14 mm [2]

Patient positioning (Fig. 2.5):

- Patient lying in semi-prone position, affected shoulder posteriorly angulated at approximately 45° on a triangular foam pad, hand in external rotation

Technique (Fig. 2.6):

- Position the metallic pointer in the cranio-medial quadrant of the humeral head that is marked on the patient skin using indelible marker
- Sterile preparation of the field of the region of the marker
- Connect the needle and appropriate syringe with extension set
- Insert the needle vertical intra-articular and control position using fluoroscopy with light visor collimation
- Inject a small amount of contrast which has to flow away from the tip of the needle as a sign of good intra-articular position of the needle
- Inject solution depending on the indication of the procedure
- Joint volume capacity is 12 mL (care is taken not to over distend the joint to avoid artificial leakage of the contrast)
- Put pressure on the needle tract when withdrawing the needle to prevent solution reflux

Aftercare:

- Adhesive tape at the puncture site
- Patient should be observed for 15 min
- Patient receives brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment

Procedure related symptoms and treatment:

- Procedure-related symptoms should be resolved in 1 week
- Pain at the puncture site could be treated with cold compression
- Feeling of fullness and stiffness of the shoulder joint could be treated with 1–2 days of relative rest of the shoulder [1]

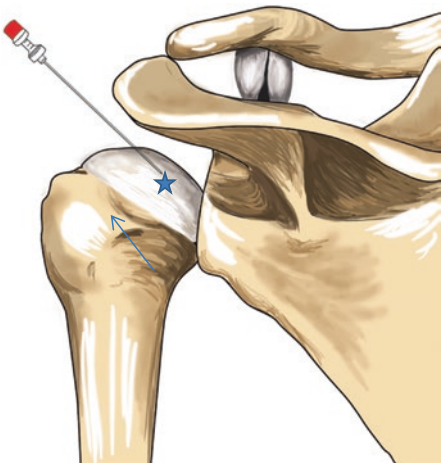

Fig. 2.4 Normal anatomy of the posterior aspect of the shoulder. Posterior glenohumeral capsule inserts at the anatomic neck of the humerus (*arrow*). External rotation of the arm slackens the posterior glenohumeral capsule. The needle is inserted in the cranio-medial quadrant (*asterisk*)

Fig. 2.5 Patient position. Patient lying in semi-prone position, affected shoulder posteriorly angulated at 45° on the triangular foam pad (*asterisk*), hand in external rotation

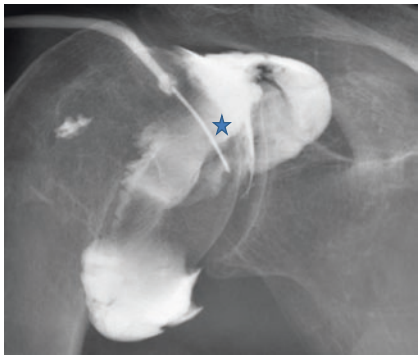

Fig. 2.6 X-ray demonstration of glenohumeral injection technique, posterior approach. The needle is inserted in the cranio-medial quadrant (*asterisk*)

2.1.2 US Guidance: Posterior Approach

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropaties

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- Highresolution ultrasound equipment with 18–5 MHz linear transducer

Syringe (depends on the indication of the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinated contrast
- Pre-packed 20 mL Artirem syringe
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs (depends on the indication of the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis 5 mg/mL
- Hyaluronas: 2 mL Synvisc Hylan G-F 20
- Contrast: 1–10 mL Xenetix 300
- 5–10 mL Artirem 0.s0025 mmol/mL

Anatomy of the region (Fig. 2.7):

- The infraspinatus tendon arises from the infraspinatus fossa of the scapula coursing deep to the deltoideus muscle and superficial to the glenoid cortex inserts onto the great tuberosity of the humerus
- The posterior glenohumeral capsule should always insert to the glenoid rim [2]
- External rotation of the arm makes the posterior glenohumeral capsule lax
- The normal labrum can vary in width and thickness from 2 to 14 mm [1]

Patient positioning (Fig. 2.8):

- Patient lying in semi-prone position, affected shoulder uppermost posteriorly rotated at approximately 45° on a triangular foam pad, hand in external rotation

Technique (Fig. 2.9):

- Prepare sterile field of the region

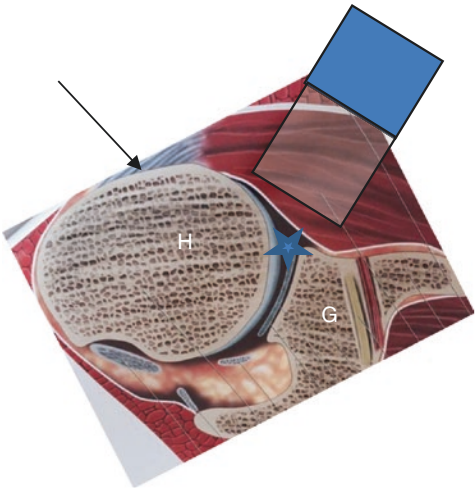

Fig. 2.7 Normal anatomy of the posterior aspect of the shoulder. The infraspinatus tendon arises from the infraspinatus fossa of the scapula and inserts onto the greater tuberosity of the humerus (*arrow*). Infraspinatus tendon is caudal and parallel to the scapular spine. The posterior recess (*asterisk*) is located between the humeral head (H) and cortex of the posterior glenoid (G)

Fig. 2.8 Patient position. Patient lying in semi-prone position, affected shoulder uppermost approximately 45° on the triangular foam pad (*asterisk*), hand in external rotation. The needle is inserted from lateral to medial 45° under the transducer

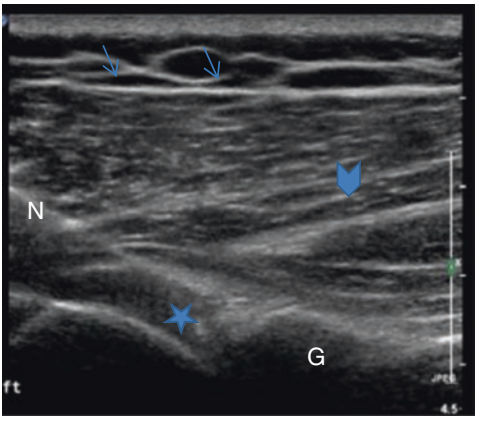

Fig. 2.9 US shoulder injection technique, posterior approach. Infraspinatus tendon (*arrowhead*) located deep to the deltoideus muscle (*arrow*) and superficial to the glenoid cortex (G) and capsule (*asterisk*) of the joint. The needle (N) is inserted at an angle of about 45° from lateral to medial

- Transducer in the long axis of the infraspinatus tendon and parallel with the tendon
- Adequate visualisation of the humeral head and glenoid posterior cortex, joint capsule and posterior labrum
- Insert the needle from lateral to medial at an angle of about 45° under the transducer, and point to the joint space
- The tip of the needle should be positioned in the triangle between the posterior capsule, the humerus cortex and the labrum
- Inject a small amount of solution which should disappear in the depth of the joint
- Ballooning of the joint capsule is a sign of the good joint filling
- Injected solution depends on the indication of the procedure
- Maximum capacity of the joint is 12 mL (care is taken not to over distend the joint to avoid artificial leakage of the contrast)
- Compress the needle tract while withdrawing the needle to prevent solution reflux

Aftercare:

- Adhesive tape at the puncture site
- Patient should be observed for 15min
- Patient receives brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment

Procedure related symptoms and treatment:

- Procedure-related symptoms should be resolved in 1 week
- Pain at the puncture site could be treated with cold compression
- Feeling of fullness and stiffness of the shoulder joint could be treated with 1 or 2 days of relative rest of the shoulder [1]

Tip:

- For good positioning of the transducer, one should first palpate the scapular spine and then place the transducer over the spine and move the transducer parallel and caudal at the level of the infraspinatus tendon and posterior aspect of the glenohumeral joint
- Due to lack of the intervening vessels, puncture of the posterior recess is a safe procedure

2.2 Acromio-Clavicular Joint (AC)

2.2.1 X-Ray Guidance

Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 1–2 mL syringe for contrast, corticosteroid and/or anaesthetic

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Maximal joint capacity is 1mL
- Corticosteroids: 0.5–1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 0.5–1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetics: 0.4–1 mL Bupivacaine Actavis 5 mg/mL
- Contrast: 0.1 mL Xenetix 300

Anatomy of the region (Fig. 2.10):

- Articular surfaces of the joint are formed by the acromion and clavicula that are separated by a meniscus attached to the superior acromio-clavicular ligament. This meniscus may be a small fibrocartilaginous extension in the joint or a complete disc that divides the joint into two parts [3]

Patient positioning (Fig. 2.11):

- Patient is lying in supine position on the fluoroscopy table

Technique (Fig. 2.12):

- Acromio-clavicular joint parallel to the beam and open (no parallax)
- Position the metallic pointer in the midpoint of the joint lucent line that is marked on the patient skin using an indelible marker
- Sterile field preparation of the region of the marker
- Connect the needle and appropriate syringe with the extension set
- Insert needle vertically intra-articular and control the position using fluoroscopy with light visor collimation
- Inject a small amount of contrast that has to flow away from the tip of the needle as a sign of good intra-articular position of the needle
- Inject solution depending on the indication of the procedure
- Maximal joint capacity is 1 mL
- Compress the needle tract while withdrawing the needle to prevent solution reflux

Aftercare:

- Adhesive tape at the puncture site
- Patient should be observed for 15min
- Patient receives brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression
- Feeling of fullness of the acromio-clavicular joint could be treated with 1-day relative rest

Tip:

- Use extension set with three cocks connecting the needle and syringes; in the tube that connects the needle and cocks, first aspirate 0.1 mL of contrast and then corticosteroid and eventually anaesthetics to prevent residuum of corticosteroid in the tube and needle and reflux in subcutaneous fatty tissue

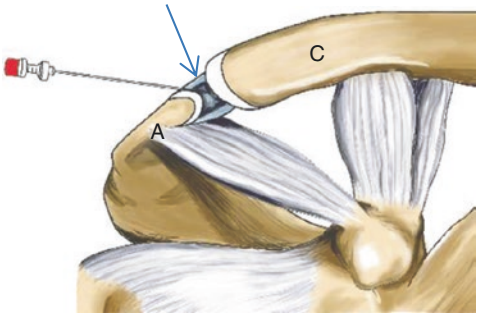

Fig. 2.10 Normal anatomy of the acromio-clavicular joint. Articular surfaces of the joint are formed by the acromion (A) and clavicula (C) that are connected by the superior acromio-clavicular ligament (*arrow*)

Fig. 2.11 Patient position. Patient is lying in supine position on the fluoroscopy table. Position the metallic pointer (*asterisk*) in the midpoint of the joint lucent line, clavicula (C)

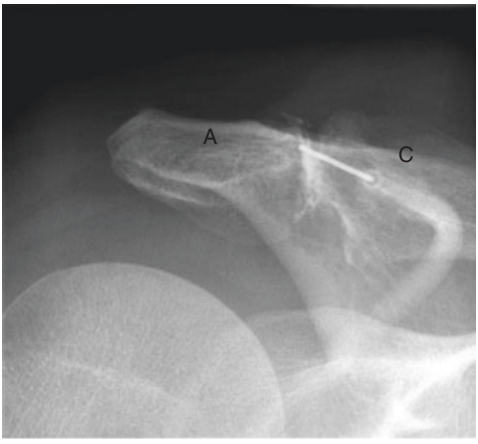

Fig. 2.12 X-ray of acromio-clavicular joint injection technique. Insert the needle vertically intra-articular, control position using fluoroscopy with light visor collimation: acromion (A) and clavicula (C)

2.2.2 US Guidance

2.2.2.1 US Guidance: Coronal Approach

Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- Highresolution ultrasound equipment with 18–5 MHz linear transducer

Syringe (depends on the indication of the procedure):

- 1–2 mL syringe for corticosteroid and/or anaesthetic

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs (depends on the indication of the procedure):

- Joint volume capacity is 1 mL
- Corticosteroids: 0.5–1 mL Depo-Medrol (methylprednisolone acetate) 40 mg/mL or 0.5–1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 0.4–1 mL Bupivacaine Actavis 5 mg/mL
- Contrast: 0.1 mL Xenetix 300

Anatomy of the region (Fig. 2.13):

- Articular surfaces of the joint are formed by the acromion and clavicula that are separated by a meniscus attached to the superior acromio-clavicular ligament. This meniscus may be a small fibrocartilage extension in the joint or a complete disc that divides the joint into two parts [3]

Patient positioning (Fig. 2.14):

- Patient is lying in supine position on the examination bed

Technique (Fig. 2.15):

- Prepare sterile field of the region
- Transducer is positioned in the long axis of the acromio-clavicular joint with good visualisation of the cortex of the acromion and clavicular and joint capsule

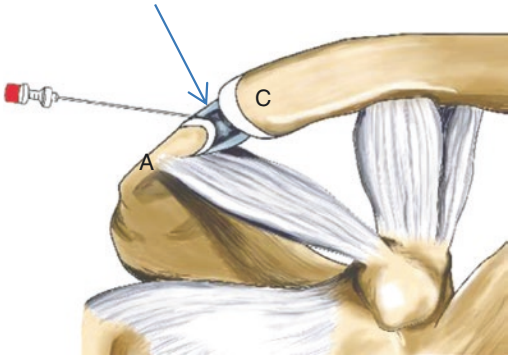

Fig. 2.13 Normal anatomy of the acromio-clavicular joint. Articular surfaces of the joint are formed by the acromion (A) and clavicula (C) which are separated by a meniscus (M) attached to the superior acromio-clavicular ligament

Fig. 2.14 Patient position. Supine position of patient with transducer in the long axis of the acromio-clavicular joint. The needle is inserted from lateral to medial, approximately angulated 45° under the transducer

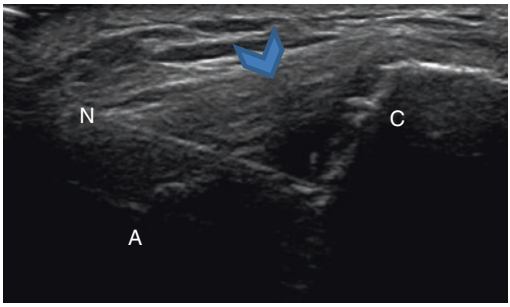

Fig. 2.15 US acromio-clavicular injection technique, coronal approach. Acromion (A), clavicular (C), acromio-clavicular ligament (*arrowhead*), 23 G needle (N)

- Insert the needle from lateral to medial 45° under the transducer with the tip at the level of the joint space
- Inject a small amount of solution which should disappear in the depth of the joint
- Ballooning of the joint capsule is a sign of good joint filling
- Injected solution depends on the indication for the procedure
- Maximum joint capacity is 1 mL
- Compress the needle tract while withdrawing the needle to prevent solution reflux

Aftercare:

- Adhesive tape at the puncture site
- Patient should be observed for 15 min
- Patient receives brochure with information on the procedure, procedure related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression
- Feeling of fullness of the acromio-clavicular joint could be treated with 1-day relative rest

Tip:

- Use extension set with three cocks connecting the needle and syringes; in the tube that connects the needle and cocks, first aspirate corticosteroid and then eventually anaesthetics to prevent residuum of corticosteroid in the tube and needle and reflux in subcutaneous fat tissue

2.2.2.2 US Guidance: Sagittal Approach

Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- Highresolution ultrasound equipment with 18–5 MHz linear transducer

Syringe (depends on the indication of the procedure):

- 1–2 mL syringe for corticosteroid and/or anaesthetic

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs (depends on the indication of the procedure):

- Corticosteroids: 0.5–1 mL Depo-Medrol (methylprednisolone acetate) 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 0.5–1 mL Bupivacaine Actavis 5 mg/mL

Anatomy of the region (Fig. 2.16):

- Articular surfaces of the joint are formed by the acromion and clavicula that are separated by a meniscus attached to the superior acromio-clavicular ligament. This meniscus may be a small fibrocartilage extension in the joint or a complete disc that divides the joint into two parts [3]

Patient positioning (Fig. 2.17):

- Patient is lying in supine position on the examination bed

Technique (Fig. 2.18):

- Prepare sterile field of the region
- Transducer in the short axis of the acromio-clavicular joint between clavicular and acromion
- Insert the needle from the anterior aspect of the joint 90° to the transducer and parallel to the surface of the transducer
- Inject a small amount of solution which should disappear in the depth of the joint
- Ballooning of the joint capsule is a sign of the good joint filling
- Injected solution depends on the indication of the procedure
- Joint volume capacity is 1 mL
- Compress the needle tract while withdrawing the needle to prevent solution reflux

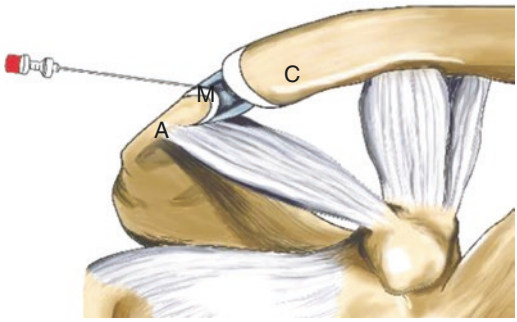

Fig. 2.16 Normal anatomy of the acromio-clavicular joint. Articular surfaces of the joint are formed by the acromion (A) and clavicula (C) which are separated by a meniscus (M) attached to the superior acromio-clavicular ligament

Fig. 2.17 Patient position. Supine position of patient with transducer in the short axis of the acromio-clavicular joint. The needle is inserted from the anterior aspect of the joint, 90° to the transducer and parallel to the surface of the transducer

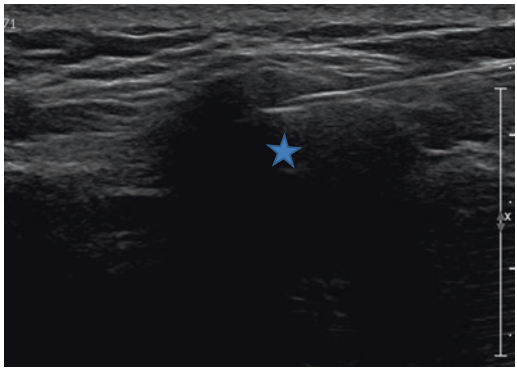

Fig. 2.18 US acromio-clavicular injection technique, sagittal approach. Joint capsule (*asterisk*), 23 G needle (N)

Aftercare:

- Adhesive tape at the puncture site
- Patient should be observed for 15 min
- Patient receives brochure with information on the procedure, procedure related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression
- Feeling of fullness of the acromio-clavicular joint could be treated with 1-day relative rest

Tip:

- Use extension set with three cocks connecting the needle and syringes; in the tube that connects the needle and cocks, first aspirate corticosteroid and then eventually anaesthetics to prevent residuum of corticosteroid in the tube and needle and reflux in subcutaneous fat tissue

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Shoulder Procedures: Extra-Articular

3

Marc G. Romijn

Abbreviations

BT	Biceps tendon
ISP	Infraspinatus muscle tendon
SA	Subacromiodeltoidea
SSC	Subscapular muscle tendon
SSP	Supraspinatus muscle tendon

3.1 Needle Aspiration of Calcific Depositions or NACD

Indication:

- Calcific tendinopathy, at least 7 mm in diameter [1, 2, 3, 5]

Contraindication:

- Tendon tear
- General contraindications (see Chap. 1)

Pre- and postprocedural medication:

- Oral NSAID starting on the day of the procedure and up to 5 days post-procedure

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Equipment:

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer
- Disinfectant
- Band-Aid
- (Sterile) ultrasound coupling gel

Syringe:

- 10 mL syringe for injection fluid

Needle:

- 18 G 88 mm (pink) needle and 2 21 G 50 mm (green) needles

Injection drugs:

- 5 mL water-soluble local anaesthetic pre-procedure and 4 mL water-soluble anaesthetic mixed with 1 mL corticosteroid post-procedure

Anatomy:

- Documented on Fig. 3.1

Patient positioning (Fig. 3.2):

- Preferably patient in a supine position, with a slightly elevated shoulder by means of a small pillow and the hand in endorotation. Physician is sitting at the side of the affected shoulder.

Technique (Fig. 3.3):

- Firstly prepare a sterile field.
- Then inject under US guidance a local anaesthetic in the needle tract and around the calcifications with a 21 G (green) needle.
- After 3 min, put the (pink) 18 G needle in the calcifications under US guidance.
- Perform 10–20 drills through the calcific deposit and chose a slightly different tract each passing.
- Then inject 4 mL water-soluble anaesthetic mixed with 1 mL of steroid using a 21 G (green) needle in the SA bursa.

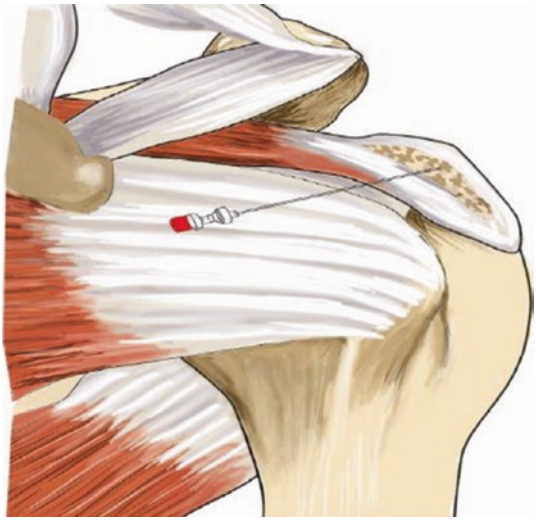


Fig. 3.1 Anatomy calcific depositions

Fig. 3.2 Patient positioning in NACD

Fig. 3.3 Technique of NACD

Aftercare:

- A week of rest followed by avoidance of the pain provoking activity is advised.
- Postprocedural pain at the puncture site can be relieved with cold compression.
- NSAID during a maximum of 5 days post-procedure.
- After 6 weeks, an X-ray examination should be performed in combination with clinical evaluation to establish the result of the procedure.
- If not fully sufficient clinically and radiologically, a repetitive procedure can be performed after an interval of 3 months.

Complications:

- Especially higher doses of corticosteroids with subcutaneous leakage and large molecular corticosteroids can cause fat atrophy.
- Furthermore there might occur general complications as mentioned in Chap. 1.

Tip:

- Although the name of the procedure suggests aspiration of the calcific depositions, only perforation is nowadays performed.
- Double-blindly performed studies show no advantage of aspiration over perforation.
- It is assumed that only the nonsymptomatic calcifications are aspired.
- The extra-articular procedures performed in the shoulder consist mainly of ultrasound-guided interventions. X-ray-guided interventions in the shoulder region are mainly performed in intra-articular indications.

3.2 Infiltration of the Bursa Subcromiodeltoidea (SA)

Indication:

- Bursitis, subacromial impingement without rotator cuff tear [1]

Contraindication:

- General contraindications (see Chap. 1)

Pre- and postprocedural medication:

- No premedication is needed.
- 5 mL can be injected: 4 mL water-soluble anaesthetics eventually mixed with 1 mL 20 mg corticosteroids.
- Postprocedural pain medication (max 3 × 1000 mg a day) (paracetamol) when necessary

Equipment:

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer
- Disinfectant
- Band-Aid
- (Sterile) ultrasound coupling gel

Syringe:

- 5 mL syringe for injection
- Needle: 21 G 50 mm (green) needle

Anatomy:

- Demonstrated on Fig. 3.4

Patient positioning (Fig. 3.5):

- If difficult, e.g. risk of collapse (young and middle-aged male patients!), supine position with the painful shoulder slightly elevated.
- Hand in neutral position. If SA bursa is difficult to visualize, try endorotation of the hand.
- Preferably in sitting position for more steerable space.

Technique (Fig. 3.6):

- Line up the transducer parallel with the SSP to visualize the enlarged/thickened bursa, and then introduce the 22 G needle from lateral to medial parallel with the transducer surface until the tip is centrally located in the bursa; make sure that the whole length of the needle is in view.
- Slowly inject under US guidance with demonstration of quick dispersion and swelling of the bursa and afterwards slowly withdraw the needle.
- After withdrawal of the needle apply pressure and gently rub the injection area to close the needle tract in order to prevent reflux and leakage in the subcutaneous tissue.

Aftercare:

- Patient is advised to rest for 1 day and then resume normal activities.

Complications:

- General complications as mentioned in Chap. 1

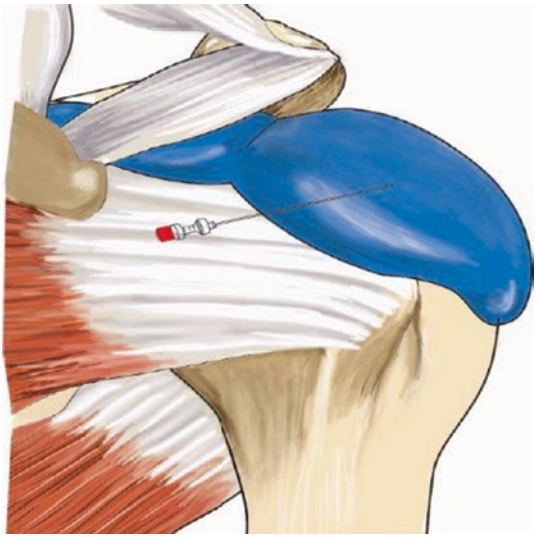


Fig. 3.4 Anatomy of SA bursa

Fig. 3.5 Patient positioning in SA bursa infiltration

Fig. 3.6 Technique of SA bursa infiltration

3.3 Infiltration of a Glenohumeral Ganglion

Indication:

- Glenohumeral ganglion cyst [1, 4]

Contraindication:

- General contraindications

Pre- and postprocedural medication:

- No premedication is needed.
- 5 mL can be injected: 4 mL water-soluble anaesthetics eventually mixed with 1 mL 20 mg corticosteroids.
- Postprocedural pain medication (max 3 × 1000 mg a day) (paracetamol) when necessary.

Equipment:

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer
- 21 G 50 mm (green) needle
- 5 mL syringe for injection fluid
- Disinfectant
- Band-Aid
- (Sterile) ultrasound coupling gel

Anatomy (Fig. 3.7):

- Ganglia are fluid filled cystic masses. They lack synovial lining. In older cysts the content might be very viscous and is difficult to aspirate. Paralabral cysts are swellings that arise around the socket of the shoulder joint (glenoid). They are pockets of joint fluid that develop outside of the joint under tears of the labrum. These may occur anywhere around the glenoid.

Patient positioning (Fig. 3.8):

- Preferably in sitting position for more steerable space. If difficult, e.g. risk of collapse (young and middle-aged male patients!), supine position is advised with the affected shoulder slightly elevated. Hand in neutral position. If the paralabral cyst is difficult to visualize, try endorotating the hand.

Technique (Fig. 3.9):

- Introduce the 22 G needle parallel to the transducer until the tip is centrally located in the cyst; make sure that the whole length of the needle is in view. Slowly inject and afterwards slowly withdraw the needle.
- After withdrawal of the needle, apply pressure and gently rub the injection area to close the needle tract in order to prevent reflux and leakage in the subcutaneous tissue.

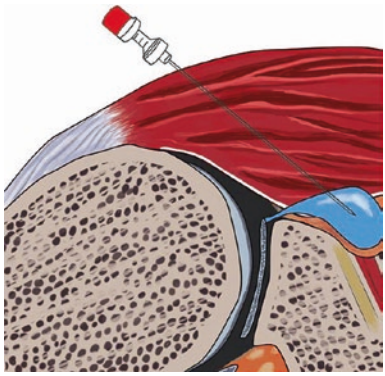
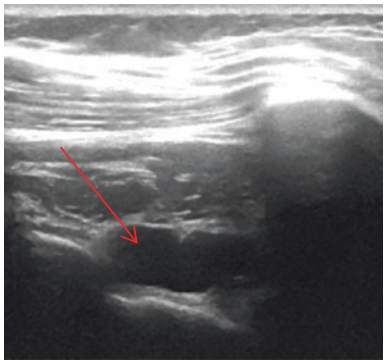


Fig. 3.7 Anatomy of GH ganglion

Fig. 3.8 Patient positioning in GH ganglion infiltration



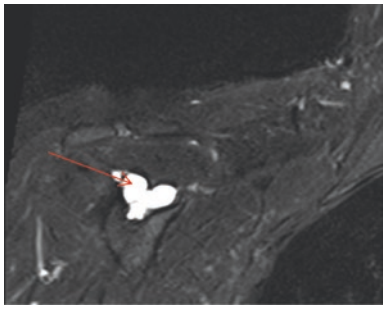


Fig. 3.9 Technique of a glenohumeral ganglion infiltration (Courtesy of Dr. Jan Gielen, Antwerp)

- There is also the option to perforate the ganglion at several places and allow leakage of fluid from the ganglion in the surrounding tissues; eventually the content can be aspirated.

Aftercare:

- No specific advice or aftercare is indicated.

Complications:

- General complications as mentioned in Chap. 1.

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Elbow Procedures, Intra-Articular

4

Marina Obradov

Abbreviations

G Gauge
LE Lateral epicondyle
US Ultrasound

4.1 Elbow Joint Lateral: Radio-Humeral Approach

4.1.1 X-Ray Guidance

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

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Pre- and post-procedural medications:

- No medication

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 1–2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinate contrast
- Pre-packed 20 mL Artirem® syringe
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol® (metylprednisolonacetat) 40 mg/mL or 1 mL Kenacort® (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis® 5 mg/mL
- Hyaluronans: 2 mL Synvisc® Hylan G-F 20
- Contrast: 1–10 mL Xenetix® 300; 10 mL Artirem® 0.0025 mmol/mL

Anatomy of the region (Fig. 4.1):

- The hyaline cartilage at the radiocapitellar joint is uniform in thickness except a small pseudo defect situated at the cleft between capitellum and lateral epicondyle of the humerus located at the posterolateral half of the radiocapitellar articulation.
- The congruity of the radiocapitellar joint is maximal in 90° elbow flexion with forearm in midway between pronation and supination, thumb up [1].
- Lateral-proximal the capsule attaches along the margin of the trochlear notch and distal along the annular ligament of the radius head. The capsule is lax in elbow flexion [2].

Patient positioning (Fig. 4.2):

- Patient lying in prone position on the fluoroscopy table with the arm over the head and elbow in 90° of flexion, thumbs up, head turned to side.

Technique (Fig. 4.3):

- Radiocapitellar joint parallel to the beam and open (no parallax).
- Use the palpation of the lateral epicondyle and position a metallic pointer distal adjacent to the radial head. Locate with intermittent radioscopy the metallic

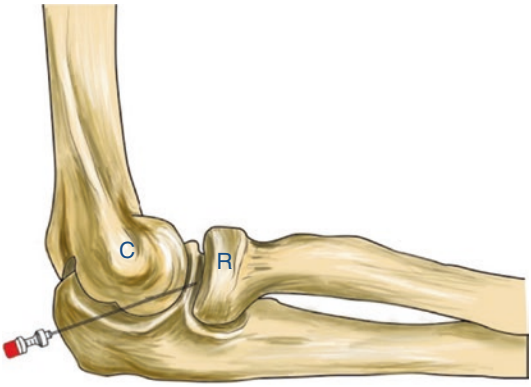

Fig. 4.1 Normal anatomy of the lateral aspect of the elbow. The discoid-shaped radial head (R) accommodated convexity of the humeral capitellum (C) and is most congruent at 90° flexion with forearm in midway between pronation and supination, thumb up

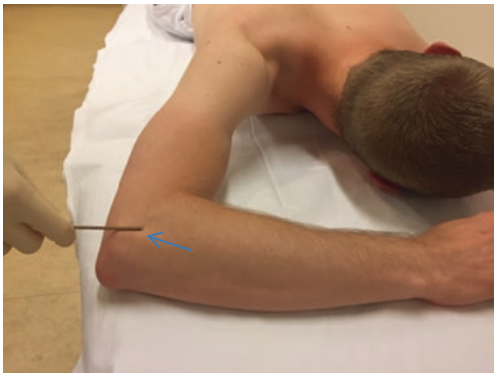

Fig. 4.2 Patient position. Patient lying in prone position on the fluoroscopy table with the arm over the head and elbow in 90° of flexion, thumb up, head turned to side. Metallic pointer is placed in the midpoint of the radiocapitellar joint (*arrow*)

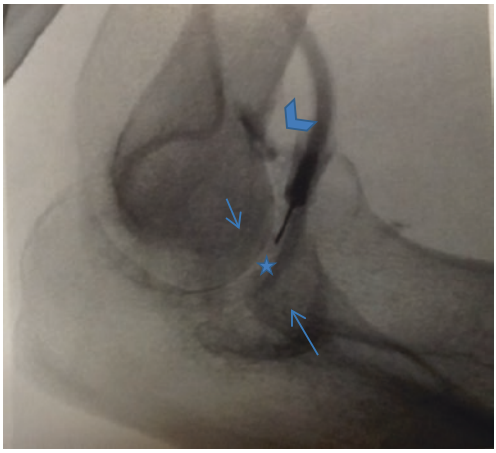

Fig. 4.3 X-ray elbow injection technique lateral approach. Radiocapitellar joint is parallel to the beam and open without no parallax (*arrows*). Target point is central in de joint (*asterisk*). The needle is inserted vertical intra-articular. Contrast flow away from the tip of the needle (*arrowhead*)

pointer at the midpoint of the lucent joint line and mark this point on the patient skin using a water-resistant marker.
- Prepare sterile the marker region.
- Connect the needle and appropriate syringe with the extension set.
- Insert needle vertical into the joint and control position using fluoroscopy with light visor collimation.
- Inject a small amount of contrast that has to flow away from the tip of the needle as a sign of good intra-articular position of the needle.
- Injected solution depends on the indication for the procedure.
- Joint volume capacity is 12 mL
- Withdraw the needle and apply pressure and gently rub the injection area to close the puncture tract in order to prevent corticosteroid reflux.

Aftercare:

- Adhesive plaster at the puncture site.
- Patient should be observed for 15 min.
- Information brochure with information on the procedure, procedure related symptoms and aftercare, treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Feeling of the fullness of the elbow joint could be treated with 1-day relative rest of the elbow [3].

Tips:

- In a case of suspected lateral elbow pathology, use posterior approach as contrast extravasation laterally from superficial needle position may mimic ligament tear.

4.1.2 US Guidance

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 1–2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinate contrast
- Pre-packed 20 mL Artirem® syringe
- Pre-packed 2 mL hyaluronan syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol® (metylprednisolonacetat) 40 mg/mL or 1 mL Kenacort® (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis® 5 mg/mL
- Hyaluronas: 2 mL Synvisc® Hylan G-F 20
- Contrast: 1–10 mL Xenetix® 300
- 10 mL Artirem® 0.0025 mmol/mL

Anatomy of the region (Fig. 4.4):

- The congruity of the radiocapitellar joint is maximal at 90° flexion with forearm in midway between pronation and supination, thumb up [1].
- Common extensor tendon arises from the lateral epicondyle and is separated from the joint capsule by the lateral ulnar collateral ligament [1].
- Laterally the capsule attached along the margin of the capitellar notch as well as along the annular ligament of the radius head, and capsule is lax in elbow flexion [2] and can be presented as triangular hyperechoic structure, the so-called lateral synovial fringe.
- The cortex of the lateral epicondyle has concave, downsloping configuration.

Patient positioning (Fig. 4.5):

- Patient is lying in the supine position on the examination table with the elbow in 90° of flexion, thumb up.
- Use a table extension plate to provide the space for the elbow flexion along the patient.

Technique (Fig. 4.6):

- Prepare sterile field of the region.
- Transducer in the long axis of the forearm.
- Adequate visualisation of the extensor tendons, cortex of the lateral epicondyle, cortex of the radius head and the joint split.
- Insert the needle from proximal to distal 45° under the transducer with the tip at the level of the joint split.
- Inject a small amount of solution which should disappear in the depth of the joint.
- Ballooning of the joint capsule is a sign of the good joint filling.
- Injected solution depends on the indication for the procedure.
- Joint volume capacity is 12 mL.
- Withdraw the needle and apply pressure and gently rub the injection area to close the puncture tract in order to prevent corticosteroid reflux.

Aftercare:

- Adhesive plaster at the puncture site.
- Patient should be observed for 15 min.
- Information brochure with information on the procedure, procedure-related symptoms and aftercare, treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Feeling of the fullness of the elbow joint could be treated with 1-day relative rest of the elbow [3].

Tips:

- In a case of suspected lateral elbow pathology, use posterior approach as contrast extravasation laterally from superficial needle position may mimic ligament tear.

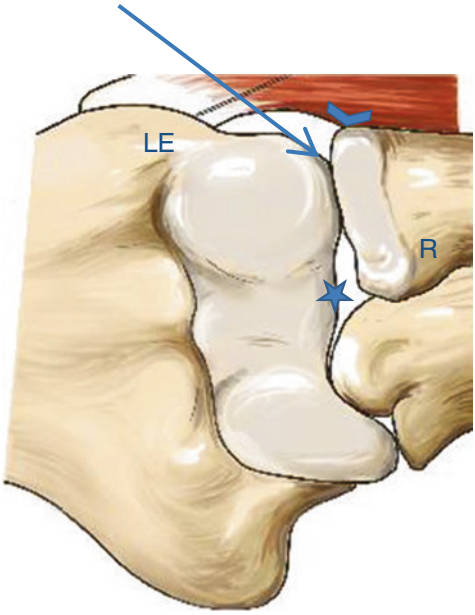

Fig. 4.4 Normal anatomy of the lateral aspect of the elbow. Downslope of the cortex of the lateral epicondyle (LE); radial head (R); joint space (*asterisk*); synovial fringe (*arrowhead*); needle (*arrow*)

Fig. 4.5 Patient position. Supine position of patient with the elbow in 90° of flexion, thumb up. Transducer is placed in the long axis of the radiocapitellar joint. The needle is inserted from proximal to distal, approximately 45° under the transducer

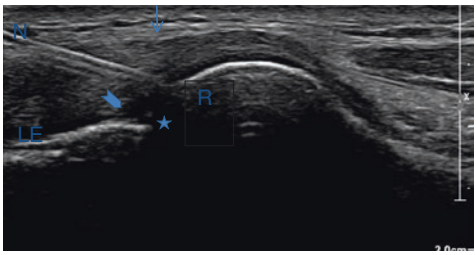

Fig. 4.6 US elbow injection technique, lateral approach. Common extensor tendon (*arrow*), downslope of the cortex of the lateral epicondyle (LE), radial head (R), joint space (*asterisk*), synovial fringe (*arrowhead*), 21 G needle (N)

4.2 Elbow Joint Posterior: Humero-Ulnar Approach

4.2.1 X-Ray Guidance

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinate contrast
- Pre-packed 20 mL Artirem syringe
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three-way stopcock connections of the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL metylprednisolonacetat 40 mg/mL (Depo-Medrol) or 1 mL triamcinolone acetonide 40 mg/mL (Kenacort)
- Anaesthetic: 5 mL Bupivacaine 5 mg/mL (Actavis)
- Hyaluronic acid: 2 mL (Synvisc Hylan G-F 20)
- Contrast: 1–10 mL sodium contrast (Xenetix 300)
- 5–10 mL gadolinium DTPA 0.0025 mmol/mL (Artirem)

Anatomy of the region (Fig. 4.7):

- In lateral projection the joint space between the olecranon and posterior humerus cortex should be open.

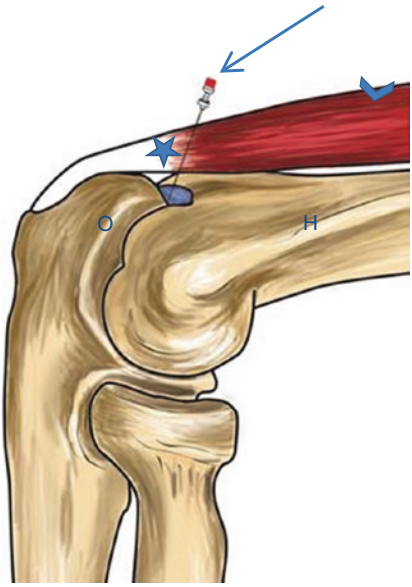

Fig. 4.7 Normal anatomy of the elbow, posterior aspect. The triceps muscle (*arrowhead*) and triceps tendon (*asterisk*) that insert at the olecranon (O). Direction of the needle is 35° cranio-caudal and the tip of the needle (*arrow*) is positioned intra-articular between the humerus (H) and olecranon (O)

Fig. 4.8 Patient position. Patient lying in prone position on the fluoroscopy table with the arm over the head and elbow in 90° of flexion. Metallic pointer is placed 1 cm above the apex of the olecranon, paramedian lateral to avoid n. ulnaris (*arrow*)

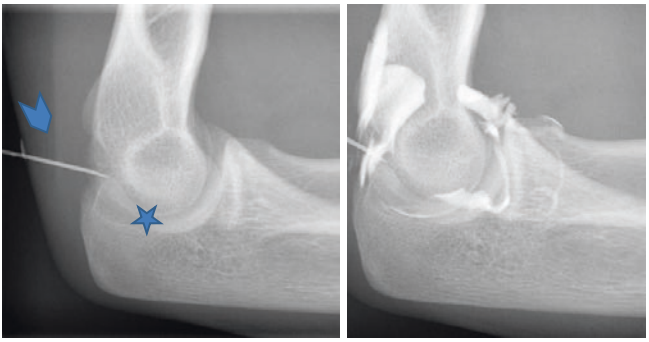

Fig. 4.9 X-ray elbow injection technique, posterior approach. Puncture site is located 1 cm proximal to the apex of the olecranon. The needle (*arrowhead*) is placed 35° cranio-caudal along the apex of the olecranon in the posterior elbow joint (*asterisk*)

- Direct proximal to the apex of the olecranon the double contour of the fossa olecrani is documented.

Patient positioning (Fig. 4.8):

- Patient lying in prone position on the fluoroscopy table with the arm over the head and elbow in 90° of flexion, and olecranon and distal humerus are on the fluoroscopy images lateral projected and joint space is open.

Technique (Fig. 4.9):

- Puncture site is located 1 cm proximal and minimal radial to the apex of the olecranon to avoid puncture of n. ulnaris.
- Use palpation to define the proximal contour of the olecranon and direct above concavity of the fossa olecrani and mark puncture site on the patient skin using indelible marker.
- Using the palpation position the metallic pointer 1 cm proximal and minimal paramedian, radial to the apex of the olecranon to avoid puncture of n. ulnaris, and make a mark on the patient's skin using indelible marker.
- Prepare sterile field of the marked region.
- Connect the needle and appropriate syringe with the extension set.
- Insert the needle angled 35° cranio-caudal along the apex of the olecranon in the direction of the joint.
- Control intra-articular position using fluoroscopy with light visor collimation.
- Injecting a small amount of contrast which has to flow away from the tip of the needle as a sign of good intra-articular position of the needle.
- Solution to be injected depends on the indication for the procedure.
- Joint capacity is 12 mL.
- Withdraw the needle and apply pressure and gently rub the injection area to close the puncture tract in order to prevent reflux.

Aftercare:

- Adhesive plaster at the puncture site.
- Patient should be observed for 15 min.
- Information brochure with information over procedure, procedure-related symptoms, aftercare and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Feeling of fullness of the elbow joint could be treated with 1-day relative rest of the elbow [3].

4.2.2 US Guidance

Indication:

- Diagnostic arthrography
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 1–2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 12 mL syringe for iodinate contrast
- Pre-packed 20 mL Artirem® syringe
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol® (metylprednisolonacetat) 40 mg/mL or 1 mL Kenacort® (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis® 5 mg/mL
- Hyaluronans: 2 mL Synvisc® Hylan G-F 20
- Contrast: 1–10 mL Xenetix® 300
- 10 mL Artirem® 0.0025 mmol/mL

Anatomy of the region (Fig. 4.10):

- Subcutaneously positioned triceps muscle overflows further distally into the triceps tendon that inserts at the cortex of the acromion, approximately 1 cm distal from the apex.
- Deep to the triceps muscle is humerus cortex and distally direct above the olecranon apex is fat pad of the fossa olecrani.

Patient positioning (Fig. 4.11):

- Patient is sitting half turned away from the examination table with the elbow in 90° flexion and palm resting on the table in so-called crab position.

Technique (Fig. 4.12):

- Prepare sterile field of the region.
- Connect the needle and appropriate syringe with extension set.
- Transducer is positioned in the long axis of the humerus at the radial side relative to the midline of the olecranon to avoid puncture of n. ulnaris.
- Visualisation of the triceps muscle and tendon above the olecranon and fat pad of the fossa olecrani should be reached.
- Insert the needle 30° cranio-caudal under the US probe along the apex of the olecranon in the direction of the joint.
- Inject a small amount of solution which should disappear in the depth of the joint.
- Ballooning of the joint capsule is a sign of the good joint filling.
- Injected solution depends on the indication for the procedure.
- Joint volume capacity is 12 mL.
- Pressure on the needle tract when withdrawing the needle to prevent solution reflux.

Aftercare:

- Adhesive plaster at the puncture site.
- Patient should be observed for 15 min.
- Information brochure with information over procedure, procedure related symptoms and treatment of the symptoms, aftercare, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Feeling of the fullness of the elbow joint could be treated with 1-day relative rest of the elbow [3].

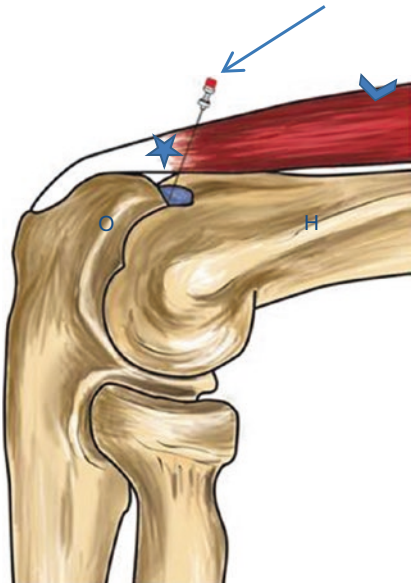

Fig. 4.10 Normal anatomy of the elbow, posterior aspect. The triceps muscle (*arrowhead*) and triceps tendon (*asterisk*) that insert at the olecranon (O). Direction of the needle is 30° cranio-caudal and the tip of the needle (*arrow*) is positioned intra-articular between the humerus (H) and olecranon (O)

Fig. 4.11 Patient position. Patient is sitting half turned away from the examination table with the elbow in 90° flexion and palm resting on the table in so-called crab position

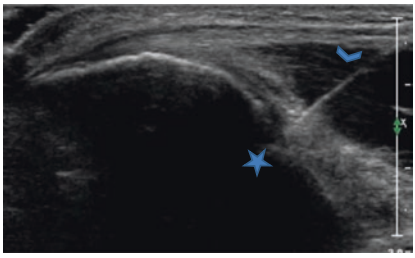

Fig. 4.12 US elbow injection technique, posterior approach. Puncture site is 1 cm proximal to the apex of the olecranon. The needle (*arrowhead*) is placed angulated 35° cranio-caudal along the apex of the olecranon in the posterior elbow joint (*asterisk*)

References

1. Bianchi S, Martinoli C. Elbow. In: Bianchi S, Martinoli C, editors. Ultrasound of the musculoskeletale system. New York: Springer; 2007. p. 350–4.
2. Chung CB. Miscellaneous disorders of the elbow. In: Chung CB, Steinbach LS, editors. MRI of the upper extremity: shoulder, elbow, wrist and hand. Philadelphia: Wolters Kluwer, Lippincott Williams & Wilkins; 2010. p. 502.
3. Peterson JJ. Elbow injections. In: Peterson JJ, Fenton DS, Czervionke LF, editors. Image-guided musculoskeletal intervention. Philadelphia: Saunders. Elsevier; 2008. p. 55.

Elbow Procedures, Extra-Articular

5

Marina Obradov

Abbreviations

G	Gauge
LE	Lateral epicondyle
PNT	Percutaneous needle tenotomy
PRP	Platelet-rich plasma
US	Ultrasound

5.1 PNT (Percutaneous Needle Tenotomy) of the Epicondylitis Lateralis

Indication:

- Chronic epicondylitis lateralis

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

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Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 5 mL syringe for anaesthetic

Needle:

- 21 G, 50 mm green needle for anaesthetic
- 18 G, 88 mm rose spinal needle for PNT

Injection drugs:

- Anaesthetic: 5 mL Bupivacaine Actavis 5 mg/mL

Anatomy of the region (Fig. 5.1):

- In the long axis, the cortical bone of the lateral epicondyle has downsloping, concave aspect, and on the US images, it is presented as a sharp white line without interruption of the continuity.
- This is the origin site of the extensor tendons (extensor carpi radialis brevis and extensor digitorum) and the lateral collateral ligament that extends distally crossing the radiocapitellar joint.
- Deep to the extensor tendons and the lateral collateral ligament, the joint capsule is located. At the posterolateral aspect, this capsule has a hypoechoic US appearance with a triangular shape that is called the synovial fringe [1].

Patient positioning (Fig. 5.2):

- Patient is lying in supine position on the examination table with the elbow in 90° of flexion, thumb up.
- A table extension plate provides space for the elbow in flexion position along the patient.

Technique (Fig. 5.3):

- Under continuous US guidance extensive anaesthesia of the periosteum, origin of the tendons and subcutaneous tissue with 5–10 mL Bupivacaine in subcutaneous fat tissue at the surface of the tendon is necessary to perform the procedure, and 21 G needle is used.
- After adequate anaesthesia of the region, the 18 G needle is advanced along the long axis of the transducer, parallel to the longitudinal axis of the tendon from distal to proximal, from the superficial part of the tendon to the periosteum.

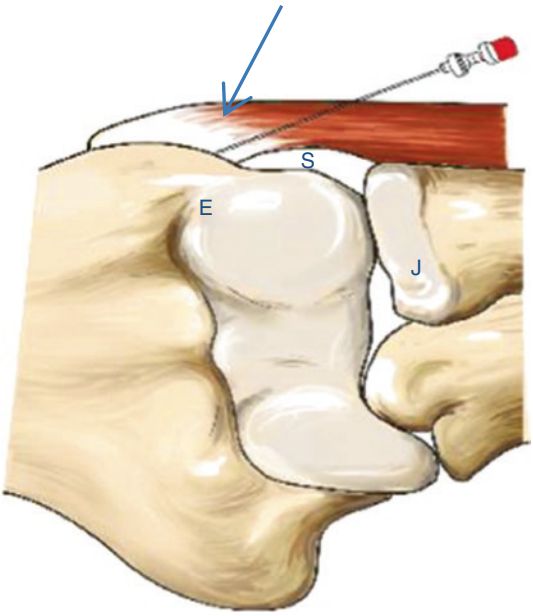

Fig. 5.1 Normal anatomy of the lateral aspect of the elbow. The cortex of the lateral epicondyle (E) is the site of origin of the extensor tendons (*arrow*) which extends distally parallel to the radiocapitellar joint (J) and radial collateral ligament and capsule with synovial fringe (S)

Fig. 5.2 Patient position. Patient lying in supine position on the examination table with elbow in 90° of flexion, thumb up, and a table extension plate (*asterisk*) provides the space for elbow flexion along the patient

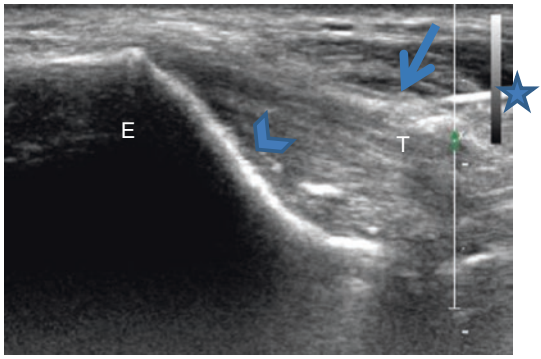

Fig. 5.3 US elbow injection technique. The probe is placed in the long axis over the lateral epicondyle (E) parallel to the extensor tendons (T). The needle (*asterisk*) is approaching from distal to proximal, from the superficial part of the tendon (*arrow*) to the periosteum (*arrowhead*)

- Multiple needle perforations of the affected tendons are performed (>10 perforations).
- Bone-tendon interface is specifically targeted with the needle tip; the bevel is twisted in the periosteum-bone interface.
- Calcifications are targeted with the same 18-gauge needle to fragment and disrupt them.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient receives brochure with information over procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.
- Relative rest 2 weeks, no irritation of the tendons.
- Continue usual daily activities.
- Physical therapy after 1 week.

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression or in more extreme case with paracetamol/acetaminophen (max 4000 mg/day).

Tips:

- If the US imaging findings are normal and there is no concordant pain in the region of the origin of the extensor tendons, it should be assumed that the clinical symptoms are not related to chronic epicondylitis lateralis and PNT is not indicated.

5.2 Bursa Olecrani

Indication:

- Diagnostic aspiration in case of bursitis
- Therapeutic injection in inflammatory or traumatic bursitis

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 1 mL syringe for corticosteroid
- 1–2 mL syringe for anaesthetic

Needle:

- 21 G, 50 mm green needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (metylprednisolonacetat); 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 1 mL Bupivacaine Actavis 5 mg/mL

Anatomy of the region (Fig. 5.4):

- The olecranon bursa is a typical superficial bursa with a synovial membrane supported by dense irregular connective tissue interposing loose areolar tissue; this causes an irregular lining with internal septations.
- The bursa is located in the subcutaneous fat tissue superficial to the olecranon cortex and distal to the insertion of the triceps tendon.
- A normal bursa is not documented on US [2].
- A thickened bursa with fluctuating hyperechoic particles can be seen in crystal deposition disease.
- Colour Doppler imaging can visualise thick synovium with rim-like hypervascularisation and soft tissue hyperaemia of the adjacent subcutaneous fat.
- In chronic haemorrhagic or septic bursitis, homogeneous predominant hyperechoic content is present, resulting in a complex image of the bursitis.

Patient positioning (Fig. 5.5):

- Patient is sitting half turned away from the examination table with the elbow in 90° flexion and the palm resting on the table in the so-called crab position.

Technique (Fig. 5.6):

- Prepare sterile field of the region.
- Transducer in the short axis of the olecranon.
- Adequate visualisation of the bursa wall and content.

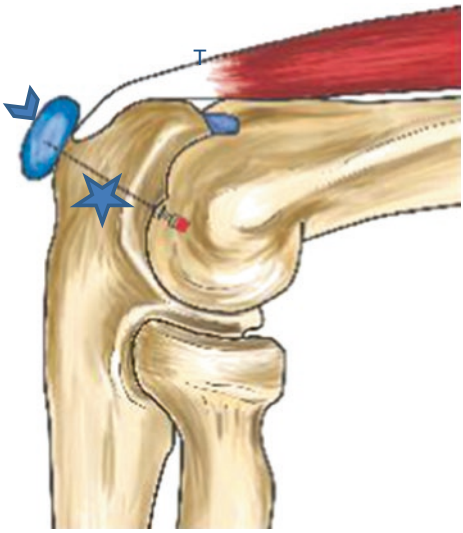

Fig. 5.4 Normal anatomy of the lateral aspect of the elbow. Superficial olecranon bursa (*arrowhead*) is located in subcutaneous fat tissue superficial to the olecranon cortex (*asterisk*) and distal to the insertion of the triceps tendon (T)

Fig. 5.5 Patient position. Patient is sitting half turned away from the examination table with the elbow in 90° flexion and palm resting on the table in the so-called crab position, transducer in the short axis of the olecranon, and needle almost parallel under the transducer

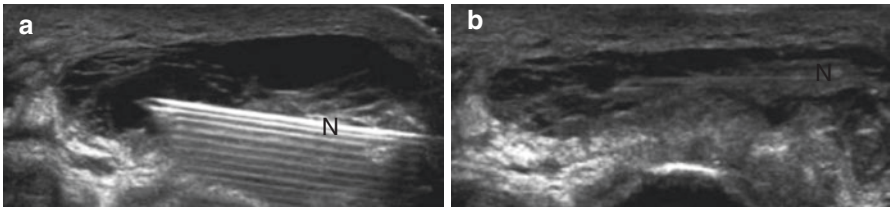

Fig. 5.6 (**a**, **b**) US-guided bursa olecrani injection technique. (**a**) Under real-time US guidance, the needle (N) is introduced within the bursa and advanced until tip reaches the hypoechoic fluid. (**b**) After aspiration a collapse of the bursa is seen. Steroid injection is performed under US surveillance

- Insert the needle almost parallel under the transducer with the tip into the fluid intervening between the thick synovium in the case of the inflammatory bursitis.
- First aspirate fluid in a case of diagnostic aspiration and then inject solution as a bolus under US guidance.
- Injected solution depends on the indication for the procedure.
- Normal maximal capacity is 2 mL.
- Pressure on the needle tract when withdrawing the needle to prevent solution reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient receives brochure with information on the procedure, procedure related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.
- Relative rest for 1 week with avoiding leaning on the elbow.

Procedure related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression

Tips:

- About 20% of patients presenting with acute bursitis have associated infection.

References

1. Chung CB. Miscellaneous disorders of the elbow. In: Chung CB, Steinbach LS, editors. MRI of the upper extremity: shoulder, elbow, wrist and hand. Philadelphia: Wolters Kluwer, Lippincott Williams & Wilkins; 2010. p. 502.
2. Bianchi S, Martinoli C. Elbow. In: Bianchi S, Martinoli C, editors. Ultrasound of the musculoskeletale system. New York: Springer; 2007. p. 369.

Wrist and Hand Procedures, Intra-Articular

6

Anastasios Kyriazopoulos

Abbreviations

CMC	Carpometacarpal
DRU	Distal radioulnar
G	Gauge
RC	Radiocarpal
US	Ultrasound

6.1 Radiocarpal Joint Injection

6.1.1 X-Ray Guidance

Indications:

- Diagnostic arthrography
- Arthrography for the purpose of intra-articular contrast for CT or MRI
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or posttraumatic arthropathies

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Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication needed

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic or iodinate contrast
- Pre-packed 20 mL Artirem syringe (Guerbet)
- Pre-packed 2 mL hyaluron syringe

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide), 40 mg/mL
- Anaesthetic: 3 mL Bupivacaine Actavis, 5 mg/mL
- Hyaluronans: 2 mL Synvisc Hylan G-F 20
- Contrast: 3–5 mL Xenetix 300; 3–5 mL Artirem, 0.0025 mmol/mL

Anatomy of the region (Fig. 6.1):

- The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations.
- Most commonly injected are the RC joint and the DRU joint.
- The radiocarpal compartment is bounded proximally by the articular surface of the distal radius and the triangular fibrocartilage complex and distally by the proximal carpal row.
- The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation.
- The CMC-I is the articulation between the os trapezium with the first os metacarpale.

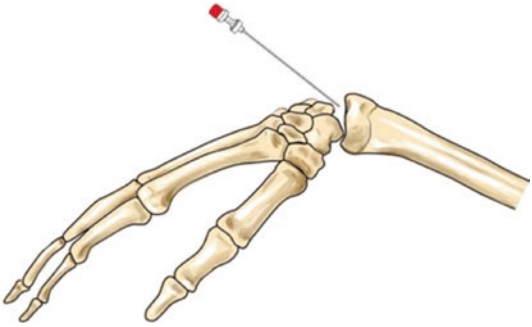

Fig. 6.1 Normal anatomy of the radiocarpal joint from lateral view

Fig. 6.2 Patient lying in prone position with the arm over the head. The wrist lying on a small pillow, 15° wrist flexion and ulnar deviation, to maximise the size of the dorsal joint space making needle placement easier

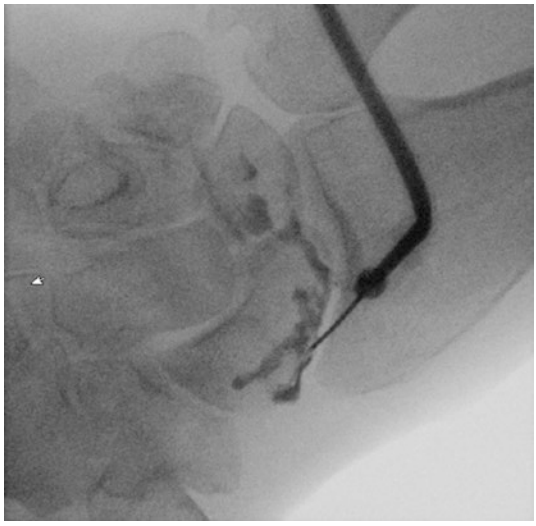

Fig. 6.3 X-ray of RC joint injection technique. The radioscaphoid is joint parallel to the beam and open without parallax. Target site is the radioscaphoid joint. Contrast flows away from the tip of the needle

Patient positioning (Fig. 6.2):

- Patient lying in prone position on the fluoroscopy table with the arm over the head. The wrist lying on a small pillow, 15° wrist flexion and ulnar deviation, to maximise the size of the dorsal joint space making needle placement easier.
- The injection may be made slightly distal to the radioscaphoid joint, with the needle angled toward the elbow to match the palmar tilt.

The injection may be made slightly distal to the radioscaphoid joint, with the needle angled toward the elbow to match the palmar tilt.
Technique (Fig. 6.3):

- The radioscaphoid joint parallel to the beam and open (no parallax).
- Put the metallic pointer in the mid-point of the radioscaphoid joint lucent line and mark on the patient skin using indelible marker.
- Prepare sterile field of the region of the marker.
- Connect the needle and appropriate syringe with extension set.
- Insert needle vertical intra-articular, control position using fluoroscopy with light visor collimation.
- Inject a small amount of contrast which has to flow away from the tip of the needle as a sign of good intra-articular position of the needle.
- Inject solution depending on the indication for the procedure.
- Maximal joint capacity is 3 mL.
- Pressure on the needle tract when withdrawing the needle to prevent corticosteroid reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient receives a brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

6.1.2 US Guidance

Indication:

- Diagnostic arthrography
- Arthrography for the purpose of intra-articular contrast for CT or MRI
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or posttraumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication needed

Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic or iodinate contrast
- Pre-packed 20 mL Artirem syringe (Guerbet)
- Pre-packed 2 mL hyaluron syringe

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting of the needle and syringes

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide), 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis, 5 mg/mL
- Hyaluronans: 2 mL Synvisc Hylan G-F 20
- Contrast: 1–10 mL Xenetix 300; 5–10 mL Artirem, 0.0025 mmol/mL

Anatomy of the region (Fig. 6.4):

- The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations.
- Most commonly injected are the RC joint and the DRU joint.
- The radiocarpal compartment is bounded proximally by the articular surface of the distal radius and the triangular fibrocartilage complex and distally by the proximal carpal row.
- The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation.
- The CMC-I is the articulation between the os trapezium with the first os metacarpale.

Patient positioning (Fig. 6.5):

- Patient lying in supine position on the table with the arm downward. The wrist lying on a small pillow, 15° wrist flexion and ulnar deviation, to maximise the size of the dorsal joint space making needle placement easier.
- The injection may be made slightly distal to the radioscaphoid joint, with the needle angled toward the elbow to match the palmar tilt.

Technique (Fig. 6.6):

- Prepare sterile field of the region.
- Transducer in the long axis of the radioscaphoid joint.
- Adequate visualisation of the cortical bone of the distal radius and proximal cortical bone of the scaphoid.

- Insert the needle from distal to proximal 45° under the transducer with the tip at the level of the joint space.
- Inject a small amount of solution which should disappear in the depth of the joint.
- Ballooning of the joint capsule is a sign of the good joint filling.
- Injected solution depends on the indication for the procedure.
- Maximal joint capacity is 3 mL.
- Pressure on the needle tract when withdrawing the needle to prevent solution reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient receives brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

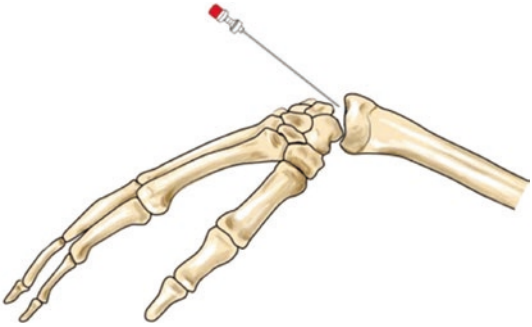

Fig. 6.4 Normal anatomy of the wrist

Fig. 6.5 Supine position of patient with the transducer placed in the long axis of the radioscaphoid joint. The needle is inserted from distal to proximal, approximately 45° under the transducer

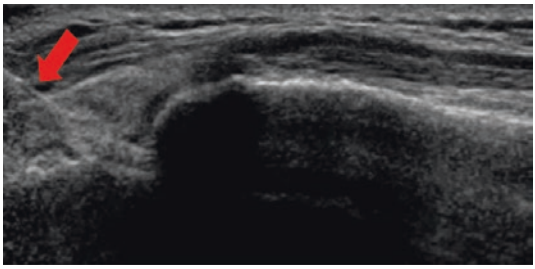

Fig. 6.6 Transducer in the long axis of the radioscaphoid joint. Adequate visualisation of the cortical bone of the distal radius and proximal cortical bone of the scaphoid. Insert the needle (*arrow*) from distal to proximal 45° under the transducer with the tip at the level of the joint space

6.2 Distal Radioulnar Joint Injection

6.2.1 X-Ray Guidance

Indications:

- Diagnostic arthrography
- Arthrography for the purpose of intra-articular contrast for CT or MRI
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or posttraumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication needed

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic or iodinate contrast
- Pre-packed 20 mL Artirem syringe (Guerbet)

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide), 40 mg/mL
- Anaesthetic: 1 mL Bupivacaine Actavis, 5 mg/mL
- Contrast: 1 mL Xenetix 300; 1 mL Artirem, 0.0025 mmol/mL

Anatomy of the region (Fig. 6.7):

- The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations.

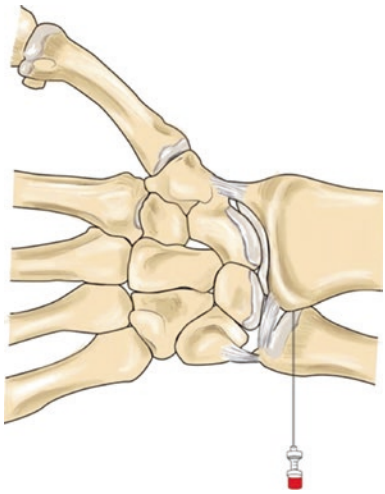

Fig. 6.7 The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations. The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation

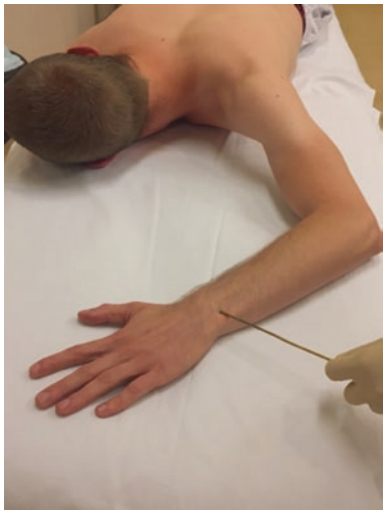

Fig. 6.8 Patient lying in prone position on the fluoroscopy table with the wrist over the head and the palm down. The target site for the injection is the ulnar aspect of the space between the distal radius and ulna

Fig. 6.9 Insert the needle vertical intra-articular control position using fluoroscopy with light visor collimation

- Most commonly injected are the RC joint and the DRU joint.
- The radiocarpal compartment is bounded proximally by the articular surface of the distal radius and the triangular fibrocartilage complex and distally by the proximal carpal row.
- The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation.
- The CMC-I is the articulation between the os trapezium with the first os metacarpale.

Patient positioning (Fig. 6.8):

- Patient lying in prone position on the fluoroscopy table with the wrist over the head and the palm down.
- The target site for the injection is the ulnar aspect of the space between the distal radius and ulna.

Technique (Fig. 6.9):

- The distal radioulnar joint parallel to the beam and open (no parallax).
- Using the palpation of the DRU joint, put the metallic pointer in the mid-point of the joint lucent line, and mark on the patient skin using indelible marker.
- Prepare sterile field of the region of the marker.
- Connect the needle and appropriate syringe with extension set.
- Insert needle vertical intra-articular, control position using fluoroscopy with light visor collimation.

- Inject a small amount of contrast which has to flow away from the tip of the needle as a sign of good intra-articular position of the needle.
- Inject solution depending on the indication for the procedure.
- Joint volume capacity is 1 mL.
- Pressure on the needle tract when withdrawing the needle to prevent reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Information brochure with information over procedure, procedure-related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

6.2.2 US Guidance

Indication:

- Diagnostic arthrography
- Arthrography for the purpose of intra-articular contrast for CT or MRI
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or posttraumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication needed

Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic or iodinate contrast
- Pre-packed 20 mL Artirem syringe (Guerbet)
- Pre-packed 2 mL hyaluron syringe

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide), 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis, 5 mg/mL
- Hyaluronans: 2 mL Synvisc Hylan G-F 20
- Contrast: 1–10 mL Xenetix 300; 5–10 mL Artirem, 0.0025 mmol/mL

Anatomy of the region (Fig. 6.10):

- The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations.
- Most commonly injected are the RC joint and the DRU joint.
- The radiocarpal compartment is bounded proximally by the articular surface of the distal radius and the triangular fibrocartilage complex and distally by the proximal carpal row.
- The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation.
- The CMC-I is the articulation between the os trapezium with the first os metacarpale.

Patient positioning (Fig. 6.11):

- Patient lying in supine position on the table with the arm downward and the palm down.
- The target site for the injection is the ulnar aspect of the space between the distal radius and ulna.

Technique (Fig. 6.12):

- Prepare sterile field of the region.
- Transducer is positioned dorsally over the distal radius and ulna. Adequate visualisation of the cortex of the distal radius and the distal ulna. Along the long axis of the transducer, a 23 G, 30 mm blue needle is inserted in 45°. A total amount of 1 mL is injected according to rising pressure during injection.
- Inject a small amount of solution which should disappear in the depth of the joint.
- Ballooning of the joint capsule is a sign of the good joint filling.
- Injected solution depends on the indication for the procedure.
- Joint volume capacity is 1 mL.
- Pressure on the needle tract when withdrawing the needle to prevent solution reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient receives brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

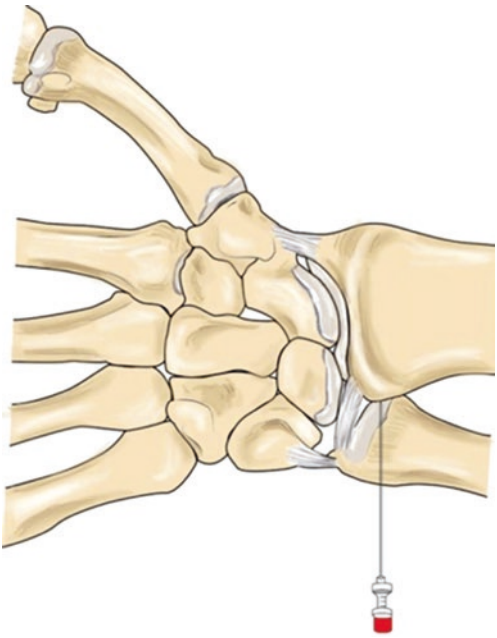

Fig. 6.10 The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations. The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation

Fig. 6.11 Patient lying in supine position on the table with the arm downward and the palm down. The target site for the injection is the ulnar aspect of the space between the distal radius and ulna

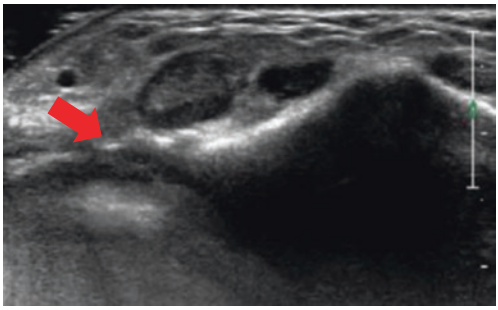

Fig. 6.12 Transducer is positioned dorsally over the distal radius and ulna. Adequate visualisation of the cortex of the distal radius and the distal ulna. Along the long axis of the transducer, a 23 G, 30 mm blue needle is inserted in 45° in the DRU joint (*arrow*). A total amount of 1 mL is injected according to rising pressure during injection

6.3 First Carpometacarpal Joint Injection

6.3.1 X-Ray Guidance

Indications:

- Diagnostic arthrography
- Arthrography for the purpose of intra-articular contrast for CT or MRI
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or posttraumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication needed

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic or iodinate contrast
- Pre-packed 20 mL Artirem syringe (Guerbet)

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting the needle and syringes

Injection drugs:

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide), 40 mg/mL
- Anaesthetic: 1 mL Bupivacaine Actavis, 5 mg/mL
- Contrast: 1 mL Xenetix 300; 1 mL Artirem, 0.0025 mmol/mL

Anatomy of the region (Fig. 6.13):

- The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations.
- Most commonly injected are the RC joint and the DRU joint.

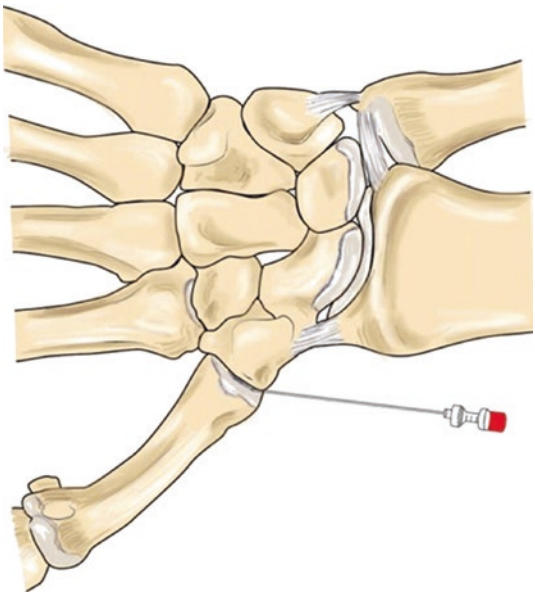

Fig. 6.13 The anatomy of the wrist is complex. The CMC-I is the articulation between the os trapezium with the first os metacarpale

Fig. 6.14 Patient lying in prone position on the fluoroscopy table with the wrist over the head. Hand lying with the thenar on a small towel, approximately 45° external rotation

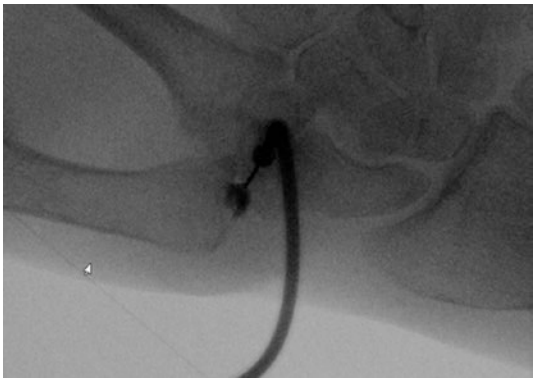

Fig. 6.15 The target site for the injection is the space between the first os metacarpal and the os trapezium. First carpometacarpal joint parallel to the beam and open (no parallax). Insert needle vertical intra-articular, control position using fluoroscopy with light visor collimation

- The radiocarpal compartment is bounded proximally by the articular surface of the distal radius and the triangular fibrocartilage complex and distally by the proximal carpal row.
- The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation.
- The CMC-I is the articulation between the os trapezium with the first os metacarpale.

Patient positioning (Fig. 6.14):

- Patient lying in prone position on the fluoroscopy table with the wrist over the head.
- Hand lying with the thenar on a small towel, approximately 45° external rotation.
- The target site for the injection is the space between the first os metacarpal and the os trapezium.

Technique (Fig. 6.15):

- First carpometacarpal joint parallel to the beam and open (no parallax).
- Using the palpation of the CMC-I joint, put the metallic pointer in the mid-point of the joint lucent line, and mark on the patient skin using indelible marker.
- Prepare sterile field of the region of the marker.
- Connect the needle and appropriate syringe with extension set.
- Insert needle vertical intra-articular, control position using fluoroscopy with light visor collimation.

- Inject a small amount of contrast which has to flow away from the tip of the needle as a sign of good intra-articular position of the needle.
- Inject solution depending on the indication for the procedure.
- Joint volume capacity is 1 mL.
- Pressure on the needle tract when withdrawing the needle to prevent reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Information brochure with information over procedure, procedure-related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

6.3.2 US Guidance

Indication:

- Diagnostic arthrography
- Arthrography for the purpose of intra-articular contrast for CT or MRI
- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or posttraumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication needed

Equipment:

- High-resolution ultrasound equipment with 18–5 MHz linear transducer

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic or iodinate contrast
- Pre-packed 20 mL Artirem syringe (Guerbet)
- Pre-packed 2 mL hyaluron syringe

Needle:

- 23 G, 30 mm blue needle
- Extension set with three cocks connecting of the needle and syringes

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate), 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide), 40 mg/mL
- Anaesthetic: 5 mL Bupivacaine Actavis, 5 mg/mL
- Hyaluronans: 2 mL Synvisc Hylan G-F 20
- Contrast: 1–10 mL Xenetix 300; 5–10 mL Artirem, 0.0025 mmol/mL

Anatomy of the region (Fig. 6.16):

- The anatomy of the wrist is complex. The joint capsule is not continuous and is composed of several compartments and articulations.
- Most commonly injected are the RC joint and the DRU joint.
- The radiocarpal compartment is bounded proximally by the articular surface of the distal radius and the triangular fibrocartilage complex and distally by the proximal carpal row.
- The triangular fibrocartilage complex (TFCC) separates the radiocarpal articulation from the distal radioulnar articulation.
- The CMC-I is the articulation between the os trapezium with the first os metacarpale.

Patient positioning (Fig. 6.17):

- Patient lying in supine position on the table with the arm downward.
- Hand lying with the thenar on a small towel, approximately 45° external rotation.
- The target site for the injection is the space between the first os metacarpal and the os trapezium.

Technique (Fig. 6.18):

- Prepare sterile field of the region.
- Transducer in the long axis of the radioscaphoid joint.
- Adequate visualisation of the cortical bone of the os trapezium and the first os metacarpale.
- Insert the needle from proximal to distal in 45° under the transducer.
- Inject a small amount of solution which should disappear in the depth of the joint.
- Ballooning of the joint capsule is a sign of the good joint filling.
- Injected solution depends on the indication for the procedure.
- Joint volume capacity is 1 mL.
- Pressure on the needle tract when withdrawing the needle to prevent solution reflux.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient receives brochure with information over procedure, procedure-related symptoms and treatment of the symptoms, signs of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

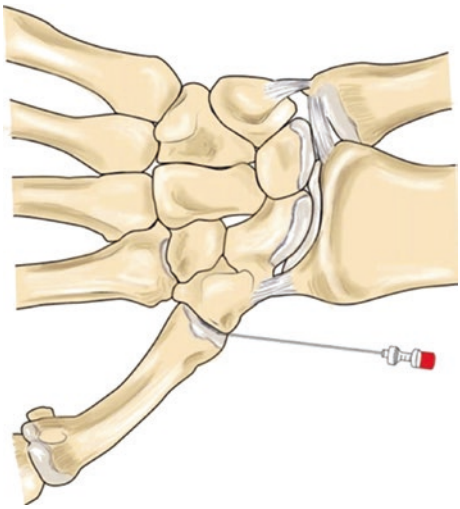

Fig. 6.16 The anatomy of the wrist is complex. The CMC-I is the articulation between the os trapezium with the first os metacarpale

Fig. 6.17 Patient lying in supine position on the table with the arm downward. Hand lying with the thenar on a small towel, approximately 45° external rotation. The target site for the injection is the space between the first os metacarpal and the os trapezium

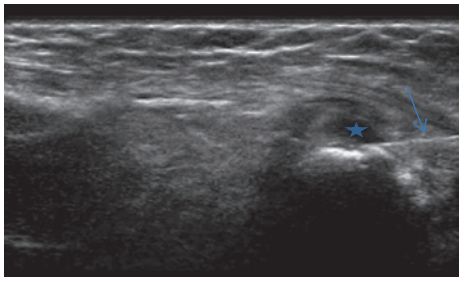

Fig. 6.18 Transducer in the long axis of the radioscaphoid joint. Adequate visualisation of the cortical bone of the os trapezium and the first os metacarpale. Insert the needle (*arrow*) from proximal to distal in 45° under the transducer. Inject a small amount of solution which should disappear in the depth of the joint. Ballooning of the joint capsule is a sign of the good joint filling (★)

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Wrist and Hand Procedures, Extra-Articular

7

Steven C. Bokhoven

Abbreviations

APB	Abductor pollicis brevis tendon
APL	Abductor pollicis longus tendon
CTS	Carpal tunnel syndrome
ECRB	Extensor carpi radialis brevis tendon
ECRL	Extensor carpi radialis longus tendon
ECU	Extensor carpi ulnaris tendon
EDC	Extensor digitorum communis tendon
EDQ	Extensor digiti quinti tendon
EIP	Extensor indicis proprius tendon
EPB	Extensor pollicis brevis tendon
EPL	Extensor pollicis longus tendon

7.1 Tendon Sheet Axial Approach (de Quervain's Disease/ECU)

Indication:

- De Quervain's disease
- Tendinosis/tendovaginitis of ECU or EPL or any other tendon in the hand and wrist

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- Proximal intersection syndrome (crossing of second extensor compartment tendons ECRL and ECRB by the first extensor compartment tendons APL and EPB)
- Distal intersection syndrome (crossing of tendons of the second and third extensor compartment tendon EPL)
- Trigger finger—thumb (stenosing tenosynovitis with thickening of the A1 pulley)
- Dupuytren disease (palmar fibromatosis of the hand, "Viking disease", "Celtic hand")
- Local anaesthetic infiltration (marcainisation) to differentiate origin of pain

Contraindication:

- Tendon tear
- General contraindications (see Chap. 1)

Pre- and post-procedure medication

- No premedication is indicated.
- Post-procedure: paracetamol when necessary (max three times, 1000 mg a day).

Equipment

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer ("hockey stick"-shaped transducer can be helpful)
- Disinfectant
- Band-Aid
- (Sterile) ultrasound gel

Syringe

- 2 cm^3 syringe for injection fluid

Needle

- 23 G 30 mm (blue) or 25 G 16 mm (orange) needle

Injectate

- 0.5–1 mL can be injected: local anaesthetic or anaesthetic combined with maximum of 20 mg of corticosteroid

Anatomy (Fig. 7.1a–c):

- The APL and EPB usually share a single tendon sheet. Tendons and compartments are shown in Fig. 7.1a, and the tendon sheets are shown in Fig. 7.1b1, b2, c.

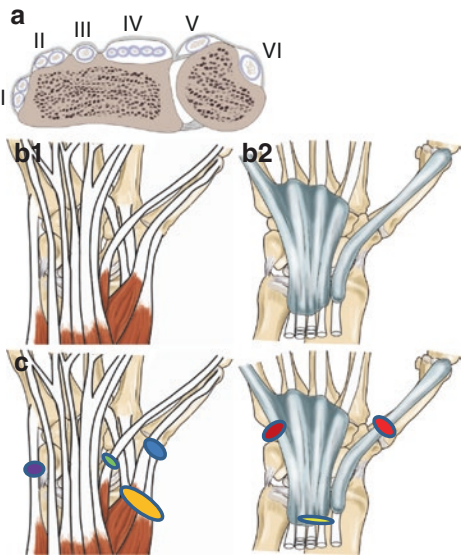

Fig. 7.1 (**a**) Extensor tendons and compartments of the wrist near Lister's tubercle, marked with *arrow*. The compartments contain the following tendons: *I*, EPB and APL; *II*, ECRB and ECRL; *III*, EPL; *IV*, EIP and EDC; *V*, EDQ; *VI*, ECU. (**b**) Dorsal (b1) and ventral (b2) tendon sheets in the hand and wrist. (**c**): Sites of tendinosis; = De Quervain's, = proximal intersection syndrome, = EPL with more distal the distal intersection site, D = ECU, = flexor carpi radialis tendon, = flexor digitorum superficialis tendon, = flexor carpi ulnaris tendon

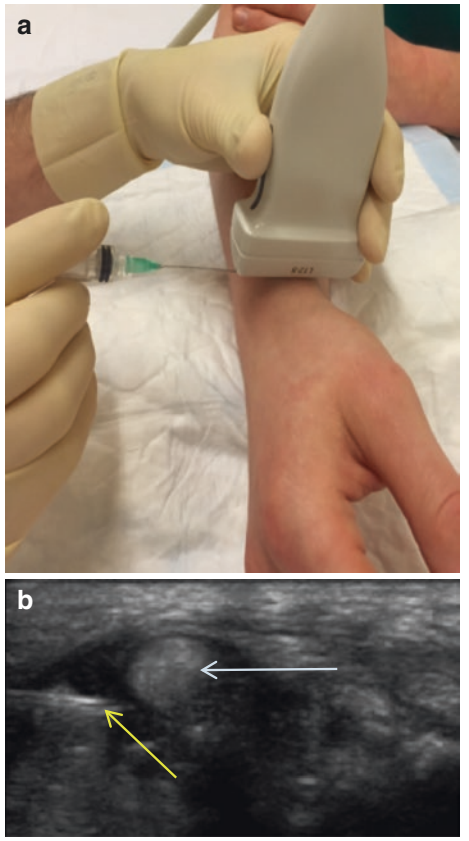

Fig. 7.2 (**a**) Ultrasound-guided injection EPB, APL in axial plane, from dorsal to ventral. (**b**) Ultrasound image of injection in axial plane, with the needle (*yellow arrow*) deep of the tendon (*blue arrow*)

- The tendons are superficially located and are best appreciated and injected at the site of concordant pain (Fig. 7.1b, c).
- In the proximal intersection syndrome, this will be where the ECRL and ECRB are crossed by the APL and EPB proximal to the extensor retinaculum [1].
- A helpful landmark is Lister's tubercle at the dorsoradial side of the wrist.
- The palmar fibromatosis in Dupuytren disease and stenosing tenosynovitis of the trigger finger are locally assessed and treated.

Patient positioning (Fig. 7.2a):

- In general an axial deep, near parallel to the transducer, approach of the tendon sheath is desired when longitudinal approach is difficult (Fig. 7.2a). Patient should be as comfortable as possible. Patient lying down on a table with the hand on the abdomen or next to the patient provides comfort and less chance of falling if a (vasovagal) collapse occurs.

Technique (Fig. 7.2b):

- In general a longitudinal, shallow, near parallel to the transducer, approach of the tendon sheath is most desired [2, 3]. The needle is placed superficial of the tendon fibres within the tendon sheath (Fig. 7.2a).
- In de Quervain's disease, an axial approach (Fig. 7.2b) to the tendon sheath is in favour with the needle placed deep of the tendon fibres [4], within the tendon sheet (Fig. 7.2c).
- At the dorsal wrist, to avoid the neurovascular bundle, an injection from dorsal to ventral side is recommended.
- When multiple tendon sheaths are to be injected, most of the time all can be approached using a single puncture site.
- In general no local anaesthetics are used.

Aftercare

- A week of rest followed by avoidance of the provoking activity is advised.
- Good explanation of expected discomfort is desired and post-procedure pain at the puncture site can be relieved with cold compression.

Complications

- Especially higher dose of corticosteroids and large molecular corticosteroids can cause fat atrophy which in the hand and wrist is a more severe complication due to cosmetics.
- Furthermore there might occur general complications as mentioned in Chap. 1.

7.2 Tendon Sheet Longitudinal Approach (Trigger Finger/Intersection Syndrome)

Indication:

- De Quervain's disease
- Tendinosis/tendovaginitis of ECU or EPL or any other tendon in the hand and wrist
- Proximal intersection syndrome (crossing of second extensor compartment tendons ECRL and ECRB by the first extensor compartment tendons APL and EPB)
- Distal intersection syndrome (crossing of tendons of the second and third extensor compartment tendon EPL)
- Trigger finger—thumb [5, 6]: stenosing tenosynovitis with thickening of the A1 pulley
- Dupuytren disease (palmar fibromatosis of the hand, "Viking disease" and "Celtic hand")
- Local anaesthetic infiltration (marcainisation) to differentiate origin of pain

Contraindication:

- Tendon tear
- General contraindications (see Chap. 1)

Pre- and post-procedure medication

- No premedication is indicated.
- Post-procedure: paracetamol when necessary (max three times, 1000 mg a day)

Equipment

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer ("hockey stick"-shaped transducer can be helpful)
- Disinfectant
- Band-Aid
- (Sterile) ultrasound gel

Syringe

- 2 cm^3 Syringe for injection fluid

Needle:

- 23 G 30 mm (blue) or 25 G 16 mm (orange) needle

Injectate:

- 0.5–1 mL can be injected: local anaesthetic or anaesthetic combined with maximum of 20 mg of corticosteroid.

Anatomy (Fig. 7.3a–c):

- The APL and EPB usually share a single tendon sheet [1]. Tendons are shown in Fig. 7.3a, and the tendon sheets are shown in Fig. 7.3b1, b2.
- The tendons are superficially located and are best appreciated and injected at the site of concordant pain (Fig. 7.3b1, b2, c).
- In the proximal intersection syndrome, this will be where the second compartment tendons ECRL and ECRB are crossed by the first compartment tendons APL and EPB.
- A helpful landmark is Lister's tubercle (Fig. 7.3a) at the dorsoradial side of the wrist [7].
- The palmar fibromatosis in Dupuytren disease and stenosing tenosynovitis of the trigger finger are locally assessed and treated [8].

Patient positioning (Fig. 7.4):

- In general a longitudinal, shallow, near parallel to the transducer approach of the tendon sheath is most desired. The needle is placed superficial of the tendon fibres within the tendon sheath (Fig. 7.4). Patient should therefore be as comfortable as possible with the puncture site and tendon in maximal extension. Patient can lie down in case of risk of (vasovagal) collapse or sit next to the tableside with performer at the end of the table.

Technique (Fig. 7.5a, b):

- In general a longitudinal, shallow, near parallel to the transducer approach of the tendon sheath is most desired (Fig. 7.5a, b).
- When multiple tendon sheaths are to be injected, most of the time, all can be approached using a single puncture site.
- In general no local anaesthetics are used.

Aftercare

- A week of rest followed by avoidance of the provoking activity is advised.
- Post-procedure pain at the puncture site can be relieved with cold compression; therefore good explanation of expected discomfort is desired.

Complications

- Especially higher dose of corticosteroids and large molecular corticosteroids can cause fat atrophy which in the hand and wrist is a more severe complication due to cosmetics.
- Furthermore there might occur general complications as mentioned in Chap. 1.

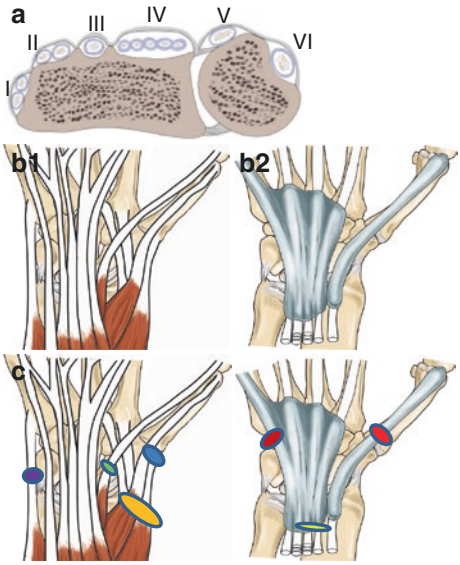

Fig. 7.3 (**a**) Extensor tendons and compartments of the wrist near Lister's tubercle, marked with arrow. The compartments contain the following tendons: *I*, EPB and APL; *II*, ECRB and ECRL; *III*, EPL; *IV*, EIP and EDC; *V*, EDQ; *VI*, ECU. (**b**) Dorsal (b1) and ventral (b2) tendon sheets in the hand and wrist. (c) Sites of tendinosis, = De Quervain's, = proximal intersection syndrome, = EPL with more distal the distal intersection site, D = ECU, = flexor carpi radialis tendon, = flexor digitorum superficialis tendon, = flexor carpi ulnaris tendon

Fig. 7.4 Ultrasound-guided injection in longitudinal plane

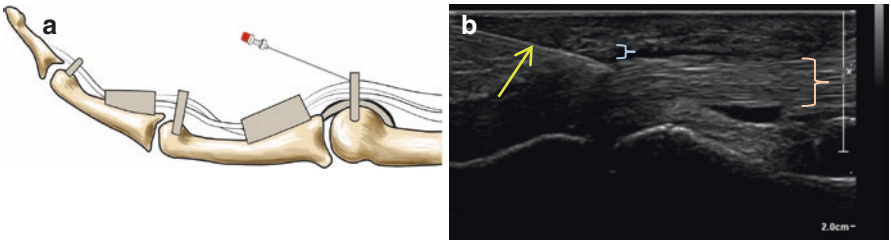

Fig. 7.5 (**a**) Diagram of trigger finger A1 pulley injection. (**b**) Ultrasound image of injection in longitudinal plane (needle, *yellow arrow*; tendon, *orange accolade*; tendon sheath, *blue accolade*)

7.3 Medial Nerve Entrapment: Carpal Tunnel Syndrome

Indication:

- Medial nerve neuropathy, local anaesthetic infiltration (marcainisation) to differentiate origin of pain

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedure medication

- No premedication is indicated.
- Post-procedure: paracetamol when necessary (max three times, 1000 mg a day)

Equipment

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer ("hockey stick"-shaped transducer can be helpful)
- Disinfectant
- Band-Aid
- (Sterile) ultrasound gel
- 1 cm^3 iodinated contrast in syringe

Syringe

- 2 cm^3 syringe for injection fluid

Needle

- 23 G 30 mm (blue) needle

Injectate

- 0.5–1 mL can be injected: local anaesthetic or anaesthetic combined with maximum of 20 mg of corticosteroid

Anatomy (Fig. 7.6):

- The carpal tunnel is best appreciated from the level of the proximal carpal row in between the scaphoid and pisiform bones [1], with the Guyon tunnel superficial from the transverse carpal ligament (Fig. 7.6). The ulnar nerve and ulnar artery are located in the Guyon tunnel.

Patient positioning (Fig. 7.7):

- In general patient should be as comfortable as possible with ventral wrist exposed on the table as shown in Fig. 7.7. The forearm will be supinated and the wrist

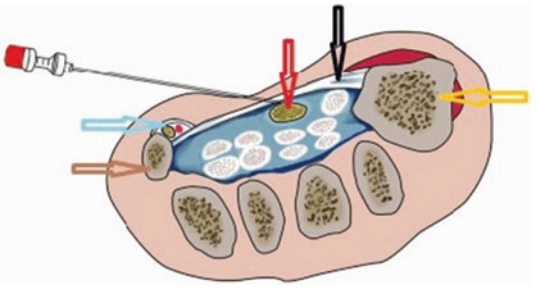

Fig. 7.6 Ventral wrist: carpal tunnel and ⇨ = Guyon tunnel, ⇦ = scaphoid bone, ⇨ = pisiform bone, ⇩ = median nerve, ⇩ = transverse carpal ligament

Fig. 7.7 Ultrasound-guided CTS injection from ulnar (preferred) and radial side

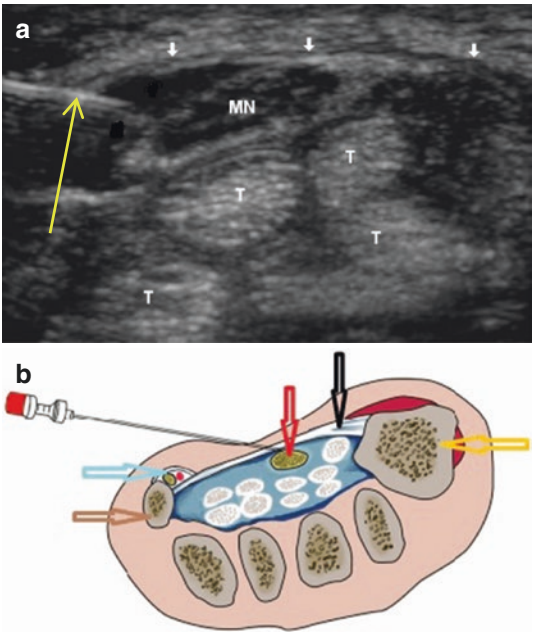

Fig. 7.8 (**a**) Ultrasound image of injection carpal tunnel deep from the transverse carpal ligament (*white arrows*) from ulnar side in axial plane; needle (*yellow arrow* just superficial to the median nerve (MN)). (**b**) Diagram CTS injection from radial side; most of the time, from ulnar side is preferred. ⇨ = Guyon tunnel; ⇩ = median nerve; ⇩ = transverse carpal ligament; ⇦ = scaphoid bone; ⇨ = pisiform bone

slightly dorsiflexed. It is best done with patient sitting at the side of the table and performer at the end of the table. Also injection with patient lying down on the table with the hand on the abdomen is done in case of risk of (vasovagal) collapse.

Technique (Fig. 7.8a, b):

- The carpal tunnel is best appreciated in axial view (Fig. 7.8a, b). When injecting under ultrasound guidance, axial in plane approach is therefore the procedure of choice [9]. Both ulnar and radial arteries are easily avoided in comparison to longitudinal approach (even with axial control, out of plane). Ulnar more than radial approach provides room to deliver half of the injectate deep from the transverse carpal ligament. Then, after retraction of the needle for a little bit and deeper injection, the other half of the injectate is delivered deep from the medial nerve. This provides surrounding injectate around the medial nerve in the end.

Aftercare

- A week of rest followed by avoidance of the provoking activity is advised.
- Good explanation of expected discomfort is desired.

Complications

- There might occur general complications as mentioned in Chap. 1.

7.4 Wrist Ganglion and Miscellaneous

Indication:

- Symptomatic ganglion cyst [10]
- Wartenberg's disease (entrapment of the superficial branch of the radial nerve)
- Active pannus (inflammatory synovial tissue in rheumatoid joints)

Contraindication:

- Unknown lesion (cave vascularity, location, patient history with malignancy)
- General contraindications (see Chap. 1)

Pre- and post-procedure medication

- No premedication is indicated.
- Post-procedure paracetamol when necessary (max three times, 1000 mg a day).

Equipment

- Ultrasound machine with preferably high-resolution (i.e. 18 MHz) linear transducer ("hockey stick"-shaped transducer can be helpful)
- Disinfectant
- Band-Aid
- (Sterile) ultrasound gel
- 1 cm^3 iodinated contrast in syringe

Syringe

- 2 cm^3 syringe for injection fluid

Needle

- 23 G 30 mm (blue) needle or 25 G 16 mm (orange) needle for local anaesthetics
- 18 G (pink) or 17 G 50 mm (white) needle for aspiration and perforation

Injectate

- 0.5–1 mL can be injected: local anaesthetic or anaesthetic combined with maximum of 20 mg of corticosteroid.
- Local anaesthetic, i.e. 2 cm^3 lidocaine.

Anatomy (Fig. 7.9):

- Ganglia are fluid-filled cystic masses. They lack synovial lining and occur mostly at the dorsal side of the wrist superficial to the intrinsic scapholunate ligament in young patients and are uncommonly found at the radial palmar side in older patients. In other locations they are rare. Most are palpable.
- A ganglion cyst should be differentiated from a carpal boss which is a common bony protuberance at the CMC joint 3 or 4 and from an accessory muscle belly.
- In Wartenberg's disease the superficial branch of the radial nerve is impinged; corticosteroid injection at the site of tenderness is the treatment of choice.
- Pannus is locally assessed and treated [11, 12].

Patient positioning (Fig. 7.10):

- In general patient should be as comfortable as possible.
- Patient lying down on a table with the hand on the abdomen or next to the patient provides comfort and less chance of falling if a (vasovagal) collapse occurs.
- Patient sitting next to the tableside with the arm in optimal position on the table and performer at the end of the table is also workable.

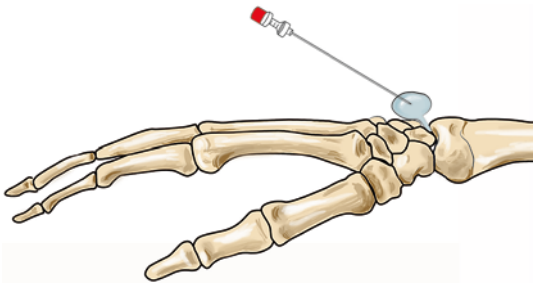

Fig. 7.9 Diagram of aspiration and anatomy of a dorsal wrist ganglion cyst

Fig. 7.10 Ultrasound-guided aspiration ganglion cyst: image of US position

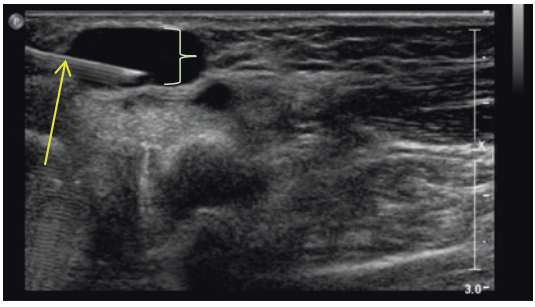

Fig. 7.11 Ultrasound image of aspiration with needle (*yellow arrow*) in dorsal wrist ganglion cyst (*green accolade*)

Technique (Fig. 7.11):

- To nonoperatively treat a ganglion cyst, aspiration is an easy option (Fig. 7.11). There is no evidence about the beneficial effects of corticosteroids. Multiple needle perforations, fenestration, tend to show a lower recurrence rate. Local anaesthetic injection prior to the procedure is admitted using a thin needle. The ultrasound-guided injection is best performed in the orientation that best suits the operator [3], which will often be in plane longitudinal. It is best to use a slightly thicker needle (at least 18 G).

Aftercare:

- Explanation of the expected pain and discomfort is desired. Cold compression may relieve the pain.
- No other specific advice or aftercare is indicated.

Complications

- There might occur general complications as mentioned in Chap. 1.

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Intra-Articular Hip Procedures

8

Alberto Bazzocchi, Giancarlo Facchini,
and Maria Pilar Aparisi Gómez

8.1 Hip Joint, Anterior Approach

8.1.1 X-Ray Guidance

Indications:

- Diagnostic arthrography.
- Aspiration (E.G. after Hip Replacement).
- Therapeutic injection (in degenerative and inflammatory diseases).
- Note: when ultrasound imaging is available and the performer is confident with it, ultrasound guidance is preferred.

Contraindications:

- Suspected infection or infection in the superficial soft tissues (for therapeutic procedures)
- Immunosupression
- Coagulopathy/anticoagulant therapy that is not well controlled
- Allergy to local anaesthetic, contrast media or steroids

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Pre- and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. For therapeutic injection a short course of NSAID post-procedure can be given, if necessary. The patient is advised that symptoms may exacerbate and advised to have pain relief drugs if needed. It is important to emphasize not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

Equipment:

- X-ray fluoroscopic equipment with small focus collimation

Syringes:

- 15–20 mL syringe for iodinated or gadolinium-based contrast media
- 5–10 mL syringe for anaesthetics
- 20–60 mL syringe for aspiration/evacuation
- 2.5 mL syringe for corticosteroids
- 2–4 mL pre-packed hyaluronan syringe

Needles:

- 22 G, 8.9 cm for diagnostic and therapeutic injection
- 18 G, 8.9 cm (or 17 G, i.e. spinal needle (e.g. Chiba—15 cm)) for aspiration

Drugs for injection:

- 10–15 mL iodinated contrast medium.
- Standard dilution of gadolinium chelates for joint distention: 2.5 mmol gadopentetate dimeglumine → mix 0.1 mL of gadopentetate dimeglumine in 20 mL of saline solution (10–15 mL to be injected); different gadolinium products may contain different gadolinium concentrations, for different solutions (e.g. 12 mL of iodinated contrast medium mixed with 0.06 mL gadopentetate dimeglumine 0.5 mmol/mL); pre-packed gadolinium for intra-articular use also exists (10–15 mL, to be injected).
- 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)].
- 2–6 mL anaesthetics [lidocaine (1%)].
- 2–4 mL hyaluronan.

Anatomy (Fig. 8.1):

- The hip is a “ball and socket” synovium-lined joint with the spherical femoral head and the cup-shaped acetabulum both covered by hyaline articular cartilage that is augmented with the acetabular labrum.

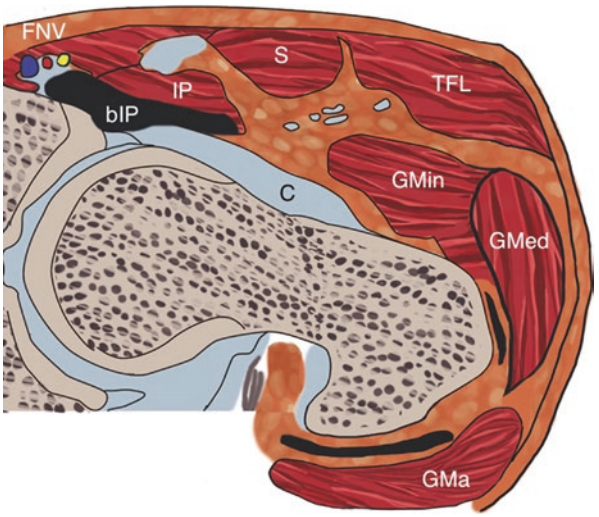

Fig. 8.1 Normal anatomy. *FNV* femoral neurovascular bundle; *bIP* iliopsoas bursa, *IP* iliopsoas, *S* Sartorius, *TFL* tensor fascia lata, *GMin* gluteus minimus, *GMed* gluteus medius, *GMa* gluteus major, *C* capsule

Fig. 8.2 Patient positioning. Patient lying on the fluoroscopy table in supine position. Note that the hip is positioned with slight internal rotation (relaxed anterior musculature and capsule)

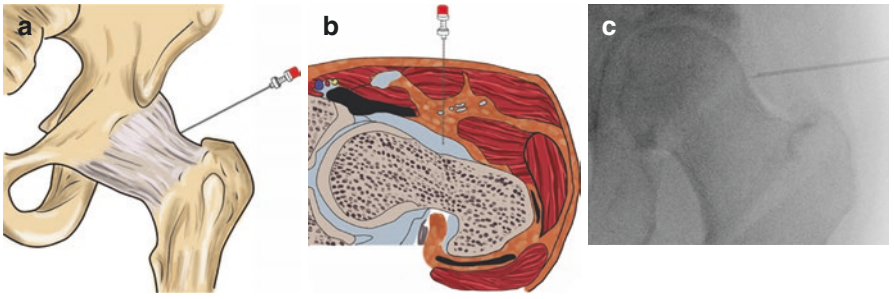

Fig. 8.3 Radioscopic injection technique. Hip joint injection by targeting the lateral portion of the anterior recess. (**a**) The needle is advanced to the cortex of the lateral femoral head-neck junction with the bevel of the needle oriented medially. (**b**) Schematic transverse oblique section of the hip joint demonstrating the tip of the needle in the lateral portion. (**c**) Radioscopic control of position of the needle (Image courtesy of Dr. M. Obradov (NL))

- The capsule extends around the joint attaching superiorly to the acetabulum and inferiorly to the intertrochanteric area.
- The deep synovial layer reflects back from the intertrochanteric area to the head-neck junction delineating the anterior joint recess.
- The anterior recess encompasses lateral and medial parts separated by the zona orbicularis (annular ligament).
- The femoral neurovascular bundle must be identified by palpation medial to the femoral neck.
- The capacity of the normal hip joint in adults is 8–20 mL.

Patient positioning (Fig. 8.2):

- Patient lying on the fluoroscopy table in supine position with the hip positioned with neutral or slight internal rotation (relaxed anterior musculature and capsule)

Technique (Fig. 8.3):

- Radioscopic anterior approach to the lateral portion of the anterior recess (Fig. 8.3)
  - Procedure is explained to patient and consent obtained.
  - The neurovascular bundle is identified by palpation.
  - The target is the lateral aspect of the femoral neck.
  - Under anteroposterior fluoroscopic imaging, the skin is marked at a spot over the centre of the femoral neck, using a radiopaque marker.
  - Sterile field is prepared at the location of the marker.
  - Cutaneous and subcutaneous and soft tissue infiltration is performed with local anaesthetic. (If required, anaesthetic for superficial/extra-articular layers is usually injected when thick needles are used, i.e. in aspiration procedures.)
  - The needle is advanced to the cortex of the lateral femoral head-neck junction with the bevel of the needle oriented medially (not to penetrate the cortical surface).
  - The needle is inserted upon bone contact and, subsequently, very slightly withdrawn.
  - Aspiration is performed, and this allows gross evaluation for infection as well as decompression of a joint effusion, if present.
  - For contrast media procedures, injection of a small amount of contrast is performed (few millilitres) which has to flow away from the tip of the needle as a sign of good intra-articular position.
  - Inject solution depending on the indication for the procedure.
  - The needle is finally removed.
  - Please note that when aspiration is performed for diagnostic purposes, an aseptic environment is crucial not only to avoid prosthesis/joint/tissue infection but also contamination of collected material.

This approach has been shown to be less painful than the medial approach but is associated with a greater extra-articular contrast leak rate in arthrographic procedures. Lateral approach should be considered in obese patients.

- Radioscopic anterior approach to the medial portion of the anterior recess (Fig. 8.4)
  - The femoral neurovascular bundle is identified by palpation.
  - The target is the superior head-neck junction.
  - Under anteroposterior fluoroscopic imaging, the skin is marked at a spot over the superior head-neck junction, using a radiopaque marker.
  - Sterile field is prepared at the location of the marker.
  - Penetrate the skin, and direct towards the junction of the femoral head and neck. The target may be at the superior rim of the head-neck junction.
  - Cutaneous and subcutaneous and soft tissue infiltration is performed with local anaesthetic. (If required, anaesthetic for superficial/extra-articular layers is usually injected when thick needles are used, i.e. in aspiration procedures.)
  - The needle is inserted upon bone contact and, subsequently, very slightly withdrawn.
  - Aspiration is performed, and this allows gross evaluation for infection as well as decompression of a joint effusion, if present.
  - For contrast media procedures, injection of a small amount of contrast is performed (few millilitres) which has to flow away from the tip of the needle as a sign of good intra-articular position.
  - Inject solution depending on the indication for the procedure.
  - The needle is finally removed.

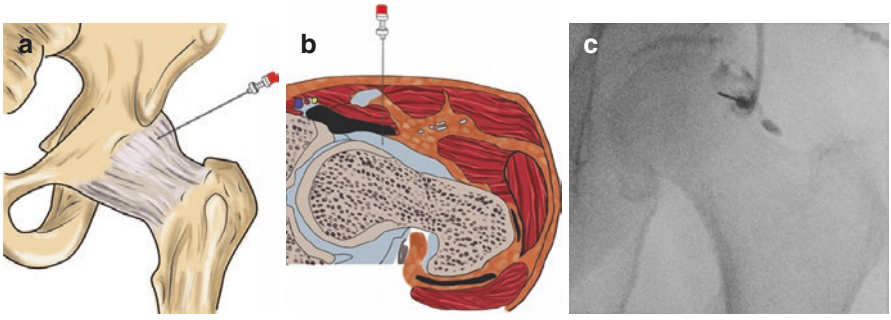

Fig. 8.4 Radioscopic injection technique. Hip joint injection by targeting the mid-portion of the anterior recess. (**a**) The needle is orientated towards the superior aspect of the head-neck junction, avoiding the femoral vessels. (**b**) Schematic transverse oblique section of the hip joint demonstrating the tip of the needle in the medial portion. (**c**) Radioscopic control with injection of contrast (Image courtesy of Dr. M. Obradov (NL))

Aftercare:

- Direct pressure on the puncture site is steadily applied.
- Adhesive tape is placed at the puncture site.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure-related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Self-limiting local adverse events include mild transient sensation of heaviness in the hip and mild short-term increase in pain. The most common adverse effect is mild self-resolving soreness at the injection site.
- Pain at the puncture site can be treated with cold compression.

8.1.2 Ultrasound Guidance

Indications:

- Diagnostic arthrography.
- Aspiration (e.g. after hip replacement).
- Therapeutic injection (in degenerative and inflammatory diseases).
- Note: When ultrasound imaging is available and the performer is confident with it, ultrasound guidance is preferred.

Contraindications:

- Suspected infection or infection in the superficial soft tissues (for therapeutic procedures)
- Immunosupression
- Coagulopathy/anticoagulant therapy that is not well controlled
- Allergy to local anaesthetic, contrast media or steroids

Pre- and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. For therapeutic injection a short course of NSAID post-procedure can be given, if necessary. The patient is advised that symptoms may exacerbate and to have pain relief drugs if needed. It is important to emphasize not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

Equipment:

- Low (to medium)-frequency linear array transducer (or convex probe for obese or very muscular patients).
- The progression of the needle through different tissue layers (subcutaneous tissue, rectus femoris, iliopsoas muscle and capsule) can be followed if it is kept inside the ultrasound beam with better visualization the more perpendicular the needle is to the ultrasound beam.
- Wide scan (trapezoid-shaped image display) and steering can be useful to enlarge the field of view and improve imaging.

Syringes:

- 15–20 mL syringe for iodinated or gadolinium-based contrast media
- 5–10 mL syringe for anaesthetics
- 20–60 mL syringe for aspiration/evacuation
- 2.5 mL syringe for corticosteroids
- 2–4 mL pre-packed hyaluronan syringe

Needles:

- 22 G, 8.9 cm for diagnostic and therapeutic injection
- 18 G, 8.9 cm (or 17 G, i.e. Chiba needle—15 cm) for aspiration

Injection drugs:

- 10–15 mL iodinated contrast medium.
- Standard dilution of gadolinium chelates for joint distention: 2.5 mmol gadopentetate dimeglumine → mix 0.1 mL of gadopentetate dimeglumine in 20 mL of saline solution (10–15 mL to be injected); different gadolinium products may contain different gadolinium concentrations, for different solutions [e.g. 12 mL of iodinated contrast medium mixed with 0.06 mL gadopentetate dimeglumine 0.5 mmol/mL]; pre-packed gadolinium for intra-articular use also exists (10–15 mL, to be injected).
- 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)].
- 2–6 mL anaesthetics [lidocaine (1%)].
- 2–4 mL hyaluronan.

Anatomy (Fig. 8.5):

- Moving from proximal to distal region of the hip, four bony structures can be identified as highly reflective lines: the anteroinferior iliac spine, acetabular rim, femoral head and femoral neck.

- In a sagittal oblique plane parallel to the long axis of the femoral neck, the pennate structure of several muscles can be identified: the sartorius muscle is located superficially under the subcutaneous tissue, the rectus femoris muscle laterally to the femoral head and the iliopsoas muscle medially covering the femoral head.
- The joint capsule can be seen as a concave thin linear hyperechoic structure extending from the acetabular rim to its insertion distal to the femoral neck. The hyperechoic rounded surface of the femoral head is covered by a thin hypoechoic layer of hyaline cartilage.
- The synovial recess lies between the deep fascia of the iliopsoas and the femoral neck.
- Cranial to the anterior recess, the fibrocartilaginous anterior glenoid labrum of the acetabulum can be detected as a homogeneously echo-bright triangular structure.
- The iliopsoas tendon overlies the labrum medially.
- The femoral neurovascular bundle is identified in the short-axis view: the nerve, femoral artery and vein (N-A-V) can be identified in that order from lateral to medial. The femoral vein is easily compressible with the probe and together with the artery is easily identified with colour Doppler. The long-axis view of the femoral head-neck using colour Doppler allows to identify the lateral circumflex femoral artery.

Patient positioning (Fig. 8.6):

- Patient is placed in supine with the hip in slight internal rotation or neutral position.

Technique (Fig. 8.7):

- Clinical and imaging review of the involved joint are performed and informed consent obtained.
- The anterior iliac spine is located by palpation.
- Using the non-dominant hand to hold the probe, this is oriented longitudinally, medial to the anterior superior iliac spine.
- The anterior hip joint, femoral neck and joint capsule are visualized.
- The transducer is turned into a transverse plane and the femoral vessels identified. The vessels have to be medial to the injection site.
- The transducer is reorientated to the long-axis view of the femoral head-neck and the lateral circumflex artery identified to ensure that this is not in the planned/potential needle path.
- In the sagittal plane the anterior joint capsule may be approached from above or below the transducer, depending on the patient's body habitus and possible vascular interference (the approach is more often and typically from below). The access point is marked.

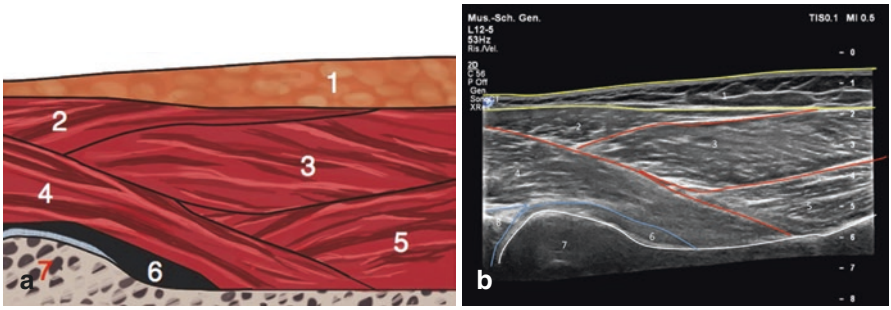

Fig. 8.5 (**a**) Shows schematic representation of regional anatomy. (**b**) Illustrates sonographic anatomy: *1*, subcutaneous tissue; *2*, sartorius; *3*, rectus femoris; *4*, iliopsoas; *5*, vastus medialis; *6*, capsule; *7*, femur; *8*, labrum

Fig. 8.6 Patient positioning in US-guided procedure.Patient is placed in supine position, with the hip in neutral position (as depicted) or in slight internal rotation

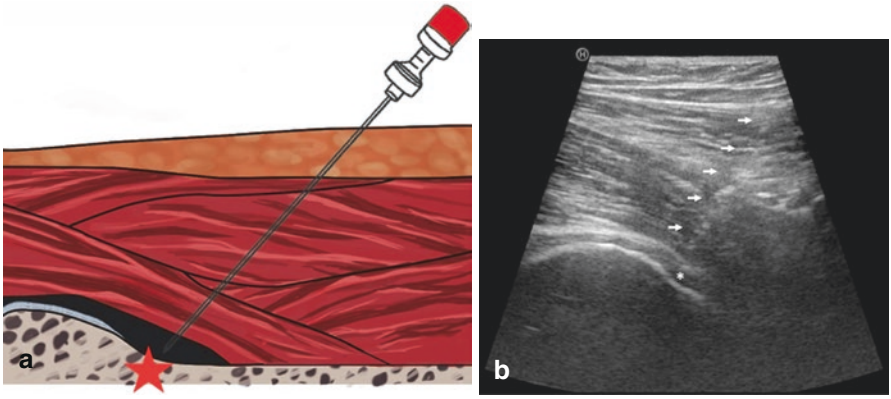

Fig. 8.7 US hip injection technique, anterior approach. (**a**) The needle is inserted approximately 2 cm from the distal part of the probe with an angle of about 45° to the horizontal skin plane having as a target the head-neck junction (*red star*). (**b**) The needle insertion can be traced from the moment it enters the ultrasound beam, approximately 1 cm below the skin, through the fat tissue, rectus femoris and iliopsoas muscle and capsule, up to the bone (*white arrows*) to the head-neck junction (*asterisk*)

- The sterile field is prepared in the region of the marker.
- The dominant hand is used to hold the syringe to anaesthetize the subcutaneous region (and deeper layers up to the periarticular region, if required—anaesthetic for superficial/extra-articular layers is usually injected when thick needles are used, i.e. in aspiration procedures).
- Through the anaesthetized track, the needle is inserted approximately 2 cm from the distal part of the probe with an angle of about 45° to the horizontal skin plane having as a target the head-neck junction. The needle insertion can be traced from the moment it enters the ultrasound beam, approximately 1 cm below the skin, through the fat tissue, rectus femoris and iliopsoas muscle and capsule, up to the bone.
- After bony cortex contact, the needle is retracted 3–4 mm in order to avoid engaging the tip in the posterior synovial layer and to facilitate the tip placement inside the anterior joint recess.
- Aspiration is then performed, allowing gross evaluation for infection as well as decompression of a joint effusion, if present, to allow space for injection volume.
- The solution is injected (type of solution depends on the indication for the procedure).
- The needle is removed.
- Please note that when aspiration is performed for diagnostic purposes, an aseptic environment is crucial not only to avoid prosthesis/joint/tissue infection but also contamination of collected material.

Aftercare:

- Direct pressure on the puncture site is steadily applied.
- Adhesive tape is placed at the puncture site.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure-related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Self-limiting local adverse events include mild transient sensation of heaviness in the hip and mild short-term increase in pain. The most common adverse effect is mild self-resolving soreness at the injection site.
- Pain at the puncture site can be treated with cold compression.

8.2 Hip Joint Lateral Approach

8.2.1 X-Ray Guidance

Indications:

- Diagnostic arthrography.
- Aspiration (e.g. after hip replacement).
- Therapeutic injection (in degenerative and inflammatory diseases).
- Note: when ultrasound imaging is available and the performer is confident with it, ultrasound guidance is preferred.

Contraindications:

- Suspected infection or infection in the superficial soft tissues (for therapeutic procedures)
- Immunosuppression
- Coagulopathy/anticoagulant therapy that is not well controlled
- Allergy to local anaesthetic, contrast media or steroids

Pre- and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. For therapeutic injection a short course of NSAID post-procedure can be given, if necessary. The patient is advised that symptoms may exacerbate and to have pain relief drugs if needed. It is important to emphasize not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

Equipment:

- X-ray fluoroscopic equipment with small focus collimation

Syringes:

- 15–20 mL syringe for iodinated or gadolinium-based contrast media
- 5–10 mL syringe for anaesthetics
- 20–60 mL syringe for aspiration/evacuation
- 2.5 mL syringe for corticosteroids
- 2–4 mL pre-packed hyaluronan syringe

Needles:

- 22 G, 8.9 cm for diagnostic and therapeutic injection
- 18 G, 8.9 cm (or 17 G, spinal (i.e. Chiba needle—15 cm)) for aspiration

Injection drugs:

- 10–15 mL iodinated contrast medium.
- Standard dilution of gadolinium chelates for joint distention: 2.5 mmol gadopentetate dimeglumine → mix 0.1 mL of gadopentetate dimeglumine in 20 mL of saline solution (10–15 mL to be injected); different gadolinium products may contain different gadolinium concentrations, for different solutions [e.g. 12 mL of iodinated contrast medium mixed with 0.06 mL gadopentetate dimeglumine 0.5 mmol/mL]; pre-packed gadolinium for intra-articular use also exists (10–15 mL, to be injected).
- 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)].
- 2–6 mL anaesthetics [lidocaine (1%)].
- 2–4 mL hyaluronan.

Anatomy (Fig. 8.8):

- On lateral imaging, the smaller ipsilateral hip joint will be the target (the contralateral hip will appear larger due to image magnification).
- The skin entry point is identified immediately proximal to the greater trochanter.

Patient positioning (Fig. 8.9):

- The patient is placed in lateral decubitus (side-lying) position with the targeted hip at the top.

Technique (Fig. 8.10):

- Using both palpation and fluoroscopy, the skin is marked with a radiopaque marker at a point approximately 4 cm cephalic to the greater trochanter.
- Sterile field is prepared in the region of the marker.
- Cutaneous and subcutaneous and soft tissue infiltration is performed with local anaesthetic (and deeper layers up to the periarticular region, if required—anaesthetic for superficial/extra-articular layers is usually injected when thick needles are used, i.e. in aspiration procedures).
- The skin is penetrated, orientating the needle towards the top of the greater trochanter in the lateral projection.
- The needle is redirected towards the femoral head-neck junction.
- As the target is reached, projection is switched to anteroposterior and focused on the femoral head-neck junction.
- The needle is advanced to the cortex of the lateral femoral head-neck junction.
- The needle is inserted upon bone contact and, subsequently, very slightly withdrawn.
- Aspiration is performed, and this allows gross evaluation for infection as well as decompression of a joint effusion, if present.

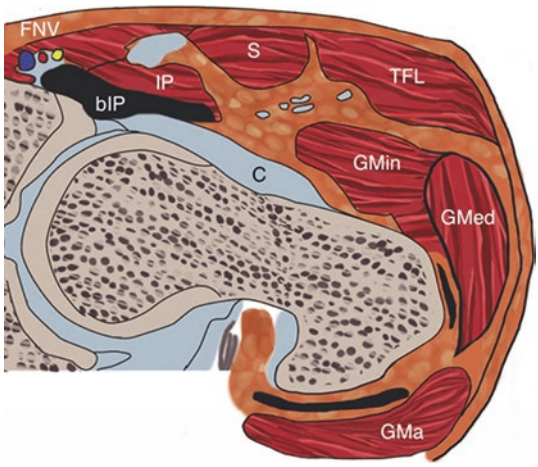

Fig. 8.8 Normal anatomy. *FNV* femoral neurovascular bundle, *bIP* iliopsoas bursa, *IP* iliopsoas, *S* sartorius, *TFL* tensor fascia lata, *GMin* gluteus minimus, *GMed* gluteus medius, *GMa* gluteus major, *C* capsule

Fig. 8.9 Patient positioning. The patient is placed in lateral decubitus (side-lying) position with the targeted hip at the top

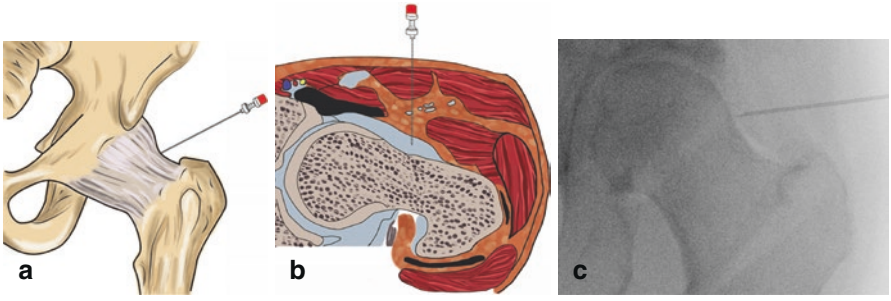

Fig. 8.10 Hip joint injection by targeting the lateral portion of the anterior recess. (**a**) Starting from the lateral projection, the needle is orientated towards the top of the greater trochanter, and then redirected towards the femoral head -neck junction, and projection switched to AP. Once this is done the needle is advanced to the cortex of the lateral femoral head-neck junction with the bevel of the needle oriented medially. (**b**) Schematic transverse oblique section of the hip joint demonstrating the tip of the needle in the lateral portion. (**c**) Radioscopic control of position of the needle (Image courtesy of Dr M. Obradov (NL))

- For contrast media procedures, injection of a small amount of contrast is performed (few millilitres) which has to flow away from the tip of the needle as a sign of good intra-articular position.
- Inject solution depending on the indication for the procedure.
- The needle is finally removed.

Aftercare:

- Direct pressure on the puncture site is steadily applied.
- Adhesive tape is placed at the puncture site.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number, information about follow-up appointment.

Procedure-related symptoms and treatment:

- Self-limiting local adverse events include mild transient sensation of heaviness in the hip and mild short-term increase in pain. The most common adverse effect is mild self-resolving soreness at the injection site.
- Pain at the puncture site can be treated with cold compression

8.2.2 Ultrasound Guidance

Indications:

- Diagnostic arthrography.
- Aspiration (e.g. after hip replacement).
- Therapeutic injection (in degenerative and inflammatory diseases).
- Note: when ultrasound imaging is available and the performer is confident with it, ultrasound guidance is preferred.

Contraindications:

- Suspected infection or infection in the superficial soft tissues (for therapeutic procedures)
- Immunosupression
- Coagulopathy/anticoagulant therapy that is not well controlled
- Allergy to local anaesthetic, contrast media or steroids

Pre-and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. For therapeutic injection a short course of NSAID post-procedure can be given, if necessary. The patient is advised that symptoms may exacerbate and to have pain relief drugs if needed. It is important to empha-

size not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

Equipment:

- Low (to medium)-frequency linear array transducer (or convex probe for obese or very muscular patients).
- The progression of the needle through different tissue layers (subcutaneous tissue, rectus femoris, iliopsoas muscle and capsule) can be followed if it is kept inside the ultrasound beam, with better visualization the more perpendicular the needle is to the ultrasound beam.
- Wide scan (trapezoid-shaped image display) and steering can be useful to enlarge the field of view and improve imaging.

Syringes:

- 15–20 mL syringe for iodinated or gadolinium-based contrast media
- 5–10 mL syringe for anaesthetics
- 20–60 mL syringe for aspiration/evacuation
- 2.5 mL syringe for corticosteroids
- 2–4 mL pre-packed hyaluronan syringe

Needles:

- 22 G, 8.9 cm for diagnostic and therapeutic injection
- 18 G, 8.9 cm or 17 G Spinal (Chiba needle—15 cm) for aspiration

Injection drugs:

- 10–15 mL iodinated contrast medium.
- Standard dilution of gadolinium chelates for joint distention: 2.5 mmol gadopentetate dimeglumine → mix 0.1 mL of gadopentetate dimeglumine in 20 mL of saline solution (10–15 mL to be injected); different gadolinium products may contain different gadolinium concentrations, for different solutions [e.g. 12 mL of iodinated contrast medium mixed with 0.06 mL gadopentetate dimeglumine 0.5 mmol/mL]; pre-packed gadolinium for intra-articular use also exists (10–15 mL, to be injected).
- 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)].
- 2–6 mL anaesthetics [lidocaine (1%)].
- 2–4 mL hyaluronan.

Anatomy (Fig. 8.11):

- Moving from proximal to distal region of the hip, four bony structures can be identified as highly reflective lines: the anteroinferior iliac spine, acetabular rim, femoral head and femoral neck.

- In a sagittal oblique plane parallel to the long axis of the femoral neck, the pennate structure of several muscles can be identified: the sartorius muscle is located superficially under the subcutaneous tissue, the rectus femoris muscle laterally to the femoral head and the iliopsoas muscle medially covering the femoral head.
- The joint capsule can be seen as a concave thin linear hyperechoic structure extending from the acetabular rim and labrum to its insertion distal to the femoral neck. The hyperechoic rounded surface of the femoral head is covered by a thin hypoechoic layer of hyaline cartilage.
- The synovial recess lies between the deep fascia of the iliopsoas and the femoral neck.
- Cranial to the anterior recess, the fibrocartilaginous anterior glenoid labrum of the acetabulum can be detected as a homogeneously echo-bright triangular structure.
- The iliopsoas tendon overlies the labrum medially.
- The femoral neurovascular bundle is identified in the short-axis view: the nerve, femoral artery and vein (N-A-V) can be identified in that order from lateral to medial. The femoral vein is easily compressible with the probe and together with the artery is easily identified with colour Doppler. The long-axis view of the femoral head-neck using colour Doppler allows to identify the lateral circumflex femoral artery.

Patient positioning (Fig. 8.12):

- Patient is placed supine with the hip in slight internal rotation or neutral position.

Technique (Fig. 8.13):

- Clinical and imaging review of the involved joint are performed and informed consent obtained.
- The anterior iliac spine is located by palpation.
- Using the non-dominant hand to hold the probe, this is oriented longitudinally, medial to the anterior superior iliac spine.
- The anterior hip joint, femoral neck and joint capsule are visualized.
- The transducer is turned into a transverse plane and the femoral vessels identified. The vessels have to be medial to the injection site.
- The transverse plane allows the needle to be introduced almost parallel to the probe face. This approach also means that the skin puncture is made laterally, far away from the main neurovascular bundle.
- The access point is marked.
- The sterile field is prepared in the region of the marker.
- The dominant hand is used to hold the syringe to anaesthetize the subcutaneous region (and deeper layers up to the periarticular region, if required—anaesthetic for superficial/extra-articular layers is usually injected when thick needles are used, i.e. in aspiration procedures).

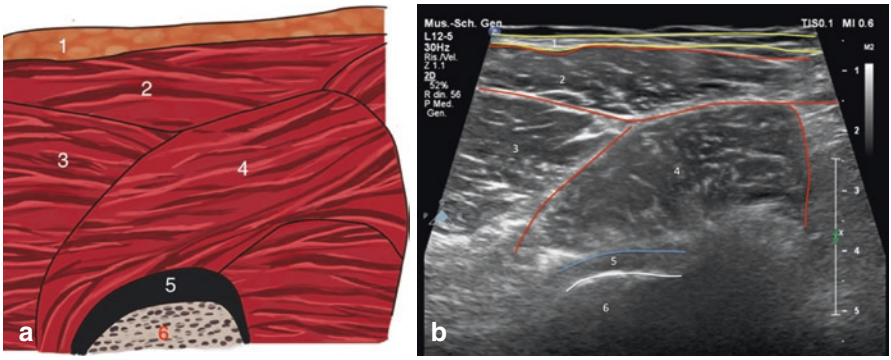

Fig. 8.11 (**a**) Depicts a schematic representation of regional anatomy in the transverse plane. (**b**) Illustrates sonographic anatomy: *1*, subcutaneous tissue; *2*, sartorius; *3*, rectus femoris; *4*, psoas; *5*, capsule; *6* femoral head-neck junction

Fig. 8.12 Patient positioning. Patient is placed supine with the hip in slight internal rotation or neutral position

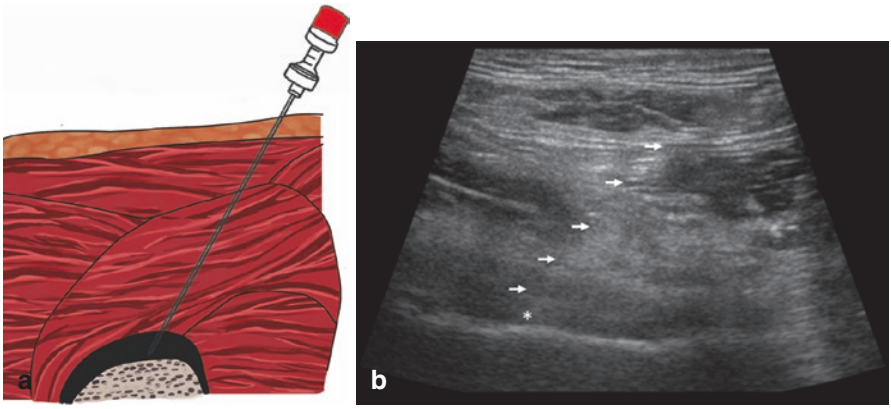

Fig. 8.13 US injection technique, lateral approach. (**a**) The needle is inserted approximately 2 cm from the distal part of the probe with an angle of about 45° to the horizontal skin plane having as a target the head-neck junction. (**b**) Sonographic visualization: *asterisk*, intra-articular target point for injection, at the level of the head and neck junction; *arrows*, needle (note that the needle is not well visualized: ultrasound beam allows for optimal visualization when the surface of the probe is parallel to the needle, and therefore beam direction perpendicular; this becomes more relevant for thinner needles and lower ultrasound frequencies)

- Through the anaesthetized track, the needle is inserted approximately 2 cm from the distal part of the probe with an angle of about 45° to the horizontal skin plane having as a target the head-neck junction.
- After bony cortex contact, the needle is retracted 3–4 mm in order to avoid engaging the tip in the posterior synovial layer and to facilitate the tip placement inside the anterior joint recess.
- Aspiration is then performed, allowing gross evaluation for infection as well as decompression of a joint effusion, if present, to allow space for injection volume.
- The solution is injected (type of solution depends on the indication for the procedure).
- The needle is removed.

Aftercare:

- Direct pressure on the puncture site is steadily applied.
- Adhesive tape is placed at the puncture site.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Self-limiting local adverse events include mild transient sensation of heaviness in the hip and mild short-term increase in pain. The most common adverse effect is mild self-resolving soreness at the injection site.
- Pain at the puncture site can be treated with cold compression.

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Extra-Articular Procedures Around the Hip

9

Alberto Bazzocchi and Maria Pilar Aparisi Gómez

9.1 Trochanteric Bursitis

Indications:

- Therapeutic injection (inflammatory disease, greater trochanteric pain syndrome)

Contraindications:

- Suspected infection, in the bursa or in the superficial soft tissues
- Immunosuppression
- Coagulopathy/anticoagulant therapy that is not well controlled
- Allergy to local anesthetic or steroids

Pre- and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. A short course of NSAID post procedure is recommended, if necessary. The patient is advised that symptoms may exacerbate and to have pain relief drugs if needed. It is important to emphasize not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

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M. Obradov, J.L.M.A. Gielen (eds.), *Image-guided Intra- and Extra-articular Musculoskeletal Interventions*, https://doi.org/10.1007/978-3-319-69895-3_9

Equipment:

- High-frequency or medium-frequency linear-array transducer (rarely, a low-frequency curvilinear-array transducer can be useful—depending on patient's body habitus and desired field of view)

Syringe:

- 2.5–5 mL syringe

Needle:

- 22 G, 8.9 cm needle (or shorter—6.4 cm—depending on patient's body habitus)

Injection drugs:

- 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)] usually with 2–5 mL anesthetics [lidocaine (1%)]

Anatomy (Fig. 9.1):

- The greater trochanter is a large protuberance at the junction of the femoral neck and shaft.
- The greater trochanter has four facets: anterior, lateral, posterior, and superoposterior.
- Seven muscles attach to the greater trochanter:
  - Gluteus minimus → anterior facet
  - Gluteus medius → lateral and superoposterior facets
  - Piriformis → superomedial insertion
  - Obturator externus → medially, trochanteric fossa
  - Obturator internus and superior and inferior gemelli → more medially adjacent to the trochanteric fossa
- Gluteus medius and gluteus minimus are being referred to as the "rotator cuff" of the hip.
- The trochanteric bursa is considered as a bursal complex with bursae present between the gluteal tendons.
- Three bursae are described:
  - Subgluteus minimus bursa, between the anterior facet and gluteus minimus tendon
  - Subgluteus medius bursa, between the lateral facet and gluteus medius tendon
  - Subgluteus maximus (greater trochanteric) bursa, over the posterior and lateral facets and between the iliotibial tract and the gluteal tendons

Patient positioning (Fig. 9.2):

- Patient in lateral decubitus position on the contralateral hip, with hips and knees gently flexed in a comfortable position (gluteal muscles must be sufficiently relaxed)

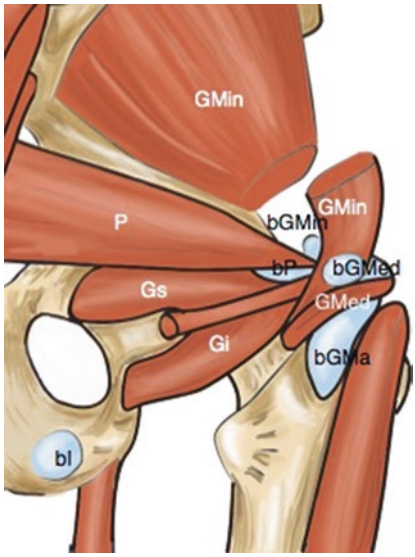

Fig. 9.1 Normal anatomy of the posterolateral aspect of the hip. *GMin* gluteus minimus, *bGMin* gluteus minimus bursa, *bGMed* gluteus minimus bursa, *GMed* gluteus medius, *bGMa* gluteus major bursa, *P* piriformis, *bP* piriformis bursa, *Gs* gemellus superior, *Gi* gemellus inferior, *bI* ischiatic bursa

Fig. 9.2 Patient positioning. Patient is placed in lateral decubitus position on the contralateral hip, with hips and knees gently flexed in a comfortable position. Gluteal muscles must be sufficiently relaxed

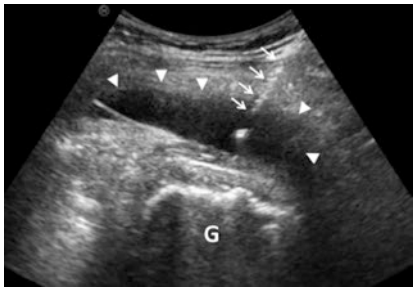

Fig. 9.3 Ultrasound-guided injection in the trochanteric bursa. The trochanteric bursa is distended with fluid (*arrowheads*). The needle is advanced until the tip lies within the fluid collection (*arrows*). The great trochanter is identified deep to the bursa (G)

Technique (Fig. 9.3):

- The transducer is placed on the transverse plane over the lateral proximal femur, translated superiorly until the bony protuberance of the greater trochanter and the apex is identified.
- The apex of the greater trochanter is located between the anterior and lateral facets; gluteus minimus tendon inserts over the anterior facet and gluteus medius tendon over the lateral facet.
- The target is frequently the greater trochanteric bursa, but other bursae should be evaluated and injection considered if there are inflammatory signs or exquisite tenderness.
- The transducer is moved posteriorly, identifying the posterior facet: greater trochanteric bursal distention may be identified between the gluteus maximus and the posterior facet.
- Ultrasound imaging shows liquid in the bursa, provided not too much pressure is applied with the hand/transducer.
- Imaging should be performed on both transverse and longitudinal planes, and comparison with the contralateral side is useful when findings are equivocal.
- The transducer is placed on the transverse plane, perpendicular to the long axis of the femur, over the bursa, and a mark/line is drawn on the skin, following the posterior aspect of the transducer.
- Aseptic environment is prepared.
- The needle is advanced following the posteroanterior axis of the transducer, until target area is reached.
- The tip of the needle needs to be clearly identified within the fluid inside the bursa.
- Please note that the needle is best visualized when the needle and probe face are parallel: visualization is less clear with increasing angle of insonation.
- The solution is injected.
- The needle is removed.

Aftercare:

- Slight direct pressure is applied on the puncture site, and after that this is covered with adhesive tape.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure-related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

9.2 Calcific Tendinopathy

The natural history of calcific tendinopathy around the hip is still unknown. Symptoms often improve or resolve in a few months, and calcifications can also decrease in size up to complete resorption. Management of calcific tendinopathy in the hip remains controversial.

Nonoperative treatment is successful in most patients; in patients experiencing prolonged and severe pain, a different approach can be considered, including needling and aspiration (although only preliminary and limited experience exists).

Calcific tendinopathy is commonly found in the greater trochanter involving the gluteus medius and gluteus minimus tendon and, less often, other sites, like the rectus femoris.

The correct diagnosis must be made; acute calcific tendinopathy is often misdiagnosed; it is important to remember that this is a self-limiting disease and laboratory findings within the normal range are observed; the target are not small calcifications at the enthesis, which are merely related to enthesopathy.

The technique is similar to the technique used for trochanteric bursitis injection.

To fragment the calcification, a single or a double—as preferred—needle approach is used, for lavage and aspiration. It is important to avoid hitting the bone (enthesis) and not to barbotage outside of the calcified area. Lavage should be performed until the solution is clear, without calcium deposits.

Normally, a bursal steroid injection is performed after the procedure.

9.3 Iliopsoas Impingement

Indications:
This impingement condition can affect a normal or a prosthetic hip.

- Iliopsoas tendon snapping.
- Iliopsoas impingement:
  - In the young athlete, it is due to scarring or tightening and can be associated with anterior labral tear (which would be a differential).
  - In the setting of a prominent acetabular component of total hip replacement.
- Diagnostic test (if the pain disappears within a few minutes of the procedure, this indicates that the cause is psoas impingement).
- Therapeutic injection—peritendon/bursa (iliopsoas impingement and bursopathy, after hip joint replacement).
- It is important to exclude other pathologies (e.g., labral tears, cartilage defects, and intra-articular loose bodies). Iliopsoas bursitis may also represent a primary pathologic condition.

Contraindications:

- Suspected infection in the joint, in the bursa, or in the superficial soft tissues.
- Immunosuppression.

- Coagulopathy/anticoagulant therapy that is not well controlled.
- Allergy to local anesthetic or steroids.
- When the iliopsoas bursa is the target, it is important to consider that the iliopsoas bursa can communicate with the joint (and bursa distention can be correlated with joint pathology): the presence of infection must be formally excluded before injecting, even with lab examination of aspirated fluid (prosthetic hip).

Pre- and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. A short course of NSAID post procedure is recommended, if necessary. The patient is advised that symptoms may exacerbate and to have pain relief drugs if needed. It is important to emphasize not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

Equipment:

- Medium-frequency or low-frequency linear-array transducer (or low-frequency curvilinear-array transducer—depending on patient's body habitus and desired field of view)

Syringe:

- 2.5–5 mL syringe

Needle:

- 22 G, 8.9 cm needle (or shorter—6.4 cm—depending on patient's body habitus)

Injected drugs:

- Diagnostic injection: 2–5 mL anesthetics [lidocaine (1%)]
- Therapeutic injection: 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)] usually with 2–5 mL anesthetics [lidocaine (1%)]

Anatomy (Fig. 9.4):

- Iliopsoas muscle is a hip flexor: the main tendon inserts on the lesser trochanter; lateral fibers of the iliacus travel parallel to the iliopsoas tendon and insert directly on the proximal femoral shaft without a tendon.
- If a snapping iliopsoas tendon is suspected, it is recommended to ask the patient to reproduce the snapping manoeuvre during ultrasound examination. If the patient cannot reproduce the snapping, perform ultrasound with the hip moved

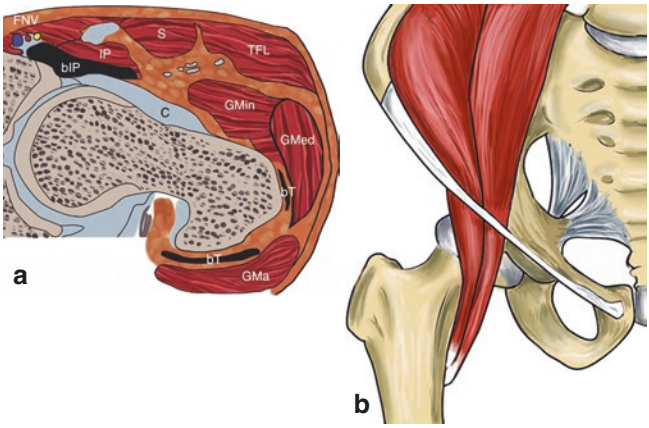

Fig. 9.4 Normal anatomy of the hip. (**a**) Depicts cross section axial: *FNV* femoral neurovascular bundle, *bIP* iliopsoas bursa, *IP* iliopsoas, *S* sartorius, *TFL* tensor fascia lata, *GMin* gluteus minimus, *GMed* gluteus medius, *GMa* gluteus major, *C* capsule, *bT* trochanteric bursae. (**b**) Coronal view demonstrating the insertion of the iliopsoas

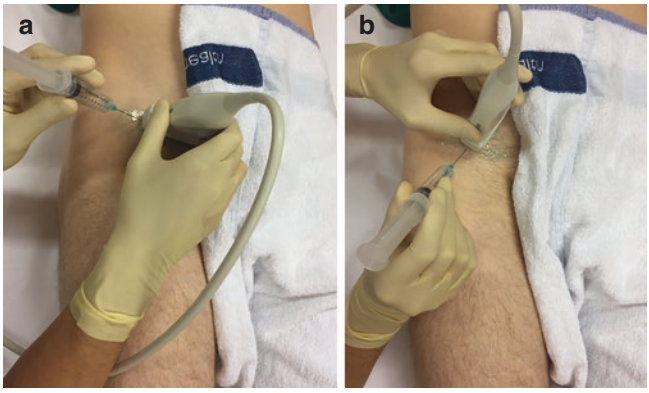

Fig. 9.5 Patient positioning. Lateral to medial approach. (**a**) The needle is advanced under ultrasound guidance, using a lateral to medial approach up to the deep lateral portion of the iliopsoas tendon, following the plane of the transducer. Sagittal approach. (**b**) The transducer is orientated following the axis of the femoral head and neck, and the iliopsoas tendon is identified lateral to the neurovascular bundle

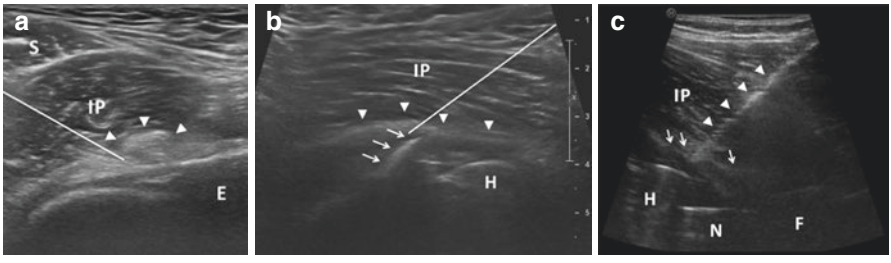

Fig. 9.6 Injection under ultrasound guidance. Lateral to medial approach (**a**) *IP* iliopsoas; arrowheads, iliopsoas tendon; *S* sartorius, *E* iliopectineal eminence; white line, needle path. Sagittal approach (**b**) *H* prosthetic head; *IP* iliopsoas; arrowheads, iliopsoas tendon; arrows, prosthetic cup determining friction; white line, needle path. Sagittal approach (**c**) *IP* iliopsoas; arrow, iliopsoas tendon; arrowheads, needle; *H* prosthetic head; *N* prosthetic neck; *F* femur

from flexion, external rotation, and abduction to full extension, adduction, and internal rotation. Evaluate the bursa (in many cases, bursitis is present) and potential communication with the joint space.

Patient positioning (Fig. 9.5):

- Supine position with the hip in neutral rotation (or slight internal rotation).

Technique (Fig. 9.6):

- The transducer is placed on the transverse plane over the femoral head and then translated superiorly and angled parallel to the inguinal ligament (oblique axial plane).
- The iliopsoas and its tendon are identified. Anisotropy problems can be avoided by toggling the transducer.
- The neurovascular bundle is identified to avoid the more medial and anterior iliac vessels.
- The entrance point of the needle is marked adjacent to the lateral aspect of the probe.
- Aseptic environment is prepared.
- The needle is advanced under ultrasound guidance, using a lateral to medial approach, following the plane of the transducer, up to the deep lateral portion of the iliopsoas tendon—between the deep surface of the iliopsoas tendon and the superficial surface of the ilium at the level of the iliopectineal eminence or alternatively between the iliopsoas tendon and acetabular rim.
- Hydrodissection may be helpful in the identification of the peritenon tissue (where to inject), avoiding inadvertent capsule penetration (joint injection).
- Injection is performed.
- The needle is finally removed.

In the case of hip arthroplasty, the needle is guided by ultrasound up to between the anterior edge of the protruding part of the prosthesis and the iliopsoas tendon.
Alternative approach: anterior approach with the needle oriented sagittally (also called sagittal approach) → the transducer is placed following the orientation of the femoral head and neck, and the iliopsoas tendon is identified laterally to the neurovascular bundle.
Aftercare:

- Slight direct pressure is applied on the puncture site, and after that this is covered with adhesive tape.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure-related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

9.4 Lateral Femoral Cutaneous Nerve Entrapment (Meralgia Paresthetica)

Indications:

- Diagnostic test
- Therapeutic perineural injection
- Neuromodulation (pulsed radiofrequency)

Pre- and post-procedural medication:

- Pre-procedural: antianxiety drugs if needed.
- Post-procedural: local cold. A short course of NSAID post-procedure is recommended, if necessary. The patient is advised that symptoms may exacerbate and to have pain relief drugs if needed. It is important to emphasize not to do this through a prolonged time, so that efficacy of the injection is not masked. The patient is also briefed about potential signs of infection.

Contraindications:

- Suspected infection in the superficial soft tissues
- Immunosuppression
- Coagulopathy/anticoagulant therapy that is not well controlled
- Allergy to local anesthetic or steroids

Equipment:

- High-frequency or medium-frequency linear-array transducer (lower frequency can be useful in patients with increased subcutaneous fat thickness)

Syringe:

- 2.5–5 mL syringe

Needle:

- 22 G, 8.9 cm needle (or shorter—6.4 cm—depending on patient's body habitus)

Injected drugs:

- Diagnostic injection: 2–5 mL anesthetics [lidocaine (1%)]
- Therapeutic injection: 1 mL corticosteroid [triamcinolone acetate (40 mg/mL) or methylprednisolone acetate (20–40 mg/mL)] usually with 2–5 mL anesthetics [lidocaine (1%)]

Anatomy (Fig. 9.7):

- The lateral femoral cutaneous nerve is purely sensory (origin from L2 to L3).
- The nerve goes downward lateral to the psoas muscle and then crosses the iliacus muscle. Near the anterior superior iliac spine, the nerve passes under the lateral aspect of the inguinal ligament and finally innervates the lateral thigh (anterior and posterior branches).
- The distance from the lateral femoral cutaneous nerve to the anterior superior iliac spine at the inguinal ligament is variable, ranging from 1 to 7 cm.
- Meralgia paresthetica is a lateral femoral cutaneous nerve entrapment syndrome. At first treatment is conservative. In nonresponding patients, surgical decompression is considered. Alternatively, other options, such as administration of local anesthetics with steroids around the nerve (and in a few cases neuromodulation), are chosen.

Patient positioning (Fig. 9.8):

- Supine position with the hip in neutral rotation

Technique (Fig. 9.9):

- The anterior iliac spine is palpated and located on ultrasound (hyperechoic profile, with posterior acoustic shadowing).
- The transducer is placed following the anatomic axial plane with the lateral end of the probe over the anterior superior iliac spine.
- The medial end of the transducer is slightly caudally tilted, to find a plane parallel to the inguinal ligament.
- The transducer is moved in a mediocaudal direction while searching for the lateral femoral cutaneous nerve (oval structure).
- The transducer is then moved medially, until the nerve is at the center of the field of view (this opens needle access).
- The skin is marked at the lateral edge of the transducer, to signal the point of entrance for the needle.
- Aseptic environment is prepared.
- The needle is advanced under ultrasound guidance in-plane with the transducer using lateral to medial approach, up to the perineural space.
- Injection is performed.
- The needle is removed.

Aftercare:

- Slight direct pressure is applied on the puncture site, and after that this is covered with adhesive tape.
- Patient should be observed for 15 min.
- Report. A brochure with information about the procedure is desirable: procedure-related symptoms and treatment of these, possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

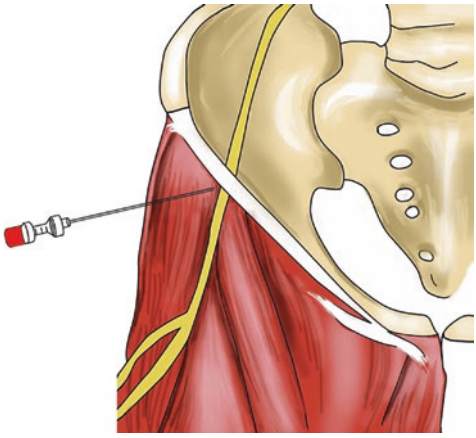

Fig. 9.7 Normal anatomy. Lateral femoral cutaneous nerve at the level of the anterior superior iliac spine. The nerve passes under the lateral aspect of the inguinal ligament and innervates the lateral thigh. The needle is advanced under ultrasound guidance in-plane with the transducer using lateral to medial approach, up to the perineural space

Fig. 9.8 Patient positioning. Supine position with the hip in neutral rotation. The transducer is placed following the anatomic axial plane

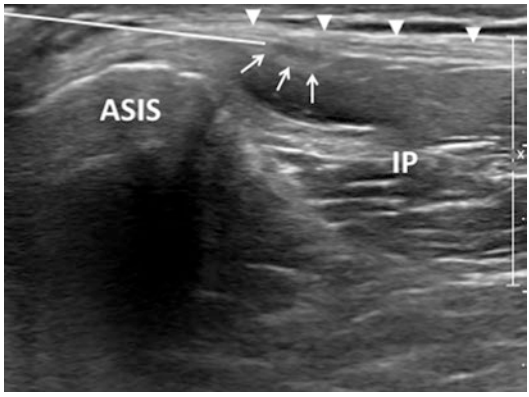

Fig. 9.9 Ultrasound-guided treatment. *ASIS* anterior superior iliac spine, *IP* iliopsoas muscle; *arrowheads*, inguinal ligament; *arrows*, lateral femoral cutaneous nerve; *white line*, needle path

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Knee Procedures: Intra-Articular

10

Miguel Oliveira e Castro

Abbreviations

G Gauge
US Ultrasound

10.1 Knee Joint

Indications:

- Therapeutic injection in degenerative, inflammatory or traumatic arthropathy
- Aspiration for decompression or diagnosis (e.g. rule out septic arthritis or crystal arthropathy)
- Diagnostic local anaesthetic injection
- Diagnostic (CT-MR) arthrography
- Synovial biopsy

Contraindications:

- General contraindications (See Chap. 1)

Pre- and post-procedural medications:

- No medication

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Equipment:

- High-resolution ultrasound equipment with 18-5 MHz linear array transducer

Syringe (depending on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for local anaesthetic
- 20 mL syringe for iodinated contrast
- Pre-filled 20 mL Artirem® syringe
- Pre-filled 2–6 mL hyaluronic acid syringe

Needle:

- 21 G, 50 mm (green) needle

Injection drugs (depending on the indication for the procedure):

- Corticosteroids: 1 mL methylprednisolone 40 mg/mL (e.g. Depo-Medrol®) or 1 mL triamcinolone acetonide 40 mg/mL (e.g. Kenacort®)
- Anaesthetics: 5 mL ropivacaine 2 mg/mL or 5 mL lidocaine 10 mg/mL
- Viscosupplementation: sodium hyaluronate solution (e.g. Suplasyn® 1-Shot 60 mg/6 mL)
- Platelet-rich plasma, 6 mL
- Iodine-based or gadolinium contrast: 10–40 mL iobitridol 300 mg I/mL (Xenetix® 300) or 10–40 mL gadoteric acid (Artirem® 0.0025 mmol/mL)

Anatomy of the region (Fig. 10.1a, b):

- The suprapatellar recess is the largest recess of the knee joint.
- It is located proximal to the patella and quadriceps fat pad, between the quadriceps tendon anteriorly and the femur and prefemoral fat pad posteriorly.

Patient positioning (Fig. 10.2):

- Patient supine with knee in slight flexion
- Comfortable position both for the patient and the operator, dependent on the chosen trajectory and medial or lateral approach

Technique (Fig. 10.3):

- Screen the suprapatellar recess, superolateral and superomedial knee for joint effusion.
- Determine the area of maximal fluid accumulation (lateral or medial), and choose the puncture site accordingly [1], planning a sagittal oblique anterior approach. The proposed needle path should avoid the central part of the quadriceps tendon.

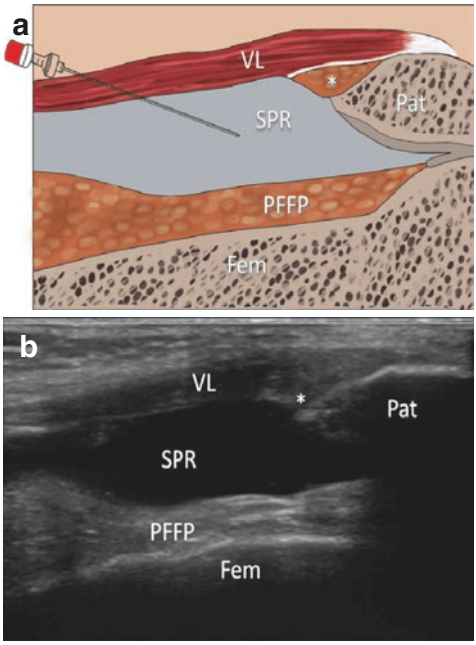

Fig. 10.1 (**a**) Anatomy of the suprapatellar lateral region of the knee. The path of the needle is shown. (**b**) Corresponding sagittal oblique anterolateral US scan. Suprapatellar recess with large effusion (SPR), patella (Pat), femur (Fem), tendon of the vastus lateralis (VL), prefemoral fat pad (PFFP), quadriceps fat pad (*asterisk*)

Fig. 10.2 The patient is positioned supine with the knee in slight flexion. Transducer is placed anteriorly in a sagittal oblique lateral or medial position (lateral in the example shown). The needle is inserted parallel to the long axis of the transducer, from proximal to distal

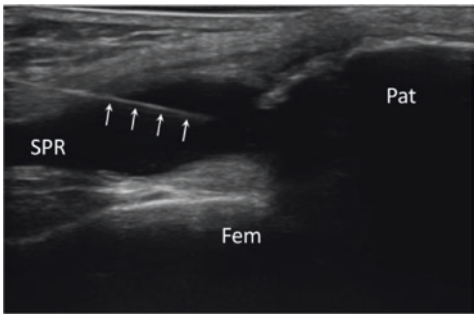

Fig. 10.3 Sagittal oblique anterolateral US scan of the knee, after needle insertion (arrows). Suprapatellar recess (SPR), patella (Pat), femur (Fem)

- An assistant may help accumulate joint fluid at the suprapatellar recess through compression with both hands with crossed thumbs at the infrapatellar area. By this procedure, aspiration and injection of the knee are favoured in cases of faint joint effusion.
- Mark the puncture site, prepare it with antiseptic solution and anaesthetize it.
- Use aseptic conditions (sterile gloves, field, probe cover and gel).
- Freehand technique can be used: under real-time ultrasound guidance using a direct "in view" sagittal oblique paramedian approach, avoiding the central part of the quadriceps tendon, insert the green needle parallel to the long axis of the transducer, from proximal to distal, until the suprapatellar recess is reached.
- Inject a small amount of lidocaine in the suprapatellar recess to ensure appropriate positioning of the needle, particularly if the suprapatellar recess is poorly distended. Free flow of the anaesthetic from the tip of the needle into the joint space can often be perceived and confirms correct positioning [2]. Fluid will "ball up" when the needle is in the soft tissues outside the joint, and adjusting its tip would thus be necessary.
- Once intra-articular location is confirmed, aspiration or injection may be performed, depending on the indication of the procedure.
- Joint volume capacity is 40–50 mL.
- Withdraw the needle, apply pressure, and gently rub the injection area to close the puncture trajectory in order to prevent reflux.

Tips and tricks:

- Place a towel or pillow underneath the knee to maintain it in slight flexion.
- If the suprapatellar recess is well distended, an axial approach (either from medial or lateral) may be used instead of a sagittal oblique approach [2].
- By avoiding excessive compression with the transducer, subtle effusions can be visualized.
- If a large effusion is present, aspirate it before performing the injection. The syringe may be exchanged for an empty one if necessary, keeping the needle in place. In case of huge fluid amounts, large syringes (50 mL) are more appropriate.
- If viscous fluid is going to be injected (e.g. hyaluronic acid) or aspirated (e.g. heterogeneous effusion), consider using a larger gauge needle (16–20 G) [3].

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- 24h rest is advised.
- Patient should receive a brochure with information on the procedure, procedure-related symptoms and aftercare, treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

10.2 Baker's Cyst

Indications:

- Therapeutic aspiration in posterior knee pain or discomfort attributable to a Baker's cyst
- Diagnostic aspiration (fluid analysis)

Contraindications:

- General contraindications (See Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound equipment with 18-5 MHz linear array transducer

Syringe:

- 2 mL syringe for corticosteroid
- 5 mL syringe for local anaesthetic
- 20 mL syringe for aspiration

Needle:

- 20 G, 40 mm (yellow) needle

Injection drugs:

- Corticosteroids: 1 mL methylprednisolone 40 mg/mL (Depo-Medrol®) or 1 mL triamcinolone acetonide 40 mg/mL (Kenacort®)
- Anaesthetics: 5 mL lidocaine 10 mg/mL

Anatomy of the region (Fig. 10.4a–d):

- A popliteal or Baker's cyst represents distension of the semimembranosus-medial gastrocnemius bursa that is physiologically connected to the knee joint. It arises in the popliteal fossa, between the medial head of the gastrocnemius, laterally, and the semimembranosus tendon, medially.
- Communication of the cyst with the knee joint at this level can sometimes be identified on transverse US scans.

Patient positioning (Fig. 10.5):

- Patient prone with knee in extension
- Comfortable position both for the patient and the operator

Technique (Fig. 10.6a, b):

- Screen the posteromedial popliteal fossa, and choose a puncture site at the distal end of the cyst, planning a sagittal needle approach.
- Mark the puncture site, prepare it with antiseptic solution, and anaesthetize it.
- Use aseptic conditions (sterile gloves, field, probe cover and gel).
- Under real-time ultrasound guidance with a direct "in view" sagittal approach, insert the yellow needle parallel to the long axis of the transducer, from distal to proximal, until it reaches the cyst (Fig. 10.6a).
- Attach a 20 mL syringe to the yellow needle and aspirate the content of the cyst. The syringe may be exchanged for an empty one if necessary, keeping the needle in place. In huge cysts, large volume syringes (50 mL) are more appropriate, reducing the aspiration of air during the change of syringes.
- When the cyst is empty or if it is not possible to aspirate any further fluid, exchange syringes and inject the corticosteroid into the cyst (Fig. 10.6b).
- Withdraw the needle, apply pressure, and rub the area to prevent reflux and reduce the risk of intra- and peribursal bleeding.

Tips and tricks:

- An axial approach (either from medial or lateral) may be used instead of a sagittal approach [4].
- The content of the cyst may be very viscous and difficult to aspirate. If so, a 18 or even 16 G needle may be used instead [3]. Also, strong traction on the plunger and continuous vacuum in the syringe are helpful to achieve a successful aspiration.
- To avoid operator fatigue, particularly if the content of the cyst is highly viscous, a second operator might be useful to create and maintain negative pressure within the syringe. Alternatively, a plastic needle cover may be used to maintain traction on the syringe plunger (Fig. 10.6c) [5].
- If the cyst is septated and loculated, several punctures targeting different locations may be necessary.
- A small amount of residual fluid left in the cyst at the end of the aspiration may help confirm the intracystic position of the needle and facilitate steroid injection.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.

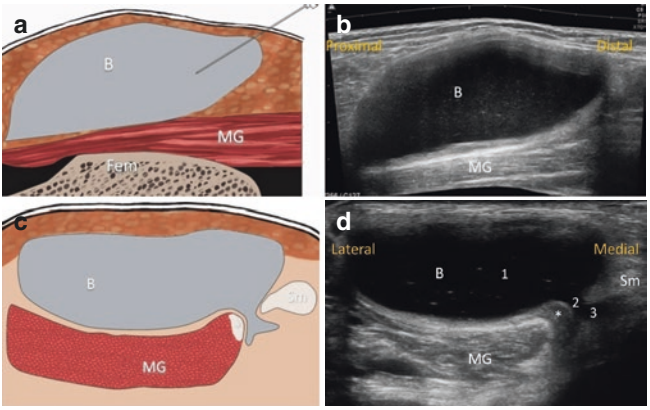

Fig. 10.4 (**a**) Anatomy of the posteromedial popliteal fossa in sagittal view. A large Baker's cyst is depicted. The path of the needle is shown. (**b**) Corresponding extended field-of-view sagittal US scan shows anechoic distension of the semimembranosus-medial gastrocnemius bursa (Baker's cyst). (**c**) Anatomy of the posteromedial popliteal fossa in transverse view. A large Baker's cyst is depicted. (**d**) Corresponding transverse US scan. The neck (2) of the Baker's cyst connects the base (3) to the body (1) of the cyst; Baker's cyst (B), medial gastrocnemius (MG) muscle and tendon (*asterisk*), semimembranosus tendon (Sm), femur (Fem)

Fig. 10.5 The patient is positioned prone with the knee in extension. Transducer is placed on the posteromedial popliteal fossa. The needle is inserted parallel to the long axis of the transducer, from distal to proximal

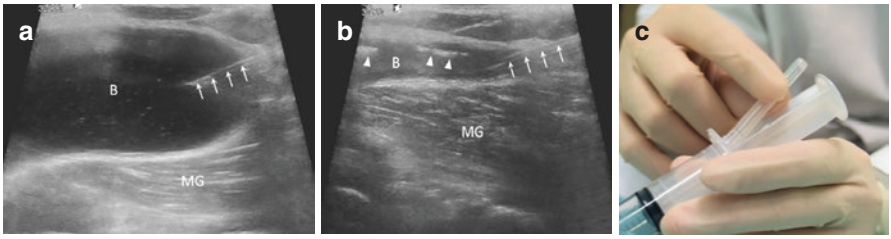

Fig. 10.6 (**a**) Sagittal US scan of a Baker's cyst after needle insertion (arrows). (**b**) Sagittal US scan of the posteromedial knee, after aspiration of the cyst's content and steroid injection. Needle (*arrows*) and air bubbles (*arrowheads*) are visible. Baker's cyst (B), medial gastrocnemius (MG). (**c**) After the tip of the needle is inside the cyst (not shown in the photograph) and the syringe plunger is pulled back, a continuous vacuum system can be created by inserting the plastic cover of a needle in one of the gutters of the plunger, maintaining it open

- Patient should receive a brochure with information on the procedure, aftercare, procedure-related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.

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Knee Procedures: Extra-Articular

11

Elena Drakonaki

Abbreviations

PNT Percutaneous needle tenotomy
PRP Platelet-rich plasma

11.1 PNT (Percutaneous Needle Tenotomy) Patellar Tendon

Indication:

- Therapeutic procedure in degenerative or overuse tendinopathy [1, 2]

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post procedural medications:

- No medication

Equipment:

- High-resolution US scanner with linear high-frequency transducer (5–17 MHz) and Doppler imaging [1, 2].

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Syringe:

- 5 mL syringe for local anaesthetic

Needle:

- 21 G, 50 mm green needle

Injection drugs:

- 5 mL local anaesthetic (lidocaine 1%).
- Other injectants (e.g. autologous blood or PRP) may occasionally be used.

Anatomy of the region (Fig. 11.1):

- The patella tendon (ligament) originates from the apex and adjoining margins of the patella, and it inserts on the tibial tuberosity. The superficial fibres cross over the patella in continuity with the superficial fibres of quadriceps femoris tendon.

Patient positioning (Fig. 11.2):

- Patient lying in prone on the examination table with a roll of paper or pillow supporting the knee in about 30° of flexion [1–3].

Technique (Fig. 11.3):

- Aseptic technique.
- The transducer is placed on the patella tendon at the proximal knee, and the patella tendon is scanned in short and long axes using B-mode and Doppler imaging. After locating the target lesion (hypoechoic area with neovascularity), the transducer is turned axially to the tendon with the target lesion in view.
- Using aseptic technique, the needle is inserted parallel to the long axis of the transducer (axially to the patella tendon).

Local anaesthetic is used superficially to the tendon to provide pain relief.

Dry needling (PNT, percutaneous needle tenotomy) of the tendon is performed under continuous ultrasound control by perforating the skin once and then inserting the needle into the tendon several times (up to ten) to perform multiple fenestrations at the area of tendon neovascularity. During the procedure, the transducer may need to be realigned in order to ensure continuous visualisation of the needle and treatment of the whole target area [1–3].

After dry needling, PRP or autologous blood may be injected at the area of the tendinopathy (depending on the treatment protocol) [1, 2]. Needle is retracted, and pressure is applied.

- An alternative approach is inserting the needle into the patellar tendon parallel to the fibres, from distal to proximal, targeting the bone/tendon interface and twisting the needle tip into the periosteum (percutaneous needle scraping) [2].

Fig. 11.1 Photo of the dry-needling procedure of the patellar tendon. The needle is inserted parallel to the long axis of the transducer axially to the patellar tendon

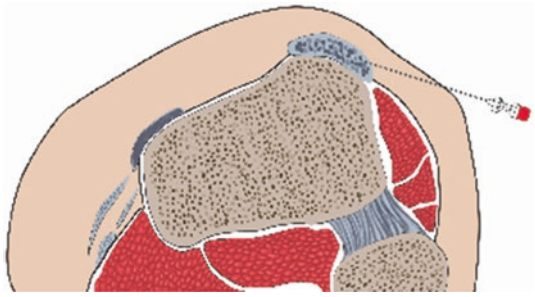

Fig. 11.2 Anatomic illustration of the patellar tendon. The needle is inserted axially to the patellar tendon

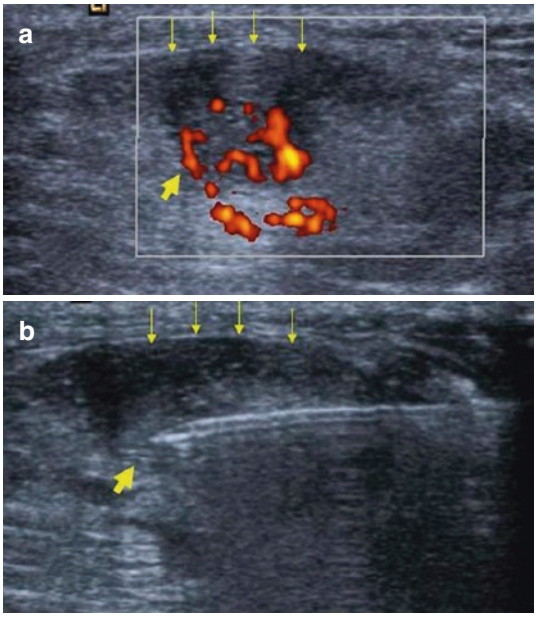

Fig. 11.3 (**a, b**) US images (Doppler and B-mode, respectively) of an area of patellar tendon tendinopathy. (**a**) The tendon (*thin arrows*) is imaged in short axis, and the target area (*thick arrow*) corresponds to an area of neovascularity. (**b**) The needle is inserted axially to the tendon into the target area, and dry needling is performed by multiple punctures into the tendon

Aftercare:

- Adhesive plaster at the puncture site.
- The patient is advised to rest from training and athletic competition for 7–14 days and then follow a physiotherapy regimen to gradually introduce sport activities.

Procedure-related symptoms and treatment:

- Transient pain at the puncture site could be treated with cold compression.

11.2 Pes Anserinus Bursa

Indication:

- Therapeutic procedure in bursitis secondary to overuse or inflammatory arthritis

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post procedural medications:

- No medication

Equipment:

- High-resolution US scanner with linear high-frequency transducer (5–17 MHz) and Doppler imaging [1, 2].

Syringe:

- 10 mL syringe to aspirate (if needed)
- 5 mL syringe for steroid and anaesthetic mixture

Needle:

- 21 G, 50 mm green needle

Injection drugs:

- 1.5 mL lidocaine 1% (or long-lasting anaesthetic like *ropivacaine*)
- 1 mL methylprednisolone acetate (Depo-Medrol 40 mg/mL)

Anatomy of the region (Fig. 11.4):

- The pes anserinus is the anatomic term used to describe the conjoined insertion of the tendons of sartorius, gracilis and semitendinosus into the anteromedial proximal tibia. The sartorius is the most superficial of the three tendons; however, the

Fig. 11.4 Anatomic illustration of the pes anserinus tendons. The bursa lies under or around the conjoined tendon insertion to the medial tibia

Fig. 11.5 Photo of the injection of steroid/anaesthetic into the pes anserinus bursa. The needle is inserted parallel to the long axis of the transducer into the bursa trying to avoid puncturing the tendons

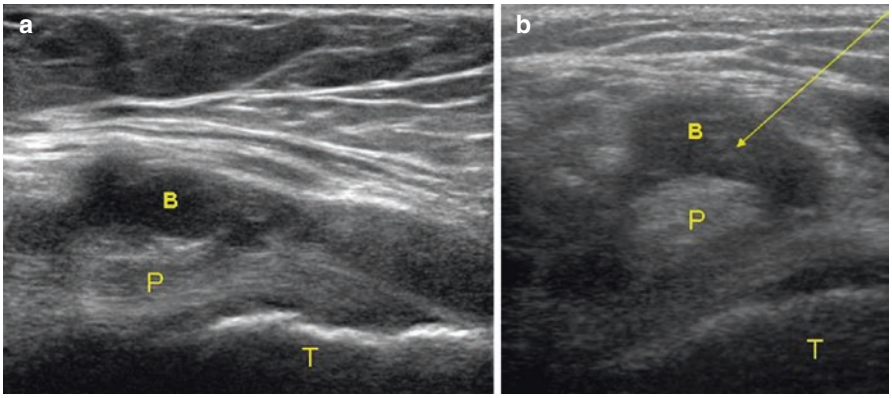

Fig. 11.6 (**a**, **b**) US images (longitudinal and axial, respectively) of the pes anserinus tendons surrounded by the distended bursa (pes anserinus bursitis). The *green arrow* corresponds to the needle tract which is inserted into the bursa, avoiding the tendons. *B* bursa, *P* pes anserinus, *T* tendon

individual tendons cannot be distinguished as separate entities at their distal insertion. Just below the pes anserinus tendons, there is a bursa, which, when inflamed, results in pain and local tenderness especially when climbing upstairs (bursitis).

Patient positioning (Fig. 11.5):

- Patient lying in prone with the hip slightly externally rotated and the knee slightly flexed (supported by a roll of paper or pillow) to allow access to the medial area of the knee

Technique (Fig. 11.6):

- Aseptic technique.
- The transducer is placed on the medial of the knee to identify the common insertion of the pes anserinus tendons in long axis. The distended bursa is identified as a hypoechoic or anechoic fluid collection over or around the pes anserinus tendons.
- Using aseptic technique, the needle is inserted parallel to the long axis of the transducer into the bursa trying to avoid puncturing the tendons.
- The mixture of local anaesthetic and steroid is injected under continuous ultrasound guidance into the bursa. Before the injection, aspiration of the bursa fluid may be performed (depending in the quantity of the fluid) [1, 2].
- Needle is retracted, and pressure is applied.

Aftercare:

- Adhesive tape at the puncture site.
- The patient is advised to rest from excessive activity and avoid climbing stairs for about a week.

Procedure-related symptoms and treatment:

- Transient pain at the puncture site could be treated with cold compression.

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Intra-Articular Ankle Procedures

12

Luca Maria Sconfienza and Davide Orlandi

Abbreviations

CT	Computed tomography
G	Gauge
MR	Magnetic resonance
NSAIDs	Non-steroidal anti-inflammatory drugs

12.1 Tibio-Talar Joint

US Guidance.
Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1).

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Pre- and post-procedural medications:

- None

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 10 mL syringe for iodinated contrast for CT arthrography
- Pre-packed 20 mL paramagnetic contrast syringe for MR arthrography
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle

Injection drugs (depend on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate) 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL bupivacaine 5 or 10 mg/mL
- Hyaluronans: 2 mL, low or medium molecular weight
- Contrast: 1–10 mL dilute iodinated contrast (for CT arthrography); 5–10 mL paramagnetic contrast 0.0025 mmol/mL (for MR arthrography)

Ultrasound anatomy of the region (Fig. 12.1):

- The anterior tibio-talar recess can be assessed performing a longitudinal scan on the anterior aspect of the ankle, between the extensor tendons.
- The anterior tibio-talar recess appears like a triangular hyperechoic area, when not distended by fluid. A thin layer of cartilage of the talus can be also seen.

Patient positioning:

- The patient lays supine on the table with the knee flexed at about 90° and with the foot slightly intra-rotated.

Techniques (Figs. 12.1 and 12.2).

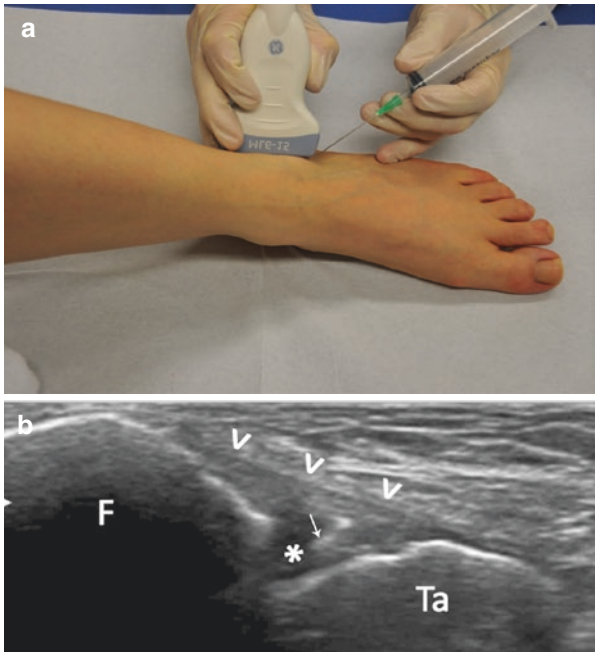

Fig. 12.1 US-guided intra-articular ankle injection using a lateral out-of-plane trans-ligamentous approach. (**a**) Image of the procedure. (**b**) US scan. *F* fibula, *Ta* talus, *asterisk* articular fluid, *arrowheads* anterior talo-fibular ligament, *arrow* needle tip

Caudo-cranial approach:

- Prepare sterile field of the region.
- Centre the articular joint in the middle of the screen.
- Insert the 21 G needle laterally to the distal side of the probe with a caudal-cranial direction (around 30°).
- Once the joint space is reached, inject a small amount of anaesthetic to confirm the correct intra-articular positioning of the needle tip (optional).
- The intra-articular injection may determine a distension of the joint recess according to the amount of fluid injected.

Coaxial out-of-plane approach:

- Centre the articular joint space in the middle of the screen.
- Insert the 21 G needle vertically at the level of the middle of the probe, with a very slight lateral-to-medial angulation (about 5°) to reach the joint space visualized in the scanning plane.
- Along its path, the needle tip is visualized as a hyperechoic dot.
- Once the joint space is reached, inject a small amount of anaesthetic to confirm the correct intra-articular positioning of the needle tip (optional).

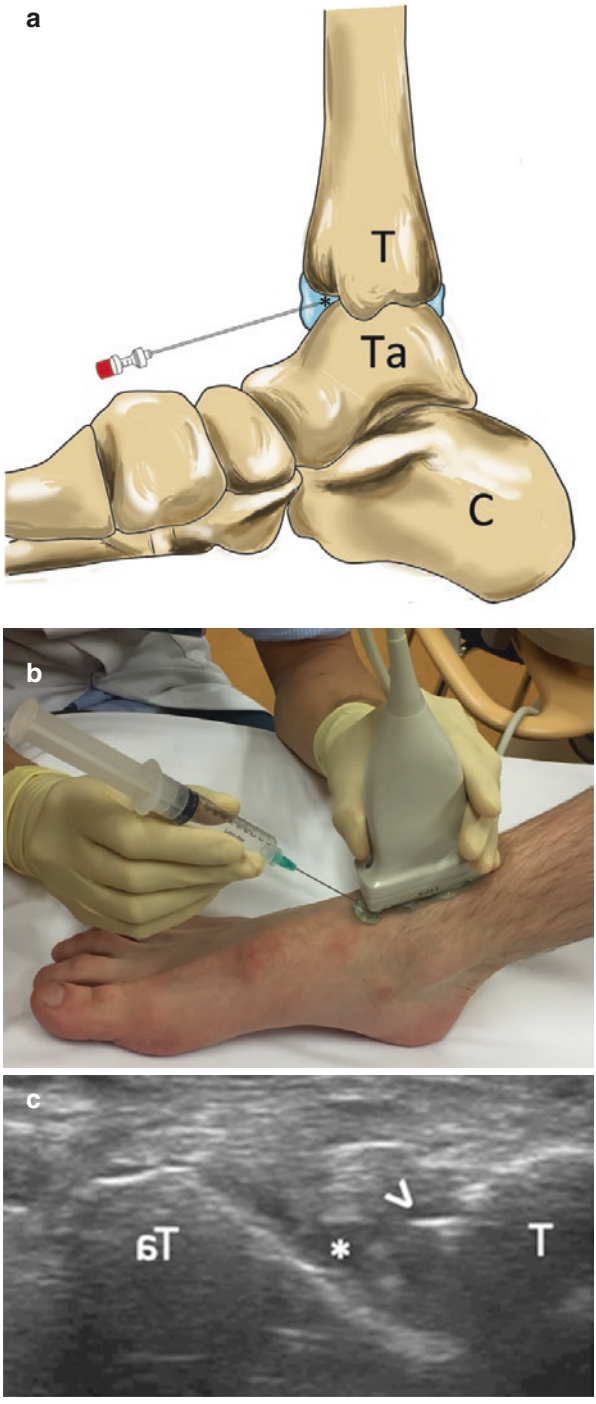

Fig. 12.2 US-guided intra-articular ankle injection using anterior longitudinal out-of-plane caudo-cranial approach. (**a**) Scheme of the procedure, (**b**) image, and (**c**) US scan. *T* tibia, *Ta* talus, *C* calcaneus, *asterisk* articular fluid, *arrowhead* needle tip

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral NSAIDs.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up controls.

12.2 Subtalar Joint

Ultrasound Guidance.
Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1).

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 20 G, 90 mm spinal needle

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate) 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL bupivacaine 5 mg/mL
- Hyaluronans: 2 mL low or medium molecular weight

Ultrasound anatomy of the region:

- The subtalar joint is demonstrated by proximal to distal, lateral to medial oblique scan performed few millimetres above the fibular head.

Patient positioning:

- The patient lies prone with the legs extended and the feet projecting over the examination table end.

Techniques (Fig. 12.3).
Cranio-caudal approach:

- Prepare sterile field of the region.
- Centre the articular joint in the middle of the screen.
- Insert the needle with an in-plane cranio-caudal approach to reach the joint space.
- Once the joint space is reached, inject a small amount of anaesthetic to confirm the correct intra-articular positioning of the needle tip (optional).
- The intra-articular injection may determine a distension of the joint recess according to the amount of fluid injected.
- If a joint ganglion has to be drained, insert the needle tip inside the ganglion walls.
- Sometimes the ganglion content is very dense and drainage could be extremely challenging.
- In these cases, the use of a large-bore needles or a biopsy handle may also be used to obtain a more effective vacuum effect.
- When the ganglion is completely drained, inject a small amount of steroid (1 mL) and local anaesthetic (1 mL).

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral NSAIDs.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up controls.

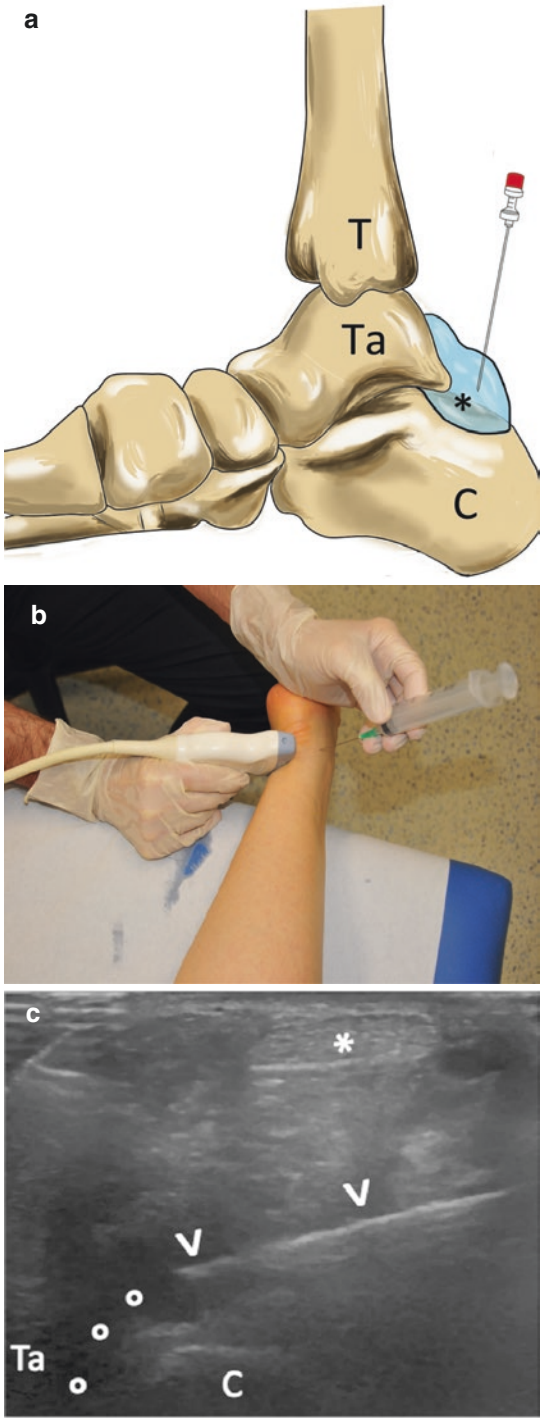

Fig. 12.3 US-guided injection of subtalar joint on in-plane short oblique axis. (**a**) Scheme of the procedure, (**b**) image, and (**c**) US scan. *Ta* talus, *C* calcaneus, *asterisk* achilles tendon, *circles* distended joint space, *arrowheads* needle

12.3 Talonavicular Joint

Ultrasound Guidance.
Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindication:

- General contraindications (see Chap. 1).

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- Pre-packed 2 mL hyaluronans syringe

Needle:

- 21 G, 50 mm green needle

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate) 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL bupivacaine 5 mg/mL
- Hyaluronans: 2 mL low or medium molecular weight

Ultrasound anatomy of the region:

- The dorsal talonavicular recess can be assessed performing a longitudinal scan on the proximal antero-medial aspect of the midfoot.
- The dorsal talonavicular recess appears like a triangular hyperechoic area, when not distended by fluid.

Patient positioning:

- The patient lies supine on the table with the knee flexed at about 90°, with the foot slightly intra-rotated.

Technique:
Coaxial out-of-plane approach:

- Centre the articular joint space in the middle of the screen.
- Insert the 21 G needle vertically at the level of the middle of the probe, with a very slight lateral-to-medial angulation (about 5°) to reach the joint space visualized in the scanning plane.
- Along its path, the needle tip is visualized as a hyperechoic dot.
- Once the joint space is reached, inject a small amount of anaesthetic to confirm the correct intra-articular positioning of the needle tip (optional).

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral NSAIDs.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up controls.

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Ankle and Foot Extra-Articular Procedures

13

Luca Maria Sconfienza and Davide Orlandi

Abbreviations

G Gauge
PRP Platelet-rich plasma

13.1 Ultrasound-Guided Treatment of Achilles Tendon

Indications:

- Therapeutic injection in degenerative or inflammatory or traumatic tendinopathies
- Peritendinitis without significant sign of tendon degeneration
  - Simple steroid injection in the peritenonium
  - High-volume injection (injection of 30–40 mL of a saline and local anaesthetic solution in the peritenonium)

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- Insertional and pre-insertional overload tendinopathy of the Achilles tendon
  - Dry-needling and steroid injection
  - Dry-needling + PRP injection

Contraindications:

- General contraindications (see Chap. 1).
- Please note that dry-needling procedures are contraindicated in case of traumatic lesions of the Achilles tendon.

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 4 mL syringe for PRP (concentration at least 5×)

Needle:

- 21 G, 50 mm green needle

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate); 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL bupivacaine 5 mg/mL
- PRP: 4 mL (concentration at least 5×)

Ultrasound anatomy of the region:

- Visualize the Achilles tendon with a longitudinal scan.
- Place the proximal portion of the probe on the hyperechoic bony line of the calcaneus, while the distal part of the probe is aligned according to the Achilles tendon.
- Then swipe the probe in order to detect the most affected site.
- Rotate the probe 90° to evaluate Achilles tendon on its short axis.

Patient positioning:

- The patient lies prone with the ankle hanging out of the bed.

Technique:
Longitudinal approach (Fig. 13.1)

- Centre the Achilles tendon in the middle of the screen.
- Insert the 21 G needle with an in-plane approach in a distal-proximal direction.
- Inject anaesthetic along the tendon path in the peritendinous soft tissues.
- Then perform a series of 15–20 repeated punctures (dry-needling) on the most degenerated portion of the tendon in order to obtain a mild bleeding.
- At this point it is possible to inject a small amount of autologous blood or PRP inside the most affected tendon fibres in order to enhance the effects of the procedure.

Lateral approach (Fig. 13.2)

- Insert the 21 G needle with an in-plane approach in a medial to lateral direction.
- With this approach it is easier to detect small degenerative changes inside the tendon and to treat them selectively.
- The dry-needling procedure is performed as above.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral painkillers.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up controls.

13.2 Deep Retrocalcaneal Bursitis

Ultrasound Guidance.
Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or traumatic arthropathies

Contraindications:

- General contraindications (see Chap. 1)

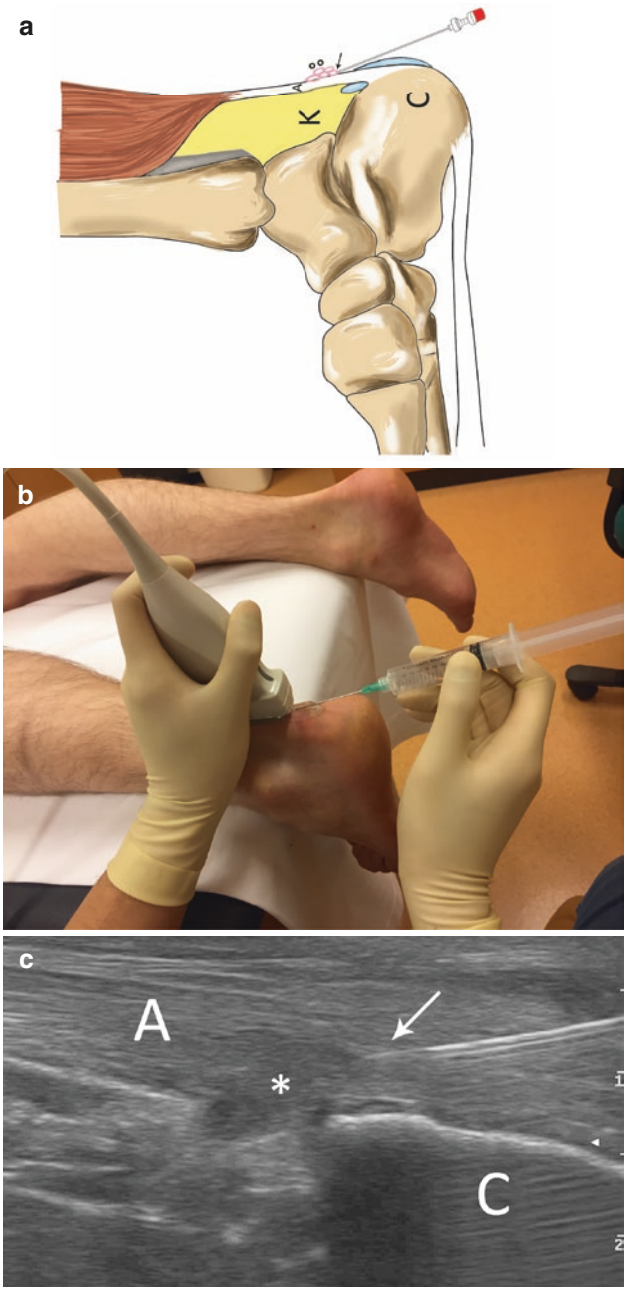

Fig. 13.1 Ultrasound-guided treatment of Achilles tendinopathy on a long-axis scan. (**a**) Scheme of the procedure, (**b**) image of the patient, and (**c**) Ultrasound scan. *A* Achilles tendon, *C* calcaneus, *arrow* needle tip, *asterisk* intratendinous degenerated area

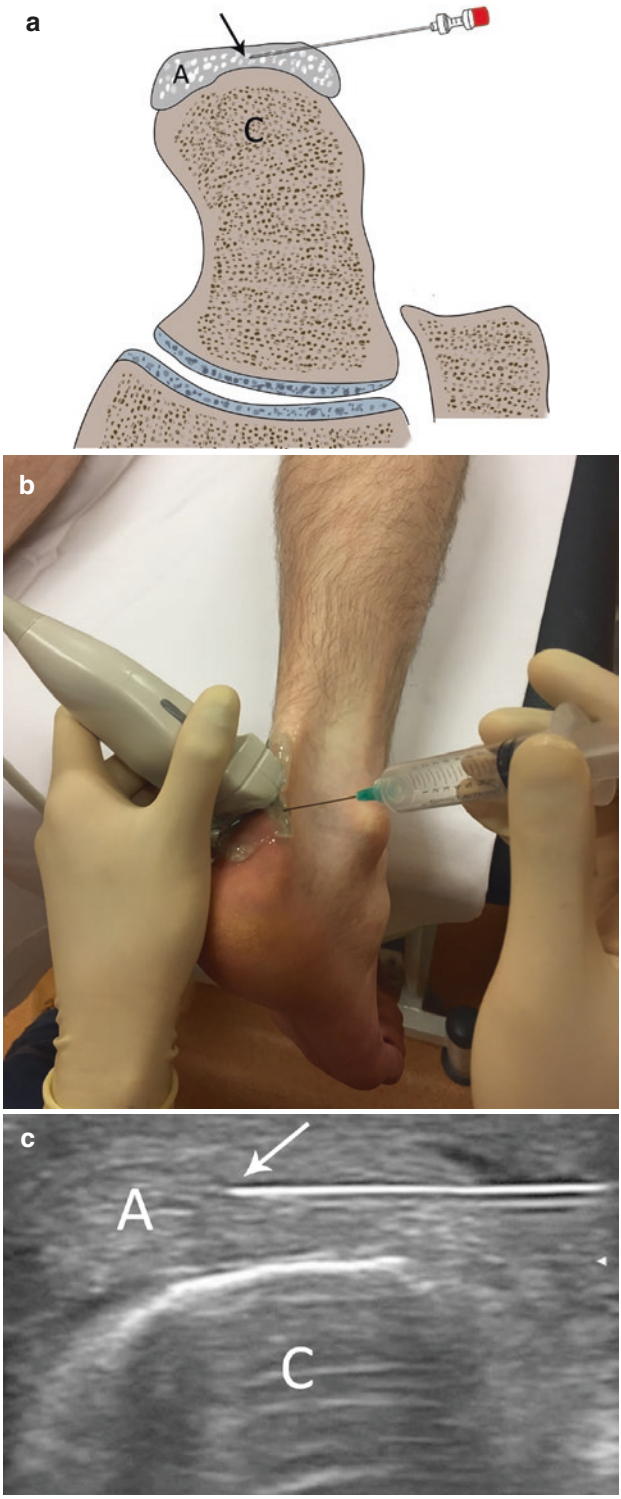

Fig. 13.2 Ultrasound-guided treatment of Achilles tendinopathy on a short-axis, in-plane scan; peritendinous steroid injection procedure scheme. (**a**) Scheme of the procedure, (**b**) image of the patient, and (**c**) Ultrasound scan. *A* Achilles tendon, *C* calcaneus, *arrow* needle tip

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 5 mL syringe for drainage if needed
- Prepacked 2 mL hyaluronan syringe

Needle:

- 23 G, 50 mm needle

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate); 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL bupivacaine 5 mg/mL
- Hyaluronans: 2 mL low or medium molecular weight

Ultrasound anatomy of the region:

- The deep retrocalcaneal bursa is first demonstrated by a longitudinal scan performed on the long axis of the Achilles tendon. Then the probe is rotated by 90° and a short-axis scan is performed.

Patient positioning:

- The patient lies prone with the legs extended and the feet projecting over the examination table end.

Technique (Fig. 13.3):
Longitudinal approach

- Prepare sterile field of the region.
- Centre the Achilles tendon and the underlying bursa in the middle of the screen.

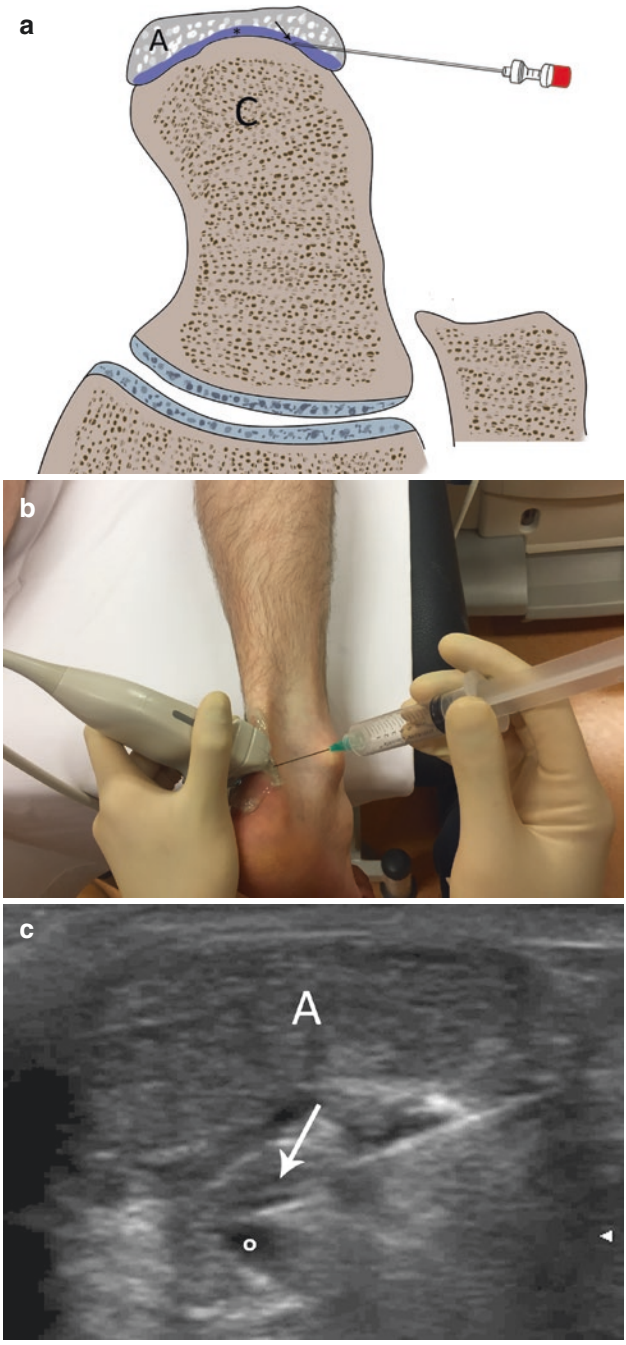

Fig. 13.3 Ultrasound-guided treatment of deep retrocalcaneal bursitis on a short oblique in-plane scan. (**a**) Scheme of the procedure, (**b**) image of the patient, and (**c**) US scan. *A* Achilles tendon, *Ta* talus, *C* calcaneus, *arrow* needle, *circle* distended bursa

- Insert the 23 G needle with an in-plane lateral to medial approach to reach the bursal space.
- When the needle tip is inserted inside the bursa, try to aspirate the eventual fluid distension until it is completely drained.
- When the bursa is drained, inject a small amount of steroid (1 mL) and local anaesthetic (1 mL) inside its walls.
- A viscosupplementation drug can also be used together with the steroid to reduce friction between bursal walls.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral painkillers.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up controls.

13.3 Ultrasound-Guided Treatment of Plantar Fasciitis

Indication:

- Therapeutic injection in degenerative or inflammatory insertional or pre-insertional overload fasciopathy of the medial or lateral branch of the plantar aponeurosis
  - Dry-needling and steroid injection
  - Dry-needling + PRP injection

Contraindications:

- General contraindications (see Chap. 1).
- Please note that dry-needling procedures are contraindicated in case of traumatic lesions of the plantar aponeurosis.

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 5 mL syringe for anaesthetic
- 4 mL syringe for PRP (concentration at least 5×)

Needle:

- 25 G, 50 mm needle (for local anaesthesia)
- 20 G spinal needle (for dry-needling procedure)

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate); 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 5 mL bupivacaine 5 mg/mL
- PRP: 4 mL (concentration at least 5×)

Ultrasound anatomy of the region:

- Visualize the plantar fascia with a longitudinal US scan performed on the plantar aspect of the calcaneus.
- Rotate the probe 90° to evaluate the plantar fascia on its short axis.
- When the plantar aponeurosis is seen on an axial scan, swipe the probe caudally in order to detect the most affected site.

Patient positioning:

- The patient lies supine or prone with the foot hanging out of the bed with the ankle flexed 90°.

Technique (Fig. 13.4):
Longitudinal approach

- Centre the plantar aponeurosis in the middle of the screen on its short axis.
- Insert the 25 G needle in the medial aspect of the heel with an in-plane approach, in a medial-lateral direction.
- Inject anaesthetic along the needle path, in the perifascial soft tissues and in the degenerated portion of the plantar aponeurosis (PA).
- Then retract the 25 G needle and insert a 20 G spinal needle in the medial aspect of the heel with an in-plane approach, in a medial-lateral direction.

Fig. 13.4 Ultrasound-guided treatment of plantar fasciitis on a short-axis in-plane scan. (**a**) Scheme of the procedure, (**b**) image of the procedure, and (**c**) US scan. *F* plantar fat pat, *asterisk* plantar fascia, *C* calcaneus, *arrow* needle tip

- Now perform a series of 15–20 repeated punctures (dry-needling) on the most degenerated portion of the aponeurosis hitting also the periosteum of the infero-medial calcaneal tuberosity in order to obtain a mild bleeding.
- At this point it is possible to inject a small amount of autologous blood or PRP inside the aponeurosis in order to enhance the effects of the procedure.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral painkillers.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up controls.

13.4 Ultrasound-Guided Treatment of Morton's Neuroma

Indication:

- Forefoot pain caused by Morton's neuroma or intermetatarsal bursitis

Contraindications:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound system with superficial, high-resolution linear transducer

Syringe (depends on the indication for the procedure):

- 2 mL syringe for corticosteroid
- 2 mL syringe for anaesthetic

Needle:

- 25 G, 50 mm needle

Injection drugs (depends on the indication for the procedure):

- Corticosteroids: 1 mL Depo-Medrol (methylprednisolone acetate); 40 mg/mL or 1 mL Kenacort (triamcinolone acetonide) 40 mg/mL
- Anaesthetic: 1 mL bupivacaine 5 mg/mL
- Alcoholic solution: 1 mL bupivacaine 5 mg/mL + 2 mL ethylic alcohol 95%

Ultrasound anatomy of the region:

- The intermetatarsal space can be assessed using different US approaches.
- The probe can be placed on axial scan over the plantar aspect of the metatarsal heads to visualize the pertinent intermetatarsal space on its short axis.
- Then rotate the probe by 90° in order to assess the intermetatarsal space on its long axis.
- Moreover the probe could be placed between the two fingers with sagittal orientation in order to assess the intermetatarsal space on its sagittal axis.

Patient positioning:

- The patient lies supine on the bed with the ankle flexed 90°.

Technique (Fig. 13.5):
Coaxial approach

- Centre the affected intermetatarsal space in the middle of the screen on its short axis.
- Insert the 25 G needle with coaxial (out-plane) approach. The needle tip will be seen as a small bright dot.

Longitudinal approach

- Centre the affected intermetatarsal space in the middle of the screen on its long axis.
- Insert the 25 G needle between the two fingers with longitudinal (in-plane) approach using a mild plantar to dorsal needle orientation.

Sagittal interdigital approach

- With the ultrasound probe positioned between the two fingers, insert the 25 G needle with a lateral (in-plane) approach from the dorsum of the foot. This latter approach allows for a better visualization of needle track.
- Inject anaesthetic along the needle path, inside the intermetatarsal bursa and inside the neuroma.
- If only intermetatarsal bursitis is present, insert the needle tip inside the bursa and inject 1 mL of anaesthetic and 1 mL of long-lasting steroid within.

Fig. 13.5 Ultrasound-guided treatment of Morton's neuroma with coaxial out-of-plane approach. (**a**) Scheme of the procedure, (**b**) position of the patient, and (**c**) US scan. *M* metatarsal heads, *T* tendons, *S* sole of the foot, *arrow* needle tip, *asterisk* neuroma

- Morton's neuroma: there is no consensus regarding which is the best treatment for this pathology.

We initially prefer to use a mixture of 2 + 1 mL of anaesthetic and steroid injected around the neuroma.

- In case of treatment failure after 1 month, we perform a second procedure using a solution of 1 mL of anaesthetic and 1 mL of 95% ethylic alcohol inside the neuroma.
- Please accurately follow the injection in order to avoid significant spreading of alcoholic solution in the surrounding soft tissues.
- Note that alcohol injection is particularly painful, so a generous amount of anaesthesia should be injected before.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Pain may occur after treatment and is managed with oral NSAIDs.
- The patient should receive information brochure with details about procedure, procedure symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up controls.

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Sacroiliac Joint

14

Dimitrios K. Filippiadis and Alexis Kelekis

Abbreviations

BMI	Body mass index
CT	Computed tomography
MRI	Magnetic resonance imaging
P-A	Posterior-anterior
SIJ	Sacroiliac joint

14.1 Sacroiliac Joint

Indication:

- Symptomatic patient (uni- or bilateral low back or groin pain without neuralgia, sitting intolerance, low back or groin numbness/tingling) with positive clinical examination with or without positive imaging findings
- Diagnostic aspiration
- Diagnostic injection
- Therapeutic infiltration in degenerative or inflammatory sacroiliitis

Contraindication:

- Coagulation pathology
- Local or systemic infection
- Patient unwilling to consent to the procedure

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Pre- and Post-procedural Medications:

- No medication

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- Ultrasound equipment with convex or linear probe depending on the patient's body mass index (BMI)
- Computed tomography (CT) suite

Syringe and Needle:

- 2.5–5 mL Luer-lock syringe for injected mixture
- 2.5–5 mL Luer-lock syringe for iodinated contrast medium
- 5–10 mL syringe for local anaesthesia (optional)
- 22 G, 70–90 mm spinal needle with Quincke type point
- Extension set with three cocks connecting of the needle and syringes

Injection Drugs:

- Long-acting corticosteroid (triamcinolone acetate, cortivazol, betamethasone injectable suspension, methylprednisolone suspension); recommended dose is up to 50 mg of triamcinolone acetate or 80 mg of methylprednisolone.
- Local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%); use local anaesthetics free of paraben or phenol in order to avoid steroid flocculation.
- 1–3 mL non-ionic iodinated myelographic contrast medium; in case of allergy, use a gadolinium contrast medium.
- Injected mixture for diagnostic purpose contains:
  - 2.5 mL local anaesthetic
- Injected mixture for therapeutic purpose contains:
  - 1–1.5 mL long-acting corticosteroid
  - 1–1.5 mL local anaesthetic

Anatomy of the Region:

- Sacroiliac diarthrosis between the sacral and iliac bones consists of two parts: a synovial cartilaginous part located inferiorly and a fibrous part located postero-superiorly (Fig. 14.1).
- The joint is innervated by ventral rami of L4 and L5 nerves, dorsal rami of S1 to S4 nerves and the superior gluteal nerve.
- The sacral hyaline cartilage is thicker than the iliac fibrocartilage.

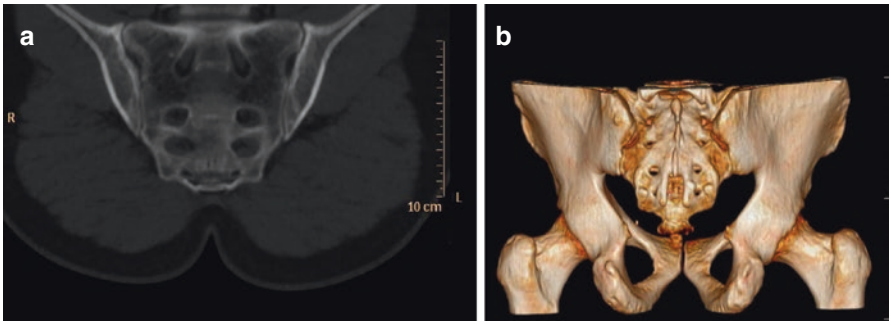

Fig. 14.1 (**a**) Coronal CT reconstruction illustrating bilateral SIJ. (**b**) 3D-CT reconstructions illustrating complexity of the SIJ axis and orientation

Patient Positioning:

- Patient lying in prone position

Technique:
Fluoroscopy (Fig. 14.2)

- Prepare sterile field of the region of interest and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- The fluoroscopy beam is angulated at 20–25° craniocaudally. Local anaesthesia at the puncture site is optional.
- With a course parallel to the fluoroscopy beam, advance the 22 G spinal needle through the ligaments and the capsule inside the SIJ; aim towards a target point located approximately 1 cm cranial to the joint's caudal margin (a minor resistance loss might be felt when entering the joint).

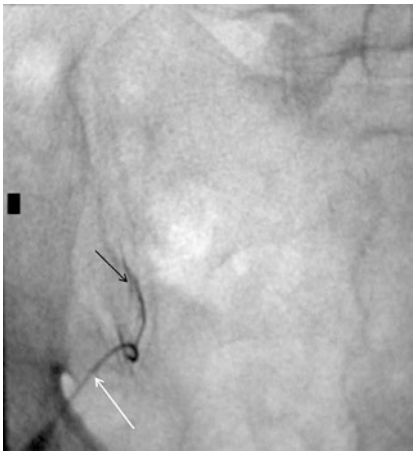

Fig. 14.2 P-A fluoroscopy view. Needle (*white arrow*) is within the right SIJ. Contrast medium (*black arrow*) injection illustrates lining of the joint's synovium

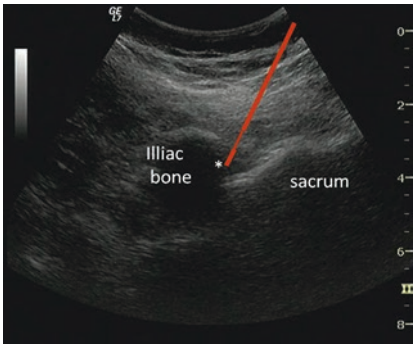

Fig. 14.3 Ultrasound image illustrating proper imaging anatomy of left sacroiliac joint (*asterisk*) and needle route

- Proper intra-articular needle positioning is verified fluoroscopically with injection of 1–3 mL of water-soluble iodinated contrast medium which will be dispersed inside the joint either lining its margins or being collected at the joint's dependent part.
- Solution to be injected depends on the indication for the procedure.

Ultrasound

- Prepare sterile field of the region of interest and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Start the transverse scanning by recognizing the spinous process of the fifth lumbar vertebra in the medial part of the image and the posterior superior iliac spine in the lateral part.
- Moving caudally along the sacral crest, at the level of S2 foramen, you will see the hypoechoic cleft of the SIJ between the sacrum (dorsal surface) and ilium (gluteal surface); this is the target point where the needle should be introduced (Fig. 14.3).
- Local anaesthesia at the puncture site is optional.
- Solution to be injected depends on the indication for the procedure.

Computed Tomography (Figs. 14.4 and 14.5)

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Perform scans with 3–5 mm axial images; scan area should cover from the middle part till the distal end of the joint.
- Selection of entry point at the skin should provide a route parallel to the joint orientation.
- Local anaesthesia at the puncture site is optional.
- Advance a 22 G spinal needle through the ligaments and the capsule inside the SIJ under the selected route (parallel to the joint orientation); aim towards a target point located approximately 1 cm cranial to the joint's caudal margin (a minor resistance loss might be felt when entering the joint).

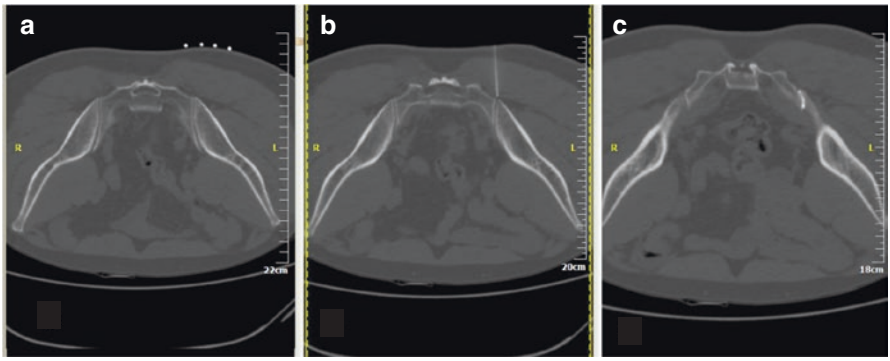

Fig. 14.4 CT axial scans. (**a**) Entry point at the skin is chosen so as the needle route will be more or less parallel to the joint axis. (**b**) Needle is at the joint level. (**c**) Post contrast medium injection there is lining of the joint's synovium

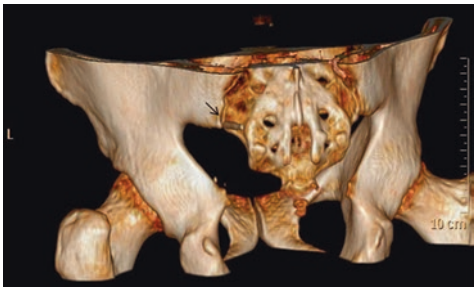

Fig. 14.5 3D-CT reconstruction illustrating the needle (*arrow*) at the target point (1 cm above the caudal end of the joint)

- Proper intra-articular needle positioning is verified with CT scan post-injection of 1–3 mL of iodinated contrast medium which will be dispersed inside the joint either lining its margins or being collected at the joint's dependent part.
- Inject solution depending on the indication for the procedure.

Tips and Tricks:

- Due to varying obliquity of anterior and posterior joint space and with a 20–25° craniocaudal beam angulation, the posterior joint space is projecting in a caudal direction.
- Aim towards a target point located approximately 1 cm cranial to the joint's caudal margin.
- A minor resistance loss might be felt when entering the joint.
- Corticosteroids act at cellular level and require a 3- to 5-day period for the effects of their action; therefore the initial pain reduction is due to local anaesthetic; instruct patient to continue analgesic medication for the first 3–5 days.
- Particulate corticosteroid preparations (non-water-soluble esthers) (see Chap. 1) are potential embolic agents in case of intravascular injection; avoid intravascular injection by verifying proper needle positioning by means of contrast medium injection.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15–30 min (prior to discharge, perform motor strength and sensory evaluation).
- Patient exits the hospital with an accompanying person and is instructed to avoid driving for several hours post-infiltration because he/she might experience temporary weakness or delayed reflexes due to the local anaesthetic action.
- Follow-up reschedule within 7–10 days.

Procedure-Related Symptoms and Treatment:

- Temporary pain exacerbation (2.5% of the cases) could be treated with oral analgesics.

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Bone Biopsy

15

Thomas Le Corroller

Abbreviations

CT Computed tomography
G Gauge
MR Magnetic resonance

15.1 CT-Guided Bone Biopsy

Indication:
Characterization of bone lesion by histologic, cytological, and bacteriological analysis [1, 2]

- Diagnosis and staging of primary neoplasms
- Characterization of histological type of metastases in patients with known disease or multiple tumors
- Assessment of tumor response to chemotherapy or radiation therapy
- Characterization of vertebral collapse (benign or pathologic fractures)
- Confirmation of osteomyelitis, spondylodiscitis or joint infection, and bacteriological characterization (Gram stain, culture, antibiogram)

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Contraindication:

- General contraindications (see Chap. 1.)
- Specific contraindications:
  - Spinal cord compression at the puncture level
  - Epidural involvement at the puncture level

Pre- and per procedural medications:

- Usually outpatient procedure.
- Local anesthesia (subcutaneous layer, muscles, and periosteum) with water-soluble anesthetic lidocaine 1% (maximal dose 300 mg).
- Long-acting anesthetic (ropivacaine maximal dose of 225 mg) eventually mixed with lidocaine in painful or longer procedures.
- Intravenous sedoanalgesia recommended with large needle sizes or anxious patients, with midazolam IV (maximal dose of 5 mg) and paracetamol IV (1–2 g).
- An anesthesiologist may be required in complex procedures and toddlers and small children or with non-collaborating patients.

Equipment:

- CT scanner.
- Mobile C-arm fluoroscopy may be used in combination to offer real-time visualization.

Sterile equipment:

Syringe:
- 10 mL syringe for local anesthetic (lidocaine 1%)
- 5–10 mL syringe for vacuum aspiration

Needle:
- 22 G spinal needle to inject local anesthetic along the whole pathway
- Selected bone biopsy system:
  - Direct puncture needle 13–15 G (Ostycut, Bonopty).
  - Coaxial needle 11–14 G (Laredo-Bard, Optimed).
  - Surgical biopsy set 10–12 G may be used when significant drilling is requested.
  - Coaxial soft tissue biopsy device 17–21 G used in lytic lesions (Temno, Cook).

Surgical scalpel is used for skin incision.
Surgical hammer may be used for cortical perforation.
Injection drugs:

- Lidocaine 1% (maximal dose 300 mg)
- Ropivacaine (maximal dose of 225 mg)

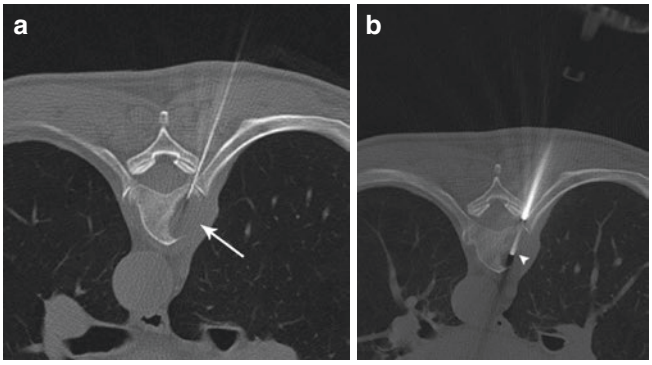

Fig. 15.1 (**a**) CT-guided bone biopsy of a purely lytic metastatic lesion involving the vertebral body of TH7 (*arrow*). A 22 G spinal needle for local anesthesia of the whole pathway. (**b**) A coaxial bone biopsy system is introduced using a right-sided costovertebral approach (**b**, *arrowhead*)

Anatomy of the region:

- Spine
  - Lumbar spine:
    Transpedicular approach is preferred.
    Posterolateral extrapedicular approach may be suited for lateral lesions with the risk of spinal nerve puncture [1].
  - Thoracic spine:
    Transpedicular approach is recommended for primary bone lesions that will require surgical excision [1].
    Costovertebral or costotransversal extrapedicular approach is otherwise preferred (Fig. 15.1) [1].
  - Cervical spine:
    Anterolateral approach is the preferred route for the anterior structures.
    Posterior or posterolateral approach is used for the posterior elements.
  - Intervertebral disc:
    Posterolateral approach is used in the lumbar spine.
    Costovertebral approach is used in the thoracic spine.
- Flat bones (skull, sternum, ribs, scapula, clavicle):
  - Tangential oblique approach is recommended to reduce the risk of damage to underlying structures (brain, mediastinum, pleura, etc.) (Fig. 15.2).

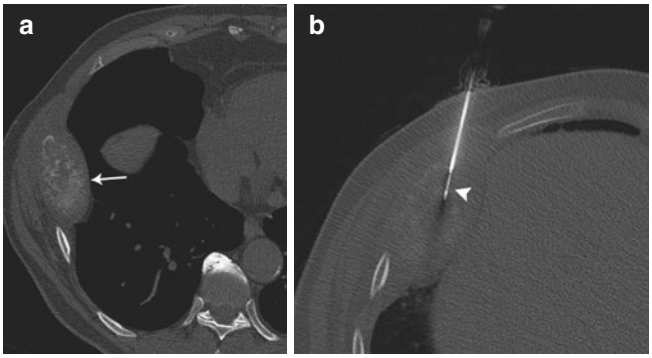

Fig. 15.2 (**a**) CT-guided bone biopsy of an expansile sclerotic metastatic lesion involving the right 5th rib (*arrow*). (**b**) A coaxial bone biopsy system is introduced using a tangential oblique approach to reduce the risk of damage to the pleura (*arrowhead*)

- Pelvis:
  - Sacral lesions: posterior approach avoiding the sacral nerves and canal
  - Acetabular lesions: direct anterior or posterior route depending on the site of the lesions
  - Pubic lesions: direct anterior or oblique route depending on the site of the lesions (Fig. 15.3)
  - Iliac wing lesions: transosseous approach avoiding muscular involvement
- Upper and lower limbs:
  - The needle pathway must be planned with the surgeon in case of primary bone tumor.
  - The route of the biopsy needle must cross only anatomical compartments involved with the lesion and avoid contaminating uninvolved compartments [3].

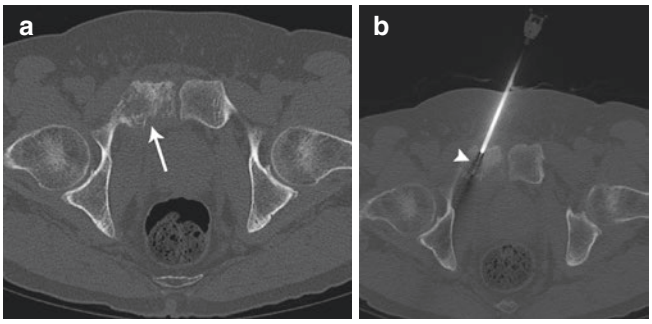

Fig. 15.3 (**a**) CT-guided bone biopsy of a lytic and sclerotic metastatic lesion involving the pubis (*arrow*). (**b**) A coaxial bone biopsy system is introduced using an oblique approach (*arrowhead*)

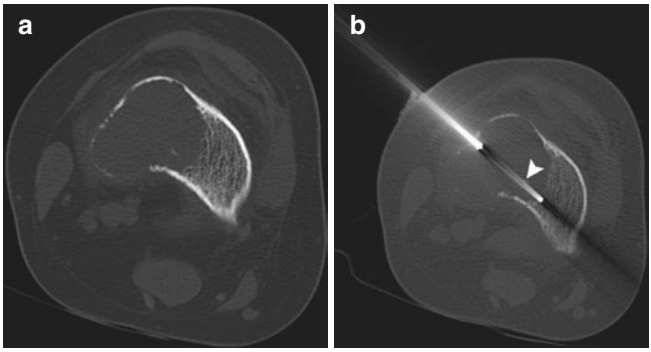

Fig. 15.4 (**a**) CT-guided bone biopsy of a lytic lesion involving the distal femur (**a**). (**b**) The needle pathway was planned with the surgeon, and the needle route was imaged clearly to allow surgical resection of the needle pathway (*arrowhead*). Final diagnosis was giant cell tumor

- Joint penetration should be avoided as capsular contamination would lead to total joint excision.
- The shorter route that stays in the anatomical compartment of the lesion is usually preferred.
- The skin entry point must be either tattooed with sterile permanent ink (methylene blue) or marked with a scar made along the long axis of the limb.
- The needle route must be imaged clearly to allow surgical resection of the needle pathway (Fig. 15.4).

Patient positioning:

- Patient is appropriately positioned on the CT table (prone, supine, or lateral position; head or feet first).

Technique:

- Bone biopsy system is selected based on the following criteria:
  - lytic or sclerotic lesion
  - thickness of the cortical bone surrounding the lesion
  - location of the lesion
  - experience of the operator
- Coaxial technique:
  - Limits the risk of tumoral or infectious dissemination (higher risk in chondral lesions).
  - Reduces damage to the surrounding normal tissue.
  - Allows several core biopsies in one line through a single pathway.

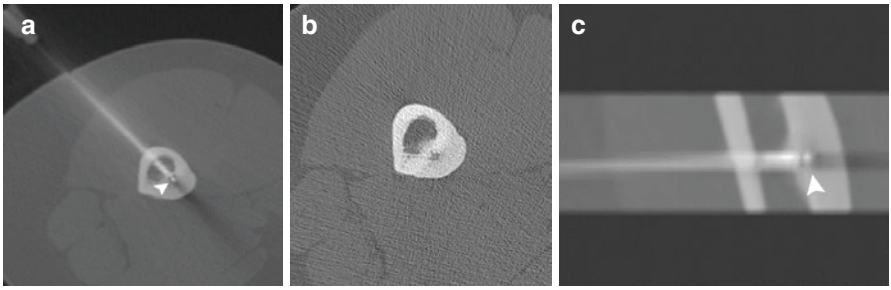

Fig. 15.5 (**a**) CT-guided bone biopsy of a small lytic lesion involving the medial cortex of the right femur diaphysis with thick cortical bone surrounding the lesion. (**b**) Penetration by drilling using a lateral approach with an orthogonal, safer, approach to the bone surface (*arrowhead*). (**c**) Multiplanar reformatted images may allow better visualization of the needle pathway in small lesions (*arrowhead*). Final diagnosis was osteoid osteoma. A thermal ablation was performed immediately after the bone biopsy

- Tandem technique:
  - A first 22 G spinal needle is placed next to the lesion and used to deliver local anesthesia to the periosteum and along the needle route.
  - The biopsy needle is then introduced as close to and as parallel as possible to the 22 G needle.
- Bone penetration
  - Thin cortical bone surrounding the lesion is penetrated through direct percussion with a surgical hammer.
  - Thick cortical bone surrounding the lesion or dense ossification is penetrated by drilling, which is more successful and safer with an orthogonal approach to the bone surface (Fig. 15.5).
- Retrieval of samples
  - The bone biopsy system is advanced to the margin of the lesion.
  - The stylet or drill is removed when it is in contact with the lesion.
  - The cannula is advanced within the lesion with continuous rotation to acquire the samples.
  - A syringe is kept in negative pressure by withdrawing the plunger when the cannula is advanced.
  - Then the sample is expelled from the cannula by an obturator.
- Examination of tissue samples
  - Solid or semisolid samples are placed within formaldehyde solution (please contact the pathology department for department specific preferred fixative solutions).

  - Immediate pathologic analysis can be obtained from fresh frozen specimens if treatment is to begin rapidly (please contact the pathology department for department specific preferred fixative solutions).
  - Blood clots and bone marrow obtained in the sample should not be discarded as they may provide significant information.
  - Aspiration products are sent in a sterile tube sealed with a sterile cap for bacteriological analysis.

Aftercare:

- Adhesive bandage covering the skin incision. The bandage is kept dry for 1 week.
- Patient kept under observation for 60 min.
- Monitoring of general parameters (blood pressure, heart rate, respiration).
- Patient can be discharged into the care of an accompanying person and is advised not to drive or to perform any task for 24 h.
- Information brochure with information on the procedure, procedure-related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number, and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Additional analgesics may be given for 1–2 days (paracetamol, tramadol).

15.2 Pet-CT-Guided Bone Biopsy

Indication:

- Hypermetabolic bone lesion not visible on CT (PET-positive lesions with no morphological correlation)

Technique:

- Nonreal-time PET/CT biopsies use co-registration of a prior PET image with a procedural CT image (Fig. 15.6).
- Real-time PET/CT biopsy may present benefits over conventional biopsy techniques in terms of accuracy of locating the correct biopsy site.

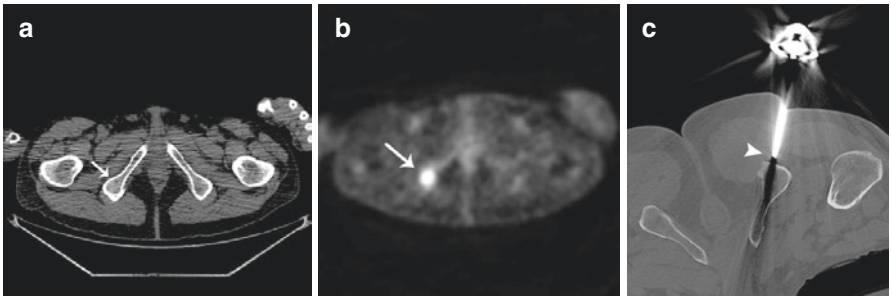

Fig. 15.6 (**a** and **b**) PET/CT demonstrating a hypermetabolic bone lesion of the right ischium not visible on CT (*arrow*). (**c**) Nonreal-time PET/CT bone biopsy of the left ischium using co-registration of a prior PET image with a procedural CT image (*arrowhead*). Final diagnosis was ethmoidal carcinoma metastasis

15.3 MR-Guided Bone Biopsy

Indication:

- Pregnancy
- Bone marrow replacement not visible on CT

Technique:

- Skin entry point determined by a specific grid placed successively in the cranio-caudal and horizontal axis. Another less specific but quicker method is to point with a finger directly at the entry point [1].
- MR compatible needles and biopsy system are required.

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Image-Guided Soft Tissue Biopsy

16

Jan L.M.A. Gielen

Abbreviations

CT	Computed tomography
MRI	Magnetic resonance imaging
US	Ultrasound

16.1 Indications, Contraindications, Medications, and Equipment

Indications:

- Mass lesions suspect for malignancy at the soft tissues
- Soft tissue metastasis in patients with multiple malignancies or for determination of biological markers

Contraindication:

- Coagulation pathology
- Local or systemic infection
- Patient unwilling to consent to the procedure
- PET and/or CT only: pregnancy due to teratogenic effects of ionizing radiation

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Pre- and post-procedural medications:

- Optional depending on the patient: oral analgesics for 24–48 h after the session.
- Local anaesthesia (subcutaneous layer, muscles and periosteum) with water-soluble anaesthetic lidocaïne 1% (maximal dose 300 mg).
- Long-acting anaesthetic (ropivacaine maximal dose of 225 mg) eventually mixed with lidocaïne in painful or longer procedures.
- An anaesthesiologist may be required in complex procedures and toddlers and small children or with noncollaborating patients.

Equipment:

- Skin disinfectant
- Band-Aid

Syringe:

- 10 or 20 cc syringe for local anaesthetic injection

Needle:

- 18 G 88 mm pink needle
- 21 G 50 mm green needles or 22 G spinal needle to provide local anaesthetic along the whole pathway, local anaesthesia of subcutaneous fat tissue is not needed
- Selected disposable soft tissue biopsy system
  - Tru-Cut 16–20 G (Bard)
  - Coaxial soft tissue biopsy device 10–14 G (Temno, Cook, Bioconcise)

Surgical scalpel is used for skin incision.
Injection drug:

- 10–20 mL anaesthetic 2% (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%) pre-procedure
- 18 G 88 mm pink needle and two 21 G 50 mm green needles

Anatomy of the region:
Detailed knowledge of compartmental anatomy is needed to plan the shortest safe needle path in order to avoid neurovascular structures, synovial spaces and multiple compartment transgression. Needle trajectory is planned in a multidisciplinary meeting with the surgeon that will remove the lesion not to jeopardize trajectory removal together with surgical malignant tumour resection.

Patient positioning:
Patient is appropriately positioned on the examination table (prone, supine or lateral position; head or feet first) depending on the area of interest to allow easy unconflicted needle position.

Technique:

Define and mark skin puncture area with use of US, PET/CT or PET/MRI and non-water-soluble marker, or mark with skin impression (closed ballpoint produces small ringlike impression).

Define angulation of the needle trajectory relative to true horizontal or vertical for CT or MR. Define angulation of the needle trajectory relative to the probe for US.

Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).

Inject local anaesthetic along the trajectory between the target lesion and the skin to provide pain relief. Start the injection in front of the lesion, and retract to the level of the skin while injecting local anaesthetic.

Perform the biopsy procedure; use either coaxial technique or tandem technique.

- Coaxial technique:
  - Limits the risk of tumoural or infectious dissemination
  - Reduces damage to the surrounding normal tissue
  - Allows several core biopsies in one line through a single pathway
- Tandem technique:
  - A first 22 G spinal needle is placed next to the lesion where it is used to deliver local anaesthesia along the needle route.
  - The biopsy needle is then introduced as close to and as parallel as possible to the 22 G needle.

Retrieval of samples:

- The biopsy system is advanced to the margin of the lesion.
- The cannula is advanced within the lesion.
- The cannula is then translated or twisted to cut the intracannicular tissue.
- A syringe is kept in negative pressure by withdrawing the plunger when the cannula is retrieved.
- Then the sample is expelled from the cannula by an obturator.

Specific location and fixation of tissue samples:

- In non-homogeneous lesions, tissue sampling (at least two) should involve multiple areas with vascularized imaging characteristics (iodine or gadolinium enhancement, with Doppler activity and/or PET avid areas).
- Solid or semi-solid samples are placed within 4% formaldehyde solution (please contact the pathology department for department-specific preferred fixative solutions).
- Immediate pathologic analysis can be obtained from fresh frozen specimens if treatment is to begin rapidly (please contact the pathology department for department-specific preferred fixative solutions).

- Blood and blood clots obtained in the sample are placed within formaldehyde solution (please contact the pathology department for specific preferred fixative solutions). These samples should not be discarded as they may provide significant pathologic information.
- Possibly aspiration products are sent in a sterile tube sealed with a sterile cap for bacteriological analysis.

Pressure on the needle tract when withdrawing the needle to prevent bleeding.
Aftercare:

- Adhesive bandage covering the skin incision. The bandage is kept dry for 1 week.
- Patient kept under observation for 60 min.
- Monitoring of general parameters (blood pressure, heart rate, respiration).
- Patient can be discharged into the care of an accompanying person and is advised not to drive or to perform any task for 24 h.
- Information brochure with information over on the procedure, procedure related symptoms and treatment of the symptoms, symptoms of possible complications, name of the radiologist, contact telephone number and information about follow-up appointment.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Additional analgesics may be given for 1–2 days (paracetamol, tramadol).

16.2 US Guided: Indication, Specific Technique

Indication:

- Superficial lesions, completely documented on US.
- Deeper lesions, non-homogeneous lesions: image fusion of US with PET/MRI or PET/CT examination performed prior to the US-guided biopsy procedure may be used to define deeper located lesions that are not completely documented on US and/or for definition of specific target areas in the lesion based on PET, MRI or CT characteristics.

Equipment:

- Ultrasound machine with preferably high-resolution (i.e., 18 MHz) linear transducer
- (sterile) Ultrasound gel and sterile draping of the ultrasound probe
- The transducer is placed on the skin; target lesion and neurovascular and joint relation with the target lesion is documented using B-mode and Doppler imaging. Shortest, safe trajectory is planned to areas with intralesional vascular activity (Fig. 16.1a–d).

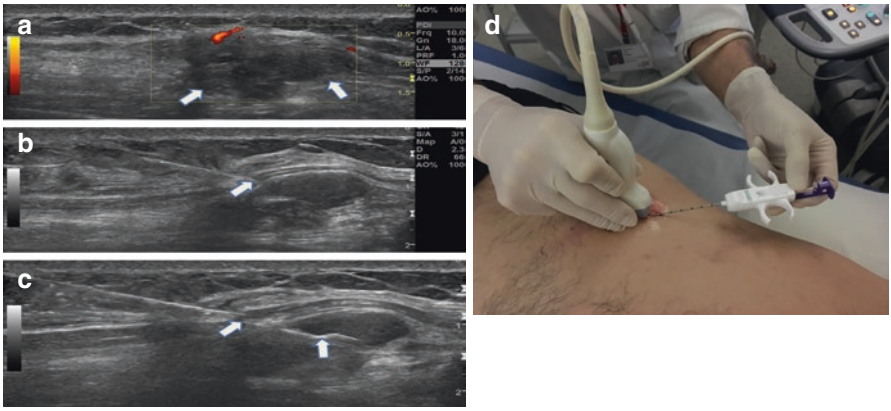

Fig. 16.1 Male patient, 70 years old, known with lung carcinoma. Solitary soft tissue nodule at the thoracic wall, serratus anterior location, with extension into the intercostal area. Non-homogeneous hyporeflective vascularized mass lesion with maximal size of 2.2 × 0.9 cm is demonstrated on ultrasound (**a**, *arrows*). Safe needle orientation is planned in order not to stab vital structures even on accidental transfixation of the lesion (nerves, vessels, joint, and pleura of the lung). Loaded Tru-Cut needle tip with 10 G thickness is positioned in front of the lesion under ultrasound guidance (**b** *arrow* and **d**). Biopsy needle is advanced in the lesion without transfixation of the lesion (**c**). Demonstration of the biopsy load channel (**c**, *arrows*) with length of 2 cm in the lesion

16.3 CT Guided: Indication, Specific Technique

Indication:

- Lesion not or incompletely documented on US.
- CT scanner.
- Intravenous jodium contrast product is used to define intralesional enhancement and to depict vital vascular structures to be avoided.
- Perform scans with axial images; scan area should cover the whole lesion.
- Axial in plane trajectory is planned in case of CT equipment without fluoroscopy (Fig. 16.2a–d).

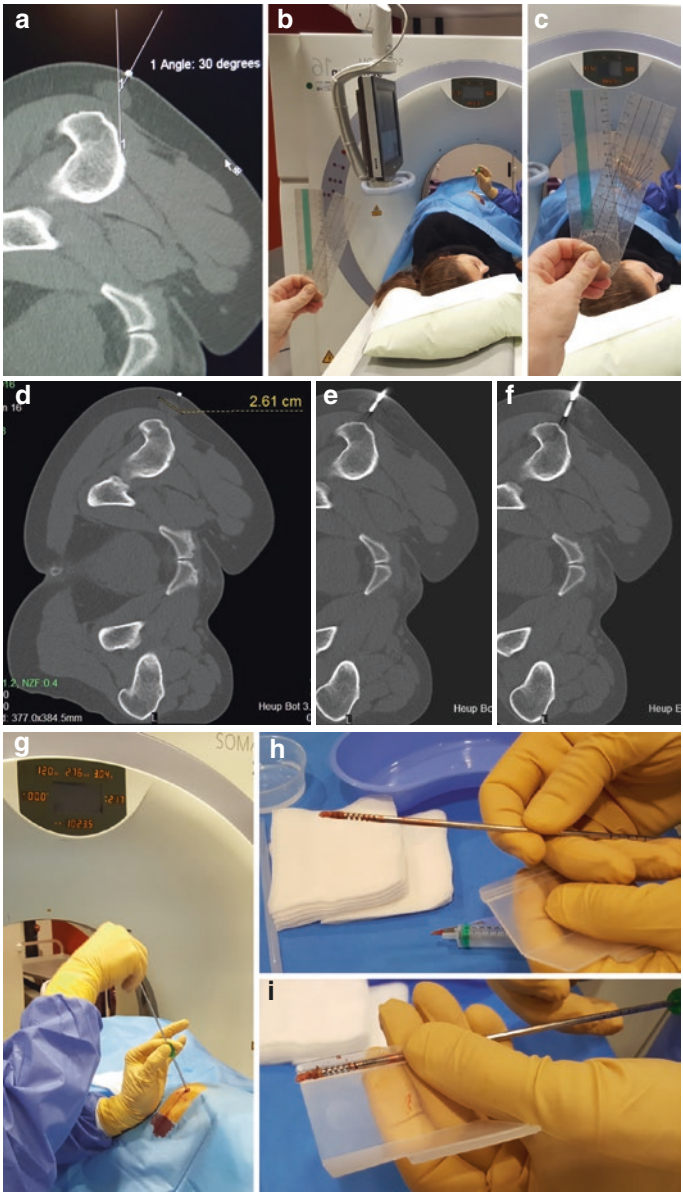

Fig. 16.2 Female patient, 38 years old. Painful mass lesion at the subcutaneous tissue of the left trochanteric area. (**a**–**c**) Prebiopsy scan for location and planning of biopsy trajectory and angulation relative to vertical axis (**a**). Thirty degrees angulation relative to the vertical axis is transferred to the needle using transparent triangle (**b**, **c**). (**d**) Prebiopsy scan with measurement of the thickness of the lesion in the planned axis the biopsy needle. Then positioning of the trocar with cutting cannula in front of the lesion, replacement of the trocar with the receiving needle that includes the helix at the distal 2cm. (**e**) confirmation of helix position in the lesion before removal of thissue, subsequent CT controlled turning of the biopsy receiving helix into the lesion without transfixation of the lesion. Engravings on the external parts of the needle components are available and are used to control the depth of the needle tip. Then the sample is cutted by turning the cutting cannula over the receiving helix. (**f**) Second biopsy location using slight different angulation. (**g**–**i**) Tissue removal procedure with retraction of the receiving needle (**g**) and release of the tissue out of the helix with use of pinned plastic needle socket (**h**, **i**)

16.4 Pet/CT Guided: Indication, Specific Technique

Indication:

- Hypermetabolic lesion not visible on CT (=PET-avid lesions with no morphological correlation) and too deeply located for US guided procedure
- Lesions with prior nonconclusive biopsy

Technique:

- Nonreal-time PET/CT biopsies use co-registration (image fusion) of a prior PET examination with a procedural CT or US image.
- Real-time PET/CT biopsy may present benefits over conventional biopsy techniques in terms of accuracy of locating the correct intralesional biopsy site.

16.5 PET/MR Guided: Indication, Specific Technique

Indication:

- Pregnancy in the second and third trimester
- Lesions with prior nonconclusive biopsy

Technique:

- Skin entry point determined by a specific MR compatible grid placed successively in the craniocaudal and horizontal axis. Another less specific but quicker method is to point with a finger directly at the entry point.
- MR compatible needles and biopsy system are required.

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Spine

17

Dimitrios K. Filippiadis and Alexis Kelekis

Abbreviations

A-P	Anteroposterior
CT	Computed tomography
G	Gauge
iv	Intravenous
mm	Millimetres
RF	Radiofrequency

17.1 Discography

Indication

- Determine symptomatic levels in patients with discogenic pain.
- Evaluation of symptomatic patients with minimum or no imaging findings.
- Evaluation of discogenic pain that directly correlates the internal morphology of the disc (with or without derangement) to the patient's usual painful symptom.

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Contraindication:

- Coagulation pathology
- Local or systemic infection
- Pregnancy due to ionizing radiation's teratogenic effects
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- Prophylactic single iv dose of antibiosis (according to the instructions of your hospital's infectious department) 30–60 min prior to the session
- Oral analgesics for 24–48 h post the session (optional use depending on patient)

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- Computed tomography (CT) suite
- Disc monitor for evaluation of intradiscal pressure under injection with continuous and steady rate (optional)

Syringe and needle:

- 10–20 mL Luer-lock syringe for local anaesthetic
- 10–20 mL Luer-lock syringe for iodinated contrast medium
- 22 G, 90–170 mm spinal needle with Quincke type point
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- 10–20 mL local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%)
- 10–20 mL iodinated contrast; non-ionic iodinated myelographic contrast medium

Anatomy of the region:

- Intervertebral discs are located between the vertebral bodies.
- They consist of a peripheral part (annulus fibrosus) which surrounds the disc's centre (nucleus pulposus).
- Nucleus pulposus is a gel-like structure consisting of embryonic spinal cord remnants and few cells containing an amorphous matrix with high concentration of mucopolysaccharides binded to water.
- Annulus fibrosus is a lamellar structure of collagen and fibrous cartilage layers which are under tension.
- Intervertebral discs are thicker in craniocaudal direction and higher anteriorly in cervical and lumbar spine and posteriorly in thoracic spine.

Patient positioning:

- Patient lying in supine position for discography in the cervical spine
- Patient lying in prone position for discography in the thoracic and lumbar spine

Technique:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).

Cervical spine:

- Patient in supine position.
- In A-P fluoroscopy view, the selected intervertebral disc is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and needle is advanced under an anterolateral approach.
- Apply pressure pushing the vessels laterally, and advance the needle under continuous fluoroscopy between the larynx and jugular-carotid vessels, till the level of the anterior longitudinal ligament.
- Needle is placed centrally in the disc, verified on lateral and A-P fluoroscopy views.

Thoracic spine:

- Patient in prone position.
- The disc space at the thoracic level is defined using a lateral oblique projection; the selected intervertebral disc is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and needle is advanced under a posterolateral approach.
- The entry point is situated laterally to the superior articulation of the lower vertebral body and medially to the head of the ipsilateral rib.
- Needle is placed centrally in the disc, verified on lateral and P-A fluoroscopy views.

Lumbar spine:

- Patient in prone position.
- The disc space at the lumbar level is defined using a lateral oblique projection (Scottie dog projection); the selected intervertebral disc is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and needle is advanced under a posterolateral approach.
- The entry point is situated just ventrolateral to the superior articular process (Fig. 17.1).
- Needle is placed centrally in the disc, verified on lateral and P-A fluoroscopy views.

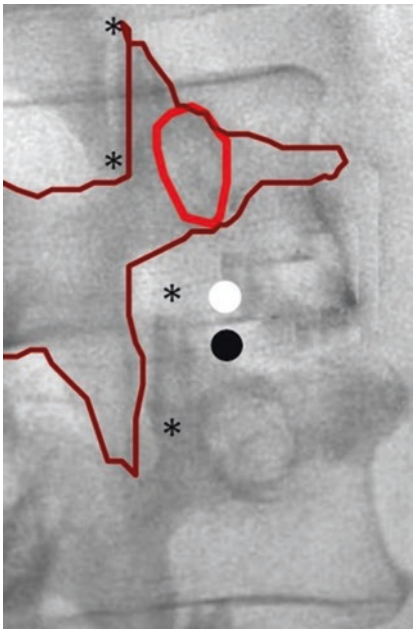

Fig. 17.1 Oblique fluoroscopy view (Scottie dog projection): you can see drawn the Scottie dog; notice the target points for facet joint infiltration (*asterisks*), for discography or disc decompression techniques (*black dot*) and for transforaminal infiltration (*white dot*)

Tips and tricks:

- Access to the L5-S1 level requires significant caudal angulation in order to visualize the correct needle route.
- Performing injection at constant rate by means of a disc monitor or any other similar device seems to be less painful—process stops at a maximum injected volume of 4 cm^3 or when intradiscal pressure rises over 100 psi.
- Provocative discography is positive when there is pain increase of 2 NVS units.
- Measurement of disc pressure seems to be a predictor for the treatment's outcome.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 2–3 h.
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post discography because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Temporary pain exacerbation could be treated with oral analgesics.

- Discitis is the most fearsome complication (<0.5%).
- Postinjection disc morphology is evaluated according to the modified Dallas discogram scale.

17.2 Intervertebral Disc Decompression Techniques

Indication:

- Adult patients capable of providing consent with symptomatic small- to medium-sized intervertebral disc herniation (hernia size should occupy <1/3–1/2 of the spinal canal's diameter)
- MRI verifying the hernia
- leg pain ± back pain; leg pain >>>> back pain in case of co-existence

Contraindication:

- Asymptomatic herniation
- Sequestration
- Neurologic deficit
- Coagulation pathology
- Local or systemic infection
- Pregnancy due to ionizing radiation's teratogenic effects
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- Prophylactic single iv dose of antibiosis (according to the instructions of your hospital's infectious department) 30–60 min prior to the session
- Oral analgesics for 24–48 h post the session (optional use depending on patient)

Equipment:

- Fluoroscopy (C-arm equipment, angiography suite with or without cone beam option)
- CT suite
- Decompressor device (mechanical, thermal, chemical)

Syringe and needle:

- 20 mL Luer-lock syringe for local anaesthetic
- 22 G, 90–170 mm spinal needle with Quincke type point
- 17 G, 120–170 mm bevelled tip trocar
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- In case of chemical decompression, one can use intradiscal alcohol gel or ozone according to the manufacturer's guidelines.

Anatomy of the region:

- Intervertebral discs are located between the vertebral bodies.
- They consist of a peripheral part (annulus fibrosus) which surrounds the disc's centre (nucleus pulposus).
- Nucleus pulposus is a gel-like structure consisting of embryonic spinal cord remnants and few cells containing an amorphous matrix with high concentration of mucopolysaccharides binded to water.
- Annulus fibrosus is a lamellar structure of collagen and fibrous cartilage layers which are under tension.
- Intervertebral discs are thicker in craniocaudal direction and higher anteriorly in cervical and lumbar spine and posteriorly in thoracic spine

Patient positioning:

- Patient lying in supine position for percutaneous disc decompression in the cervical spine
- Patient lying in prone position for percutaneous disc decompression in the thoracic and lumbar spine

Technique:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).

Cervical spine:

- Patient in supine position.
- In A-P fluoroscopy view, the selected intervertebral disc is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and a trocar is advanced under an anterolateral approach.
- Apply pressure pushing the vessels laterally, and advance the needle under continuous fluoroscopy between the larynx and jugular-carotid vessels, till the level of the anterior longitudinal ligament.
- Trocar is placed centrally in the disc, verified on lateral and A-P fluoroscopy views (Fig. 17.2).
- Final position of the trocar should be in the midline (on P-A view) and in the junction of middle posterior third (on lateral view) of the intervertebral disc, midway between the two vertebral end plates.

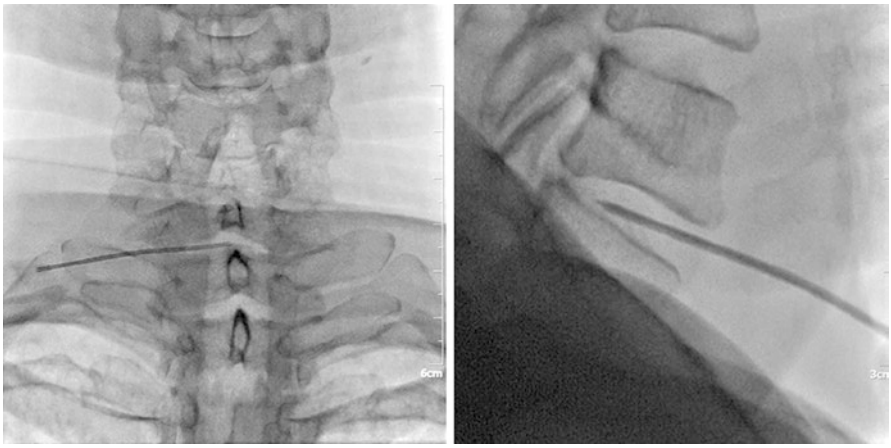

Fig. 17.2 A-P (*left image*) and lateral (*right image*) view illustrating the trocar's final position in the disc of interest (C6–C7 at this case); trocar should be towards the midline in A-P projection and towards the posterior third in lateral projection

Thoracic spine:

- Patient in prone position.
- The disc space at the thoracic level is defined using a lateral oblique projection; the selected intervertebral disc is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and a trocar is advanced under a posterolateral approach.
- The entry point is situated laterally to the superior articulation of the lower vertebral body and medially to the head of the ipsilateral rib.
- Trocar is placed centrally in the disc, verified on lateral and P-A fluoroscopy views.
- Final position of the needle should be in the midline (on P-A view) and in the anterior third (on lateral view) of the intervertebral disc, midway between the two vertebral end plates.

Lumbar spine:

- Patient in prone position.
- The disc space at the lumbar level is defined using a lateral oblique projection (Scottie dog projection); the selected intervertebral disc is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and a trocar is advanced under a posterolateral approach.
- The entry point is situated just ventrolateral to the superior articular process.
- Trocar is placed centrally in the disc, verified on lateral and P-A fluoroscopy views.

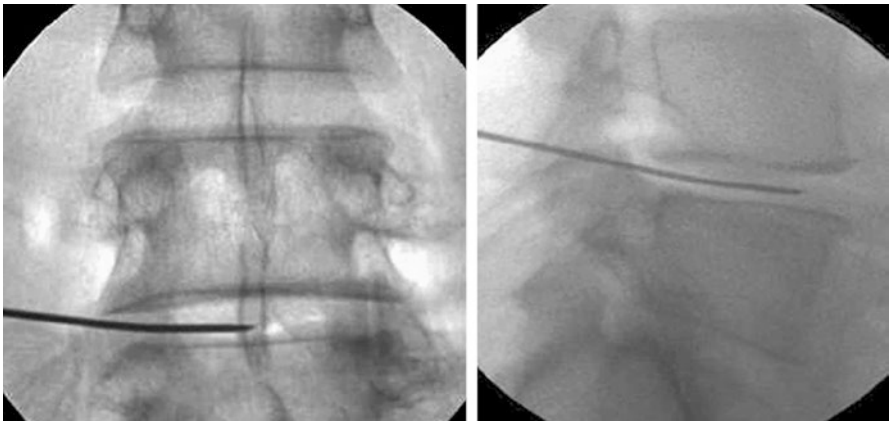

Fig. 17.3 A-P (*left image*) and lateral (*right image*) view illustrating the trocar's final position in the disc of interest (L4–L5 at this case); trocar should be towards the midline in A-P projection and towards the anterior third in lateral projection

- Final position of the trocar should be in the midline (on P-A view) and in the anterior third (on lateral view) of the intervertebral disc, midway between the two vertebral end plates (Fig. 17.3).
- Once the trocar is in the desired position within the intervertebral disc of interest, you can insert any decompression device (mechanical, thermal, chemical) and perform decompression according to the manufacturer's guidelines (Table 17.1).

Tips and tricks:

- Discogel injection is similar to an embolization procedure and should be performed under continuous fluoroscopy.
- Fluoroscopy as guiding modality in percutaneous disc decompression techniques provides real-time monitoring.
- Thermal techniques seem to be governed by a slightly higher rate (2.5%) of thermal sterile end plate inflammation.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 2–4 h.
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post disc decompression because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.

Table 17.1 Percutaneous decompression techniques (types, methods, definition, success and complication rates) and biomaterial implantation material

Decompression type	Method	Definition	Success rate	Complication rate
Mechanical decompression	Automated percutaneous lumbar discectomy (APLD)	Air- or water-driven, suction-cutting probe	All percutaneous decompression techniques are governed by a median success rate of 85%	All percutaneous decompression techniques are governed by a median Complication rate <0.5% Exception is thermal decompression techniques: 2.5% rate of sterile-dermal inflammation of vertebral end plates
	Percutaneous disc decompression (PDD)	Mechanical high rotation per minute device		
	Percutaneous discectomy	Herniotome		
Thermal decompression	Percutaneous laser decompression			
	Intradiscalelectrothermal therapy (IDET)			
	Intervertebral disc nucleoplasty with bipolar radiofrequency energy			
Chemical decompression	Discogel (gelified ethanol)			
	Ozone therapy (leads to breakdown of nucleus pulposus)			
Biomaterial implantation	Hydrogel, platelet-rich plasma and stem cell therapy (aim in intervertebral disc regeneration)		Further and more extended studies with larger patient samples are necessary for a solid evaluation concerning the success and complication rates	

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Temporary pain exacerbation could be treated with oral analgesics.
- Discitis is the most fearsome complication (<0.5%).

17.3 Epidural Infiltrations

17.3.1 Transforaminal Approach

Indication:

- Neuralgia of a single nerve root caused by a pain generator arising at a specific level
- Therapeutic infiltration (for pain reduction)
- Diagnostic infiltration (to verify whether therapy can be beneficial at a specific level)

Contraindication:

- Coagulation pathology
- Local or systemic infection
- Pregnancy due to ionizing radiation's teratogenic effects
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- No medication

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- CT suite

Syringe and needle:

- 2.5–5 mL Luer-lock syringe for injected mixture
- 2.5–5 mL Luer-lock syringe for iodinate contrast medium
- 5–10 mL syringe for local anaesthesia (optional)
- 22 G, 90–150 mm spinal needle with Quincke type point
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- Long-acting corticosteroid (triamcinolone acetate, cortivazol, betamethasone injectable suspension, methylprednisolone suspension); recommended dose is up to 50 mg of triamcinolone acetate or 80 mg of methylprednisolone.
- Local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%); use local anaesthetics free of paraben or phenol in order to avoid steroid flocculation.
- 1–3 mL non-ionic iodinated myelographic contrast medium.
- Injected mixture for diagnostic and therapeutic purpose contains:
  - 1–1.5 mL long-acting corticosteroid
  - 1–1.5 mL local anaesthetic

Anatomy of the region:

- The margins of neuroforamen include the facet joint (posterior), the vertebral pedicles (superior and inferior) and the vertebral body-intervertebral disc (anterior).
- In cervical foramen the nerve exits anterolaterally, whereas the vertebral artery is usually located anterior to the nerve passing through the foramen transversarium.

- In thoracic and lumbar foramina, nerve and vessels exit anteriorly and at the cephalad part.
- In transforaminal infiltrations (in all three spine levels), target point is at the lower and posterolateral foraminal margin.

Patient positioning:

- Patient lying in supine position for transforaminal infiltration in the cervical spine
- Patient lying in prone position for transforaminal infiltration in the thoracic and lumbar spine

Technique:
Fluoroscopy:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).

Cervical spine:

- Patient in supine position.
- In oblique-lateral fluoroscopy view, the selected level is recognized, and the vertebral end plates are superimposed in order to maximize circular appearance of the foramen.
- A skin projection is marked and the needle is advanced under a posterolateral approach.
- A-P view controls the depth of needle penetration inside the foramen (remember always stay at the lower and posterolateral foraminal margin).
- Contrast medium injection will verify the desired needle position inside the foramen (in most cases contrast medium will outline the nerve root) and *NOT* intravascularly.

Thoracic spine:

- Patient in prone position.
- In 30° oblique fluoroscopy view, the selected level is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and the needle is advanced under an inferolateral approach.
- A-P view controls the depth of needle penetration inside the foramen.
- In A-P view needle should be located in the lateral third of the pedicle, whilst in lateral view the needle should not advance beyond the posterior vertebral wall (or anterior foraminal margin).

- Remember always stay at the lower and posterolateral foraminal margin.
- Contrast medium injection will verify the desired needle position inside the foramen (in most cases contrast medium will outline the nerve root) and not intravascularly.

Lumbar spine:

- Patient in prone position.
- In a lateral oblique projection (Scottie dog projection), the selected level is recognized, and the vertebral end plates are superimposed.
- A skin projection is marked and the needle is advanced under a posterolateral approach.
- A-P view controls the depth of needle penetration inside the foramen.
- In A-P view needle should be located in the lateral fourth of the pedicle, whilst in lateral view the needle should not advance beyond the posterior vertebral wall (or anterior foraminal margin).
- Remember always stay at the lower and posterolateral foraminal margin (Fig. 17.4).

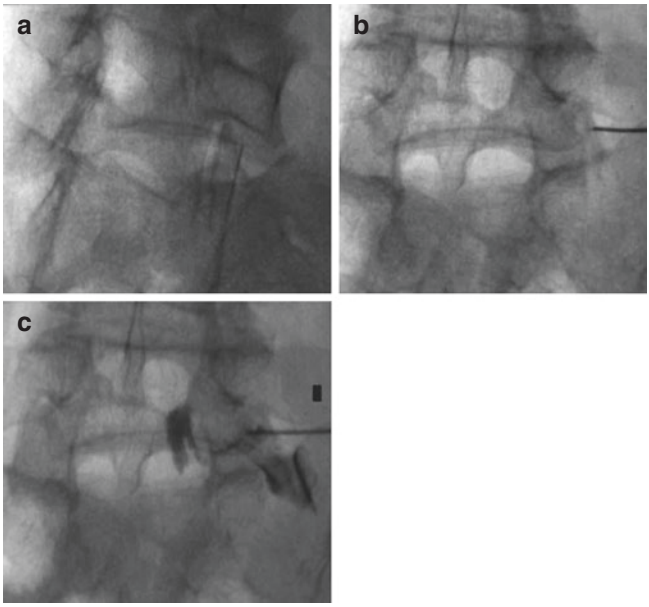

Fig. 17.4 (**a**) Scottie dog projection (oblique view); end plates of L5-SI level are aligned, (**b**) needle is advanced under a posterolateral approach, (**c**) A-P projection illustrating needle at the lateral third of the foramen; contrast medium injection verifies proper needle position outlining the nerve root

- Contrast medium injection will verify the desired needle position inside the foramen (in most cases contrast medium will outline the nerve root) and not intravascularly.

Sacral spine:

- Patient in prone position.
- In A-P view (steep cephalo-caudal projection is required in order to overlap posterior and anterior foramina), the selected level is recognized.
- Needle is advanced perpendicular to the sacrum's dorsal surface in A-P view, whilst in lateral view it should be approaching the presacral space.
- Contrast medium injection will verify the desired needle position inside the foramen (in most cases contrast medium will outline the nerve root) and not intravascularly (Fig. 17.5).
- In case of CT-guided transforaminal infiltrations, a similar direct axial approach is performed for each spinal level. Once the needle is safely placed in the lower and posterolateral foraminal border, inject 1–3 mL of iodinated contrast medium to verify extravascular position. Then, inject the solution.

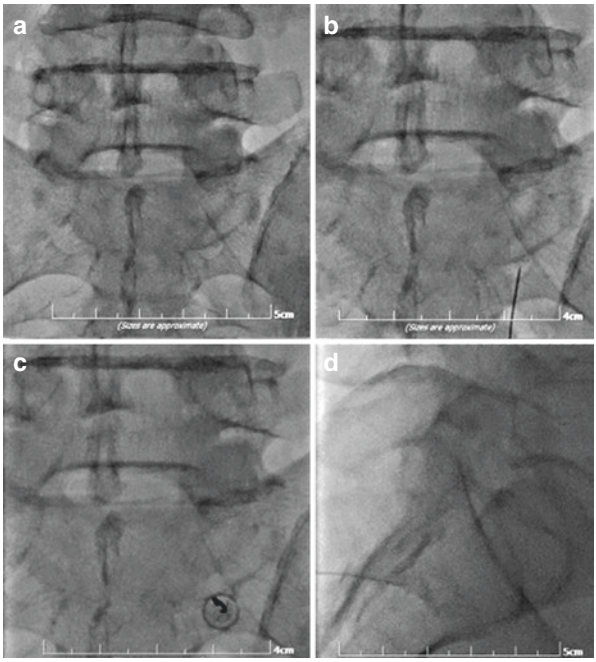

Fig. 17.5 (**a**) A-P projection, anterior and posterior foramen parts are aligned, (**b**) a skin projection is marked, (**c**) needle is advanced under a posterior approach, (**d**) lateral projection illustrating needle inside the epidural space; contrast medium injection verifies proper needle position

Tips and tricks:

- Corticosteroids act at cellular level and require a 3–5 day period for the effects of their action; therefore the initial pain reduction is due to local anaesthetic; instruct patient to continue analgesic medication for the first 3–5 days.
- Particulate corticosteroids are potential embolic agents in case of intravascular injection; avoid intravascular injection by verifying proper needle positioning by means of contrast medium injection.
- Do not look for troubles: always stay at the lower and posterolateral foraminal margin.
- In the cervical spine, a safer and of equal efficacy approach might be performing facet joint infiltration; during injection there is capsular rupture and dispersion of the injectate in the foraminal and epidural space.
- Alternative safer approaches include placing the patient in prone position and, under CT-guidance, approaching the posterior and lateral border of the facet joint and performing the injection at this location.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15–30 min (prior to discharge perform motor strength and sensory evaluation).
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post the infiltration because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.
- Follow-up reschedule within 7–10 days.

Procedure-related symptoms and treatment:

- Pain at the puncture site could be treated with cold compression.
- Temporary pain exacerbation could be treated with oral analgesics.
- Infection is the most fearsome complication (<0.5%).

17.3.2 Interlaminar Approach

Indication:

- Spinal stenosis
- Intervertebral disc herniation with resultant nerve root compression/inflammation
- Therapeutic infiltration (for pain reduction)

Contraindication:

- Coagulation pathology
- Local or systemic infection

- Pregnancy due to ionizing radiation's teratogenic effects
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- No medication

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- CT suite

Syringe and needle:

- 2.5–5 mL Luer-lock syringe for injected mixture
- 2.5–5 mL Luer-lock syringe for iodinate contrast medium
- 5–10 mL syringe for local anaesthesia (optional)
- 22 G, 70–120 mm spinal needle with Quincke type point
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- Long-acting corticosteroid (triamcinolone acetate, cortivasol, betamethasone injectable suspension, methylprednisolone suspension); recommended dose is up to 50 mg of triamcinolone acetate or 80 mg of methylprednisolone.
- Local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%); use local anaesthetics free of paraben or phenol in order to avoid steroid flocculation.
- 1–3 mL non-ionic iodinated myelographic contrast medium; in case of allergy use a gadolinium contrast medium.
- Injected mixture for diagnostic and therapeutic purpose contains:
  - 1–1.5 mL long-acting corticosteroid
  - 1–1.5 mL local anaesthetic

Anatomy of the region:

- The boundaries of spinal canal in a circumferential route include the spinous process, two vertebral laminae, two vertebral pedicles, two transverse processes and the posterior vertebral wall.
- Epidural space lies beyond the flaval ligaments and contains fat, blood vessels, nerve roots and dural sac.
- The lateral margin of epidural space is the intervertebral foramen.

Patient positioning:

- Patient lying in prone position

Technique:
Fluoroscopy:

- Patient in prone position
- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- In A-P view in the midline, slightly lateral to the spinous process (either left or right) towards the epidural fat which is seen in fluoroscopy as radiolucent globules.
- A skin projection is marked and the needle is advanced under a posterior approach.
- Lateral view controls the depth of needle penetration beyond the flaval ligaments inside the epidural space.
- Contrast medium injection will verify the desired needle position inside the epidural space, outside the dura matter and not intravascularly (Fig. 17.6a, b).

Computed tomography:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Perform scans with 1–3 mm axial images; scan area should the whole vertebral body-intervertebral disc-vertebral body complex.
- Selection of entry point at the skin should preferentially provide a route vertical to the epidural space, parallel to the spinous process.
- Local anaesthesia at the puncture site is optional.
- Advance the 22 G spinal needle through the spinal muscles inside the epidural space under the selected route; an increased resistance will be felt at when entering the flaval ligaments, and resistance loss will occur upon epidural space entrance.
- Proper needle positioning (inside the epidural space, outside the dura matter and not intravascularly) is verified with CT scan postinjection of 1–3 mL of iodinated contrast medium or air (in levels caudal to L2–L3) which will be dispersed inside the space (Fig. 17.6c, d).
- Inject solution.

Tips and tricks:

- Corticosteroids act at cellular level and require a 3–5 day period for the effects of their action; therefore the initial pain reduction is due to local anaesthetic; instruct patient to continue analgesic medication for the first 3–5 days.
- Particulate corticosteroids are potential embolic agents in case of intravascular injection; avoid intravascular injection by verifying proper needle positioning by means of contrast medium injection.
- Interlaminar infiltrations serve no diagnostic purposes.

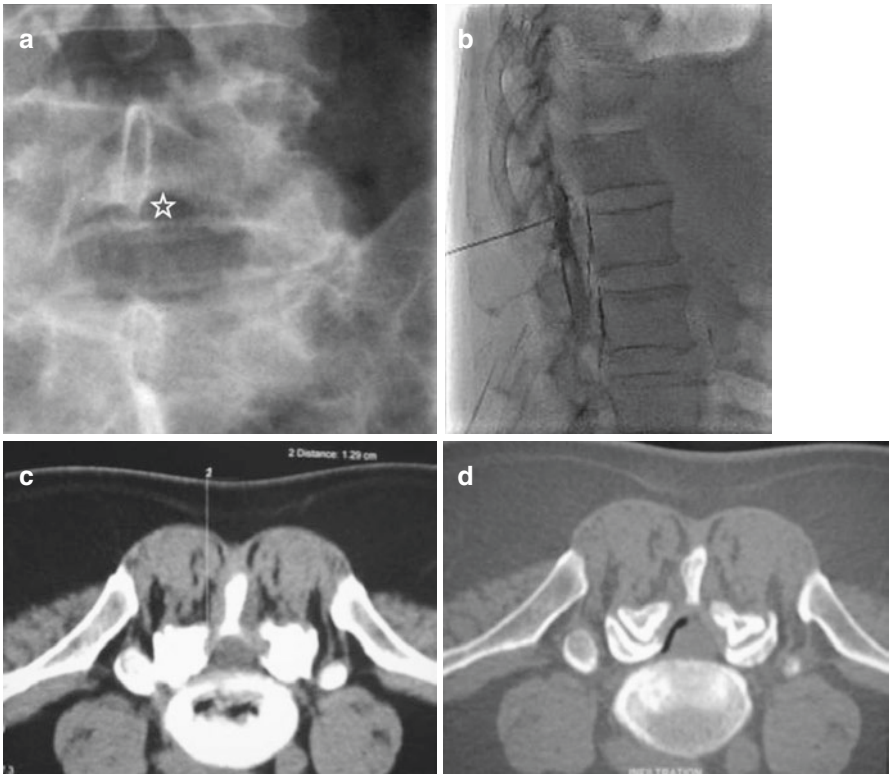

Fig. 17.6 (**a**) A-P projection; asterisk marks the target point for interlaminar epidural infiltration under fluoroscopy; (**b**) lateral projection illustrating needle inside the epidural space, contrast medium injection verifies proper needle position; (**c**) CT axial scan, entrance point in the skin and needle route are illustrated; needle is advanced under a posterior approach; (**d**) CT axial scan, air injection verifies proper needle position

- Occasionally posterior epidural space is an attractive alternative for injecting the solution.
- If you cannot approach the level of interest (e.g. due to severe stenosis of facet joint hypertrophy), perform the infiltration at the level above, and let gravity play its role.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 1–2 h (prior to discharge perform motor strength and sensory evaluation).
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post the infiltration because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.
- Follow-up reschedule within 7–10 days

Procedure-related symptoms and treatment:

- Infection is the most fearsome complication (<0.5%).

17.3.3 Caudal Approach

Indication:

- Spinal stenosis
- Operated spine
- Therapeutic infiltration (for pain reduction)

Contraindication:

- Coagulation pathology
- Local or systemic infection
- Pregnancy due to ionizing radiation's teratogenic effects
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- No medication

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- CT suite

Syringe and needle:

- 20 mL Luer-lock syringe for injected mixture
- 2.5–5 mL Luer-lock syringe for iodinate contrast medium
- 5–10 mL syringe for local anaesthesia (optional)
- 22 G, 70–90 mm spinal needle with Quincke type point
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- Long-acting corticosteroid (triamcinolone acetate, cortivazol, betamethasone injectable suspension, methylprednisolone suspension); recommended dose is up to 50 mg of triamcinolone acetate or 80 mg of methylprednisolone.

- Local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%); use local anaesthetics free of paraben or phenol in order to avoid steroid flocculation.
- 1–3 mL non-ionic iodinated myelographic contrast medium.
- Injected mixture for diagnostic and therapeutic purpose contains:
  - 1–1.5 mL long-acting corticosteroid
  - 1–1.5 mL local anaesthetic

Anatomy of the region:

- The boundaries of spinal canal in a circumferential route include the spinous process, two vertebral laminae, two vertebral pedicles, two transverse processes and the posterior vertebral wall.
- Epidural space lies beyond the flaval ligaments and contains fat, blood vessels, nerve roots and dural sac.
- The inferior margin of epidural space is the sacral hiatus.

Patient positioning:

- Patient lying in prone or lateral decubitus position

Technique:
Fluoroscopy:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- In A-P view in the lower sacral area, occasionally an inverted U-shaped orifice is seen, and this corresponds to the sacral hiatus which is the entry point to the epidural space from a caudal approach.
- A skin projection is marked and the needle is advanced under a posterior approach.
- Lateral view controls the depth of needle penetration.
- Contrast medium injection will verify the desired needle position inside the epidural space, outside the dura matter and not intravascularly (remember that dural sac extends until S2 level in adults) (Fig. 17.7).
- Inject the solution.

Tips and tricks:

- Corticosteroids act at cellular level and require a 3–5 day period for the effects of their action therefore the initial pain reduction is due to local anaesthetic; instruct patient to continue analgesic medication for the first 3–5 days.
- Larger volumes are required for caudal approach (15–20 mL), so dilute the steroid with sterile saline and local anaesthetic.

Fig. 17.7 Lateral projection illustrating needle through the sacrococcygeal hiatus inside the epidural space; contrast medium injection verifies proper needle position

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 1–2 h (prior to discharge perform motor strength and sensory evaluation).
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post the infiltration because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.
- Follow-up reschedule within 7–10 days

Procedure-related symptoms and treatment:

- Infection is the most fearsome complication (<0.5%).

17.4 Facet Joint

17.4.1 Infiltration

Indication:

- Unilateral or bilateral paravertebral neck pain; pain is aggravated on extension or rotation.
- Unilateral or bilateral paravertebral low back pain; pain is aggravated on extension or rotation, upon changing positions from sitting to standing.
- Local tenderness to palpation over the facet joint(s) of interest.
- Absence of radicular pain.
- Diagnostic injection.
- Therapeutic infiltration.

Contraindication:

- Coagulation pathology
- Local or systemic infection
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- No medication

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- CT suite

Syringe and needle:

- 2.5–5 mL Luer-lock syringe for injected mixture
- 2.5–5 mL Luer-lock syringe for iodinate contrast medium
- 5–10 mL syringe for local anaesthesia (optional)
- 22 G, 70–120 mm spinal needle with Quincke type point
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- Long-acting corticosteroid (triamcinolone acetate, cortivasol, betamethasone injectable suspension, methylprednisolone suspension); recommended dose is up to 50 mg of triamcinolone acetate or 80 mg of methylprednisolone.
- Local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%); use local anaesthetics free of paraben or phenol in order to avoid steroid flocculation.
- 1–3 mL non-ionic iodinated myelographic contrast medium; in case of allergy, use a gadolinium contrast medium.
- Injected mixture for diagnostic purpose contains:
  - 2.5 mL local anaesthetic
- Injected mixture for therapeutic purpose contains:
  - 1–1.5 mL long-acting corticosteroid
  - 1–1.5 mL local anaesthetic

Anatomy of the region:

- Facet joint (zygapophysial joint) is a synovial joint for the articulation of adjacent vertebral bodies.
- The posterior part of the joint lies in an oblique sagittal plane and is easily accessible.

- The posterior part of the joint is lined by a fibrous capsule.
- A posterior-inferior synovial recess extends beyond the capsule and is easily accessible.

Patient positioning:

- Patient lying in prone position for thoracic and lumbar spine
- Patient in sitting or prone position for cervical spine

Technique:
Fluoroscopy:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- The fluoroscopy beam is angulated at Scottie dog (lateral oblique) projection.
- Local anaesthesia at the puncture site is optional.
- With a course parallel to the fluoroscopy beam, advance the 22 G spinal needle through the capsule inside the facet joint; aim towards a target point located approximately at the joint's caudal margin (where the posterior-inferior recess lies).
- Proper intra-articular needle positioning is verified fluoroscopically with injection of 1–3 mL of iodinated contrast medium which will be dispersed inside the joint either lining its margins or being collected at the joint's recess (Figs. 17.8 and 17.9).
- Inject solution depending on the indication for the procedure.

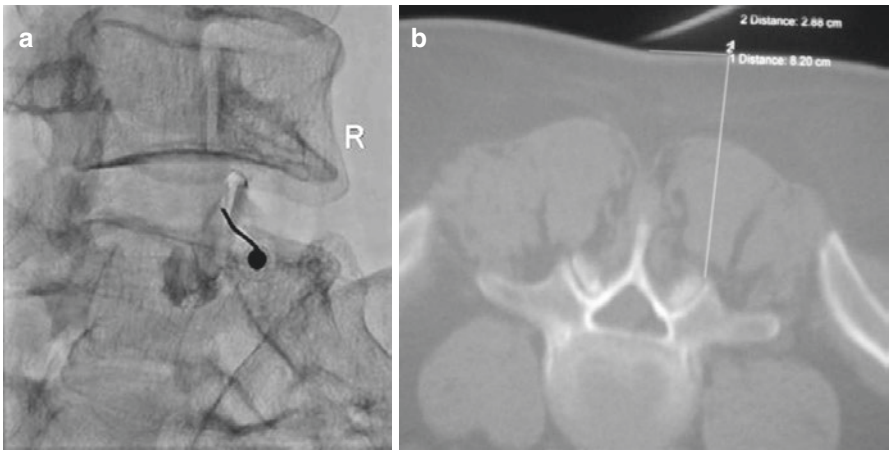

Fig. 17.8 (**a**) Scottie dog projection (oblique view); end plates of L4–L5 level are aligned; needle is inside the right L4–L5 facet joint; contrast medium injection verifies proper intra-articular needle position; (**b**) CT axial scan, entrance point in the skin and needle route are illustrated; needle is advanced under a posterior approach

Fig. 17.9 Lateral fluoroscopy view in the cervical spine; end plates of C5–C6; contrast medium injection verifies proper intra-articular needle position

Computed Tomography:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- Perform scans with 1–3 mm axial images; scan area should cover the whole vertebral disc-vertebral complex.
- Selection of entry point at the skin should provide a route parallel to the joint orientation.
- Local anaesthesia at the puncture site is optional.
- Advance the 22 G spinal needle through the ligaments and the capsule inside the facet joint under the selected route (parallel to the joint orientation); aim towards the joint's caudal part (a minor resistance loss might be felt when entering the joint).
- Proper intra-articular needle positioning is verified with CT scan postinjection of 1–3 mL of iodinated contrast medium which will be dispersed inside the joint either lining its margins or being collected at the joint's recess.
- Inject solution depending on the indication for the procedure.

Tips and tricks:

- A minor resistance loss might be felt when entering the joint.
- Corticosteroids act at cellular level and require a 3–5 day period for the effects of their action; therefore the initial pain reduction is due to local anaesthetic; instruct patient to continue analgesic medication for the first 3–5 days.
- Particulate corticosteroids are potential embolic agents in case of intravascular injection; avoid intravascular injection by verifying proper needle positioning by means of contrast medium injection.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15–30 min (prior to discharge perform motor strength and sensory evaluation).
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post the infiltration because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.
- Follow-up reschedule within 7–10 days

Procedure-related symptoms and treatment:

- Temporary pain exacerbation (2.5% of the cases) could be treated with oral analgesics.

17.4.2 Denervation

Indication:

- Unilateral or bilateral paravertebral neck pain.
- Unilateral or bilateral paravertebral low back pain; pain is aggravated on extension or rotation, upon changing positions from sitting to standing.
- Local tenderness to palpation over the facet joint(s) of interest.
- Absence of radicular pain.
- Therapeutic infiltration with short-term efficacy.

Contraindication:

- Coagulation pathology
- Local or systemic infection
- Patient unwilling to consent to the procedure

Pre- and post-procedural medications:

- No medication

Equipment:

- Fluoroscopy (X-ray fluoroscopic equipment with small focus and collimation, C-arm equipment, angiography suite with or without cone beam option)
- CT suite

Syringe and needle:

- RF generator
- RF needles
- RF electrodes
- 5–10 mL syringe for local anaesthesia
- Extension set with three cocks connecting of the needle and syringes

Injection drugs:

- Local anaesthetic (lidocaine hydrochloride 2% or bupivacaine hydrochloride 0.25–0.5%)

Anatomy of the region:

- Facet joint (zygapophysial joint) is a synovial joint for the articulation of adjacent vertebral bodies.
- Facet joints are innervated from branches of two consecutive median branch nerves.
- Any median branch nerve innervates two consecutive facet joints: the inferior part of the upper one and the superior part of the lower one.

Patient positioning:

- Patient lying in prone position for lumbar spine

Technique:
Fluoroscopy:

- Prepare sterile field of the region of interest, and apply strict sterility measures throughout the whole session (use scrubs, sterile drapes and coverings, gloves, etc.).
- The fluoroscopy beam is angulated at Scottie dog (lateral oblique) projection.
- Local anaesthesia at the puncture site is optional.
- With a course parallel to the fluoroscopy beam, advance the 22 G spinal needle; aim towards a target point located at the junction of transverse process and superior articulating process (Figs. 17.10 and 17.11).
- Proper needle positioning is confirmed by performing sensory and motor stimulation tests.
- Apply local anaesthetic.
- Perform the RF treatment.

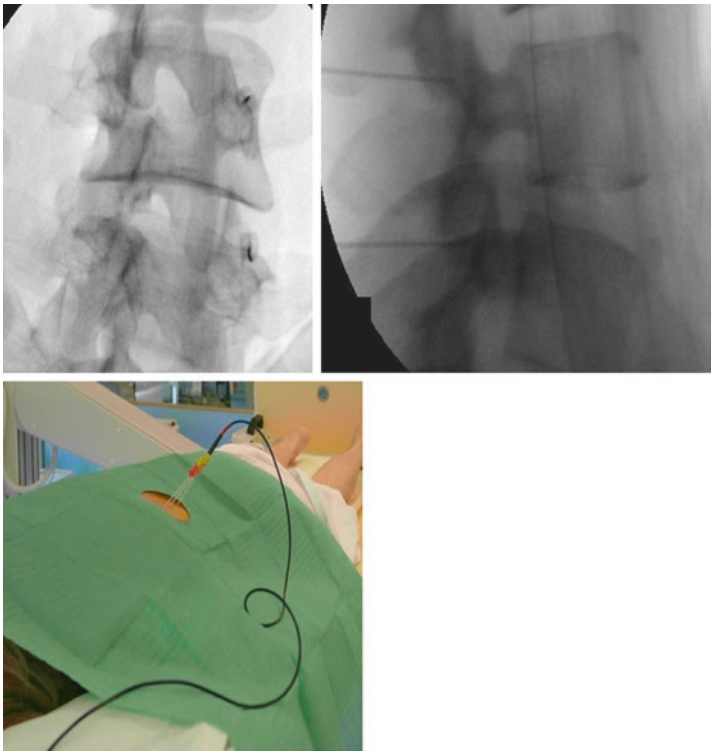

Fig. 17.10 Oblique (*upper left image*) and lateral (*upper right image*) views illustrating needle position during facet joint denervation. Needles are placed in two levels due to the dual nerve supply of the facet joint. Once needles are in position coaxially RF electrodes are introduced (*lower image*)

Fig. 17.11 Lateral fluoroscopy view illustrating needle's final position during facet joint denervation in the cervical spine

In case of CT-guided facet joint denervation, a similar direct axial approach is performed for each level. Once the needle is safely placed at the junction of transverse process and superior articulating process, perform sensory and motor stimulation tests, apply local anaesthesia and, then, perform the RF treatment.

Tips and tricks:

- Proper patient selection for facet joint denervation requires an efficient facet joint infiltration (even with short-term results).

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 30–60 min (prior to discharge perform motor strength and sensory evaluation).
- Patients exit the hospital with an accompanying person; they are instructed to avoid driving for several hours post the infiltration because they might experience temporary weakness or delayed reflexes due to the local anaesthetic.
- Follow-up reschedule within 7–10 days.

Procedure-related symptoms and treatment:

- Temporary pain exacerbation could be treated with oral analgesics.

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Symphysis Pubis Intra-Articular Procedures

18

Philip Robinson

Abbreviations

G	Gauge
PRP	Platelet-rich plasma
Rab	Rectus abdominis
SP	Symphysis pubis
US	Ultrasound

18.1 Symphysis Pubis, Anterior Approach

18.1.1 US Guidance

Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or overuse arthropathies [1–3]

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Contraindication:
General contraindications (see Chap. 1)
Pre- and post-procedural medications:

- No medication

Equipment:

- High-resolution ultrasound equipment with high-frequency linear transducer (14–18 MHz)

Syringe (depends on the indication for the procedure):

- 2 mL syringe for therapeutic injectations
- 5 mL syringe for anaesthetic

Needle:

- 20 G, 50 mm green needle
- Optional short extension set (<50 mm) for connecting the needle and syringes. Optional as do not need to avoid hand irradiation as with fluoroscopic guidance but can be useful to isolate the needle from inadvertent movement while injecting

Injection drugs (depends on the indication for the procedure):

- Anaesthetic: 1–2 mL 1% lidocaine
- Therapeutic injectations—corticosteroids: triamcinolone acetonide 40 mg/mL or other injectations (e.g. hyaluronic acid)

Anatomy of the region:

- The symphysis pubis is a non-synovial diarthrodial joint with the pubic articular surfaces covered by hyaline cartilage and separated by an intervening fibrocartilaginous disc (Fig. 18.1a) [4].
- The joint is the confluence for the thigh adductors (muscles and tendons), rectus abdominis and the medial aspect of the inguinal ligament.
- The adductor longus, brevis and gracilis have attachments to the pubic bone, pubic symphysis capsular tissues (and disc) merging with rectus abdominis (Fig. 18.1b) [4].
- This junctional area of anterior pubis, capsule and tendon origins also represents the centre of abnormality detected in MR series evaluating long-standing groin pain [3].

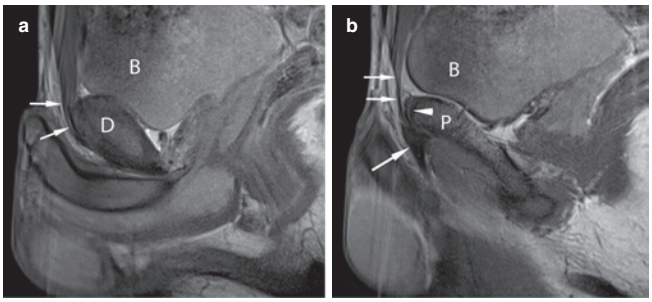

Fig. 18.1 (**a**) Sagittal T1w MR images show the bladder (B) posteriorly, the rectus abdominis/pyrimidalis tendons (*arrows*) merging with anterior symphysis capsule and disc (D). (**b**) Lateral to a shows the pubic body (P) with the rectus abdominis tendon (*arrows*) and adductor longus tendon (*large arrow*) merging anteriorly

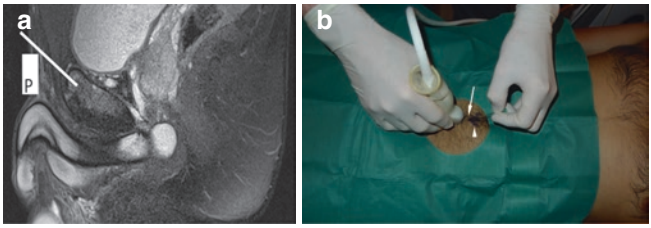

Fig. 18.2 (**a**) Sagittal PDw MR image shows probe position (P) and superior needle approach (*line*). (**b**) Operator scanning sagitally in aseptic field having marked superior end of the probe (*arrowhead*) with needle entry into the unmarked skin between the mark and probe

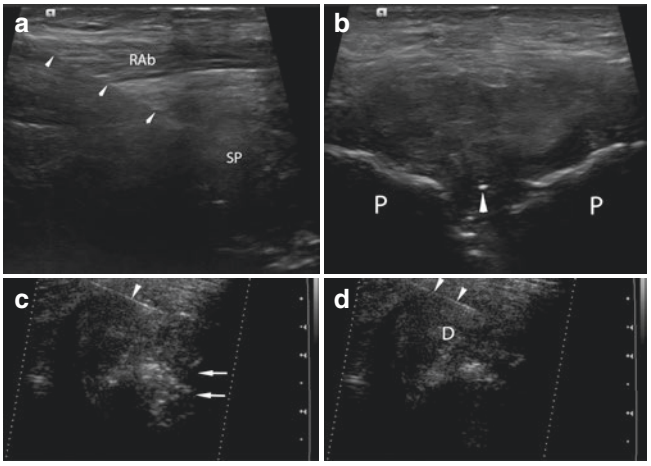

Fig. 18.3 (**a**) Longitudinal ultrasound image shows the needle (*arrowheads*) passing from superior end to the probe, through the rectus abdominis (Rab) in the joint (SP). (**b**) Transverse ultrasound image shows the needle tip (*arrowhead*) in the joint between the pubic bodies (P). (**c**) Angled ultrasound image shows the needle and echogenic disc (D) before injecting. (**d**) After injection echogenic injectate flows away (*arrows*) from the needle tip (*arrowhead*)

Patient positioning:

- The patient is supine and the thighs are relaxed and slightly abducted.

Technique:

- Scan the symphysis pubis joint in the sagittal plane, and centre over disc/anterior joint space, and mark just distal to superior probe margin.
- Prepare sterile field for the region of the mark, and infiltrate the skin and soft tissue with local anaesthetic.
- Connect the needle and appropriate syringe (+/− extension set).
- The injection needle is advanced freehand under direct ultrasound visualisation obliquely and inferiorly into the anterior and superior aspect of the joint (Figs. 18.2 and 18.3).
- Inject solution depending on the indication for the procedure with injectate flowing away from the tip of the needle (Fig. 18.3c, d).
- Joint volume capacity is usually less than 2 mL.
- Pressure on the needle tract when withdrawing the needle to prevent corticosteroid reflux if used.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient told not to perform heavy physical activity for 3–4 days if possible especially any activity that involves side-to-side motion or sudden changes of direction.

Procedure-related symptoms and treatment:

- Pain at the puncture site can be treated with cold compression and simple analgesia.
- Feeling of joint fullness is usually transient.

18.1.2 X-Ray Guidance

Indication:

- Diagnostic aspiration
- Therapeutic injection in degenerative, inflammatory or overuse arthropathies [1–3]

Contraindication:

- General contraindications (see Chap. 1)

Pre and post procedural medications:

- No medication

Equipment:

- X-ray fluoroscopic equipment with small focus and collimation

Syringe:

- 2 mL syringe for therapeutic injectation
- 5 mL syringe for anaesthetic
- 2 mL syringe for iodinated contrast

Needle:

- 20 G, 50 mm green needle or 22 g spinal needle
- Short extension set (<50 mm) for connecting the needle and syringes

Injection drugs:

- Anaesthetic: 1–2 mL 1% lidocaine
- 1–2 mL iodinated contrast
- Therapeutic injectation—corticosteroids: triamcinolone acetonide 40 mg/mL or other injectate (e.g. hyaluronic acid)

Anatomy of the region:

- The symphysis pubis is a non-synovial diarthrodial joint with the pubic articular surfaces covered by hyaline cartilage and separated by an intervening fibrocartilaginous disc (Fig. 18.4a) [4].
- The joint is the confluence for the thigh adductors (muscles and tendons), rectus abdominis and the medial aspect of the inguinal ligament.
- The adductor longus, brevis and gracilis have attachments to the pubic bone, pubic symphysis capsular tissues (and disc) merging with rectus abdominis (Fig. 18.4b) [4].
- This junctional area of anterior pubis, capsule and tendon origins also represents the centre of abnormality detected in MR series evaluating long-standing groin pain [3].

Patient positioning:

- The patient is supine and the thighs are relaxed and slightly abducted.

Technique:

- Ensure the symphysis pubis joint is parallel to the beam (Fig. 18.5a).
- Position a metallic pointer in the midpoint of the joint lucent line, and mark on the patient skin using indelible marker.
- Prepare sterile field for the region of the marker.
- Infiltrate the local anaesthetic in the skin and subcutaneous tissues.
- Connect the injection needle, extension set and appropriate syringe.
- The injection needle is advanced directly into the anterior aspect of the joint with the position confirmed by a minimum amount of iodinated contrast extending into the primary joint cleft, flowing away from the needle tip. Position controlled using fluoroscopy with light visor collimation (Fig. 18.5b).
- Inject solution depending on the indication for the procedure.
- Joint volume capacity is usually less than 2 mL.
- Pressure on the needle tract when withdrawing the needle to prevent corticosteroid reflux if used.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient told not to perform heavy physical activity for 3–4 days if possible especially any activity that involves side-to-side motion or sudden changes of direction.

Procedure-related symptoms and treatment:

- Pain at the puncture site can be treated with cold compression and simple analgesia.
- Feeling of joint fullness is usually transient.

18.1.3 Adductor Longus Origin/Capsular Dry Needling

Indication:

- Therapeutic injection in degenerative, inflammatory or overuse tendinopathy [1]

Contraindication:

- General contraindications (see Chap. 1)

Pre- and post-procedural medications:

- No medication

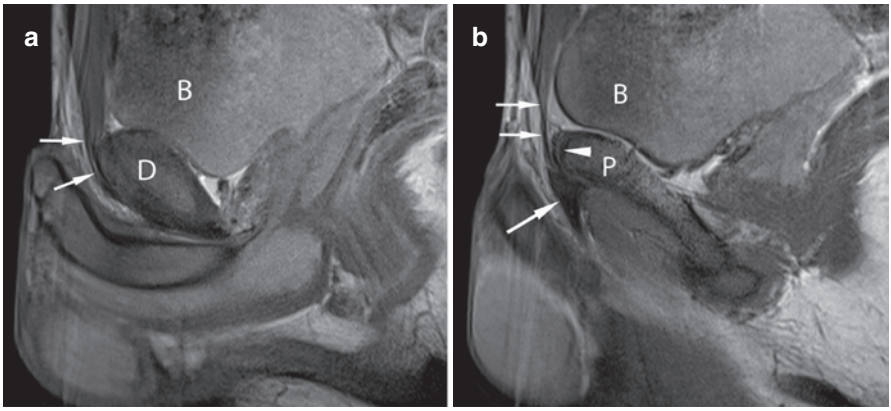

Fig. 18.4 (**a**) Sagittal T1w MR images show the bladder (B) posteriorly, the rectus abdominis/pyrimidalis tendons (*arrows*) merging with anterior symphysis capsule and disc (D). (**b**) Lateral to a shows the pubic body (P) with the rectus abdominis tendon (*arrows*) and adductor longus tendon (*large arrow*) merging anteriorly

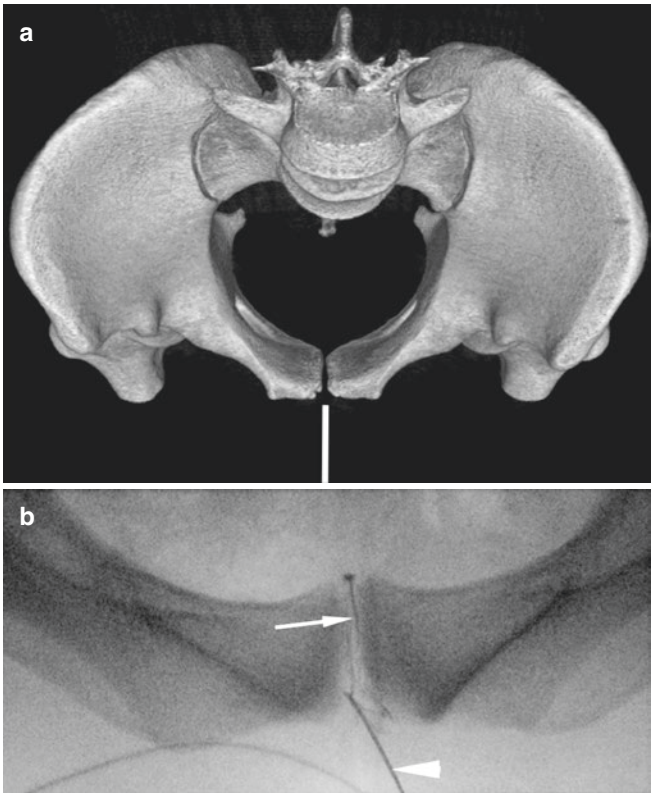

Fig. 18.5 (**a**) Reconstructed CT pelvis volume viewing the symphysis pubis from above shows the anterior needle approach for fluoroscopic technique. (**b**) Fluoroscopic image shows needle position (*arrowhead*) in joint with contrast flowing superiorly (*arrow*) through the primary cleft (image courtesy of Prof E. Schilders, London, UK)

Equipment:

- High-resolution ultrasound equipment with high-frequency linear transducer (14–18 MHz)

Syringe (depends on the indication for the procedure):

- 2 mL syringe for therapeutic injectation
- 5 mL syringe for anaesthetic

Needle:

- 20 G, 50 mm green needle
- Optional short extension set (<50 mm) for connecting the needle and syringes. Optional as do not need to avoid hand irradiation as with fluoroscopic guidance but can be useful to isolate the needle from inadvertent movement while injecting

Injection drugs (depends on the indication for the procedure):

- Anaesthetic: 1–2 mL 1% lidocaine
- Therapeutic injectation—corticosteroids: triamcinolone acetonide 40 mg/mL or other injectate (e.g. PRP)

Anatomy of the region:

- The symphysis pubis is a non-synovial diarthrodial joint with the pubic articular surfaces covered by hyaline cartilage and separated by an intervening fibrocartilaginous disc (Fig. 18.6a) [4].
- The joint is the confluence for the thigh adductors (muscles and tendons), rectus abdominis and the medial aspect of the inguinal ligament.
- The adductor longus, brevis and gracilis have attachments to the pubic bone, pubic symphysis capsular tissues (and disc) merging with rectus abdominis (Fig. 18.6b) [4].
- This junctional area of anterior pubis, capsule and tendon origins also represents the centre of abnormality detected in MR series evaluating long-standing groin pain [3].

Patient positioning:

- The patient is supine and the thighs are relaxed, slightly abducted and externally rotated (Fig. 18.7a).

Technique:

- Scan the symphysis pubis joint in the transverse plane, and centre over disc/anterior joint space, and then move the probe laterally and inferiorly to the symptomatic side over the adductor longus tendon at its junction with the SP capsule and mark lateral to the probe margin (Fig. 18.7a).

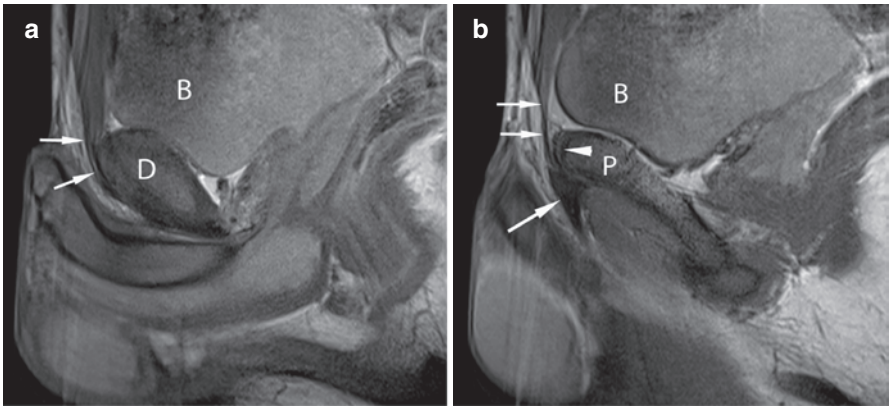

Fig. 18.6 (**a**) Sagittal T1w MR images show the bladder (B) posteriorly, the rectus abdominis/pyrimidalis tendons (*arrows*) merging with anterior symphysis capsule and disc (D). (**b**) Lateral to a shows the pubic body (P) with the rectus abdominis tendon (*arrows*) and adductor longus tendon (*large arrow*) merging anteriorly

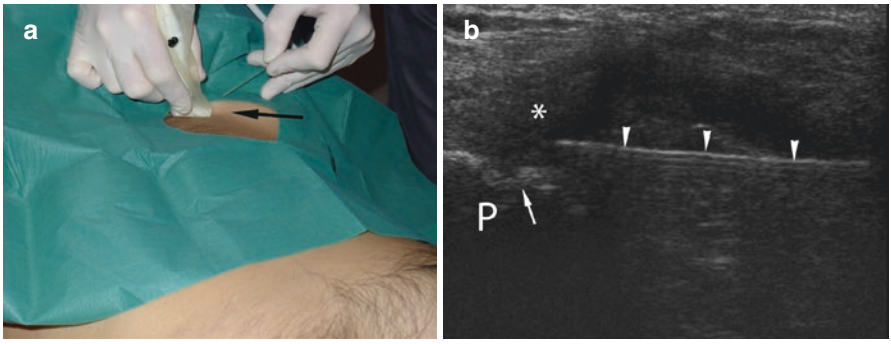

Fig. 18.7 (**a**) Operator scanning transversely in aseptic field at lateral symphysis pubis having marked the lateral end of the probe with needle entry (*arrow*) into the unmarked skin between the mark and probe. (**b**) Transverse ultrasound image shows the pubis (P) with normal cortical irregularity (*arrow*). Using a lateral approach, the needle (*arrowheads*) is within the hypoechoic capsular and adductor tissues (*)

- Prepare sterile field for the region of the mark, and infiltrate the skin and soft tissue with local anaesthetic.
- Connect the needle and appropriate syringe (+/− extension set).
- The injection needle is advanced freehand under direct ultrasound visualisation into the tendon/capsule junction (Fig. 18.7b).
- Infiltrate further anaesthetic into the soft tissues followed by injectation (e.g. corticosteroid or PRP) or dry needling depending on the treatment plan.
- Pressure on the needle tract when withdrawing the needle to prevent corticosteroid reflux if used.

Aftercare:

- Adhesive tape at the puncture site.
- Patient should be observed for 15 min.
- Patient told not to perform heavy physical activity for 3–4 days if possible especially any activity that involves side-to-side motion or sudden changes of direction.

Procedure-related symptoms and treatment:

- Pain at the puncture site can be treated with cold compression and simple analgesia.

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