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INTERVENTIONAL MSK PROCEDURES SPECIAL FEATURE: REVIEW ARTICLE

Interventional MSK procedures: the hip

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ABSTRACT

Percutaneous musculoskeletal procedures are widely accepted as low invasive, highly effective, efficient and safe methods in a vast amount of hip pathologies either in diagnostic or in therapeutic management. Hip intra-articular injections are used for the symptomatic treatment of osteoarthritis. Peritendinous or intrabursal corticosteroid injections can be used for the symptomatic treatment of greater trochanteric pain syndrome and anterior iliopsoas impingement. In past decades, the role of interventional radiology has rapidly increased in metastatic disease, thanks to the development of many ablative techniques. Image-guided percutaneous ablation of skeletal metastases provides a minimally invasive treatment option that appears to be a safe and effective palliative treatment for localized painful lytic lesion. Methods of tumour destruction based on temperature, such as radiofrequency ablation (RFA) and cryotherapy, are performed for the management of musculoskeletal metastases. MR-guided focused ultrasound surgery provides a non-invasive alternative to these ablative methods. Cementoplasty is now widely used for pain management and consolidation of acetabular metastases and can be combined with RFA. RFA is also used to treat benign tumours, namely osteoid osteomas. New interventional procedures such as percutaneous screw fixation are also proposed to treat non-displaced or minimally displaced acetabular roof fractures.

INTRODUCTION

Hip intra-articular injections have been used for many years as a diagnostic and/or therapeutic tool and even today remain an effective treatment for osteoarthritis providing pain relief. Ultrasound guidance can be used for injections in patients with greater trochanteric pain syndrome and CT scan guidance for corticosteroid injection in the management of anterior iliopsoas impingement after total hip arthroplasty. Interventional radiology plays a major role in the management of bone tumours. Several image-guided percutaneous ablation methods have proved effective for palliation of metastases involving bone and for the treatment of benign bone tumours, namely osteoid osteoma. To treat pain and consolidate the bone, cementoplasty could be required. In the therapeutic management of acetabular fractures, the combination of CT and fluoroscopy guidance could have a place in treating non-displaced or minimally displaced acetabular roof fractures.

INTRA-ARTICULAR ASPIRATIONS AND INJECTIONS

Indications

Intra-articular injections are widely used for both diagnostic and therapeutic purposes in the hip. Only four

randomized, controlled trials of intra-articular corticosteroid injections in hip osteoarthritis have been reported *via* fluoroscopic or ultrasound guidance.^{1–4} In comparison to placebo, saline or local anaesthetic injections, corticosteroid injections have demonstrated a definite short-lived effect on acute pain and improvement of the range of motion in osteoarthritis, but with no significant persistent effect at the 3-month follow-up in most studies. Intra-articular injection of hyaluronic acid is still controversial in the management of hip osteoarthritis (OA), as its efficacy has not been clearly established.^{3,5–9} More recently, intra-articular injections of platelet-rich plasma (PRP) have been proposed but presently there is a paucity of data supporting its wide use in clinical practice.¹⁰

Corticosteroid injections have also demonstrated some efficacy in pain relief in inflammatory joint diseases such as rheumatoid arthritis and ankylosing spondylitis.¹¹ Intra-articular injections of anaesthetics can also be performed for diagnostic purposes, mainly to distinguish symptomatic joint disease from potential extra-articular sources of hip pain.¹²

METHODS AND MATERIALS

The procedure must be performed under strict aseptic conditions. The patient is placed on a fluoroscopic table in a supine position, with a wedge under the knee. A few millilitres of local anaesthetic can be injected into the subcutaneous tissues at the entrance point. A small gauge, adequate length needle (22- to 20-gauge needle) is introduced under fluoroscopic guidance from a lateral or an anterior approach, avoiding the femoral vessels until it reaches the femoral neck at the junction with the femoral head. The intra-articular position of the needle can be confirmed by the injection of 1 or 2 ml of contrast medium. Joint fluid is aspirated, if present. Then, the therapeutic injection can be started. In the same way, a diagnostic aspiration in patients with joint effusion can also be performed in order to analyse the articular fluid. Its main indication is a clinical suspicion of septic arthritis.

The procedure can also be performed under ultrasound guidance. The approach and needle are usually the same as those used with the fluoroscopic technique. A multifrequency linear probe is placed on the skin to visualize the femoral head–neck junction in the long axis. The needle is advanced anterosuperiorly into the joint capsule at the femoral head–neck junction. The intra-articular position is confirmed by the injection of a few millilitres of anaesthetic diffusing as a hyperechoic filling (Figure 1).

PERITENDINOUS/INTRABURSAL INJECTIONS

Greater trochanteric syndrome

Indications

Greater trochanteric pain syndrome is more often the result of gluteus medius tendinopathy.¹³ Trochanteric bursitis is less

common by itself and is seen more often in association with gluteus medius tendinopathy.¹⁴ Tendinopathy of the gluteus minimus occurs less frequently.

Corticosteroid injections provide good short-term outcomes but they have a declining effectiveness of pain relief over a few months, with high rates of recurrence. Failure to respond to injection even temporarily suggests other pathology, including spinal or intra-articular hip disorder.

Materials and technique

A combination of local analgesic and corticosteroids may be injected under direct ultrasonographic guidance. Fluoroscopic guidance is less frequently used. Patients are positioned on their contralateral side with both hips slightly flexed. Local skin anaesthesia is performed under sterile conditions after cutaneous asepsis. Ultrasound-guided injection is performed using anterolateral approach with a 22- to 25-gauge needle *via* a transverse or longitudinal approach.^{14,15} Peritendinous fluid pooling confirms proper needle positioning (Figure 2). Ultrasound can also be used to guide aspiration of calcifications when present. When bursal effusion is demonstrated, it should be aspirated to improve medication concentration and reduce any possible impingement.¹⁵ The needle is guided inside the affected bursa by approaching the greater trochanter from a lateral or posterolateral direction, depending on the localization of the affected bursa.¹⁵ Ultrasound-guided tendon fenestration may also be a consideration.¹⁶ The use of PRP, autologous blood in and around tendons at any site is not currently supported by strong clinical evidence (Figure 3).

Iliopsoas impingement

Indications

Iliopsoas bursal/peritendinous injections are useful in determining the cause of hip pain after hip replacement. Complete or near complete relief of the symptoms confirms the diagnosis of Iliopsoas impingement. Such injections may provide temporary or permanent symptomatic relief and may postpone or avoid

Figure 1. Ultrasound-guided hyaluronic acid injection for hip osteoarthritis. Longitudinal ultrasonographic scan below the inguinal ligament of the hip joint. The surfaces of the femoral head and the neck of the femoral bone are noted. The 20-gauge spinal needle is indicated with arrows. The accuracy of the injection is confirmed by direct visualization of a few millilitres of anaesthetic (lidocaine 1%) filling the capsule. Then, the hyaluronic acid is injected.

Figure 2. Ultrasound-guided peritendinous corticosteroid injection. Tip of 22-gauge spinal needle (arrow) is placed at the surface of the lateral facet insertion of the gluteus medius tendon. Peritendinous corticosteroid injection is performed (arrowhead). Note the cortical irregularities of the surface of the greater trochanter.

Figure 3. Ultrasound-guided platelet-rich plasma (PRP) injection. Tip of 22-gauge spinal needle (arrow) is placed in the lateral facet insertion of the gluteus medius tendon and intra-tendinous PRP injection is performed.

surgical intervention. Failure of the injection to provide relief may indicate an alternate cause for hip pain, such as labral tears.¹⁷ The only potential immediate complication is a transient femoral nerve palsy, which seems to be related to the effect of lidocaine infiltrating the deep tissue during needle placement.

Ultrasound-guided percutaneous tenotomy for the treatment of iliopsoas impingement utilizing a modified 18G coaxial, beveled needle might represent a promising additional management option for iliopsoas impingement after total hip replacement.¹⁸

Materials and technique

When ultrasound guidance is used, the iliopsoas tendon is identified at the level of the acetabular brim with transverse imaging. Following local anaesthesia, a 22- or 20-gauge needle is advanced into the iliopsoas bursa deep to the tendon at the level of acetabular brim, using a lateral to medial approach under real-time sonographic imaging.¹⁹ The injection allows direct distention of the iliopsoas bursa and/or visibility of microbubbles around the tendon. The needle is positioned into the bursa if fluid distention is present.¹⁷ When there is no bursal fluid, the needle is placed deep to the iliopsoas tendon at the point where impingement is maximal.

Such injections are more rarely performed under fluoroscopic or CT guidance (Figure 4).

PERCUTANEOUS BIOPSIES

Biopsies of bone lesions of the hip are frequently performed for tumour pathological determination and mainly CT guided.^{20–22} Results are similar to those of surgical open biopsies with less cost and complications.^{20–22} They respond to the same general requirements as in other locations. The areas of solid tumoural portions and cortical destruction areas must be identified by imaging to improve realization and quality of samples.²³ In case of possible primary sarcoma, a co-ordinate and co-operative discussion with orthopaedic surgeon is mandatory.^{20,23} Indeed, surgical resection should include a biopsy tract to allow a “limb-sparing surgery” and avoid a wider resection or irradiation and a higher risk of recurrence. Anatomically based guidelines have been proposed for hip biopsy approach.²³ The choice of core needle size and type depends on the location and appearance of the lesion. A coaxial system allows for avoidance of tissue contamination along the biopsy track, and fine needle aspiration should be performed after biopsy.²³

Figure 4. (a, b) Iliopsoas impingement on acetabular component. (a) The injection is made under CT guidance in an extra-articular position at the anterior border of the cup in contact with the iliopsoas. (b) Post procedure CT scan with contrast-medium in the iliopsoas bursa.

PERCUTANEOUS TECHNIQUES OF ABLATION IN METASTASES

Patients with skeletal metastases are often inadequately relieved by standard treatments. In addition, analgesic drug treatment may be inadequate or associated with adverse reactions. To combat recalcitrant pain, several alternative, image-guided ablative methods have been developed.²⁴ The term “ablation” refers to the local destruction of the tumour by means of local deposition of some form of energy [radiofrequency (RF), laser, microwave, ultrasound and cryoablation].^{24–26} The aim of these techniques is to provide reduction of pain and improvement of the quality of life. They are performed under strict sterile conditions. The decision for such treatment must be multidisciplinary, made together by the interventional radiologist, the radiotherapist, the pain specialist, the medical oncologist and the surgeon. Contraindications are severe coagulation disorders and systemic or local infection.

Radiofrequency ablation

Indications

Radiofrequency ablation (RFA) utilizes a high-frequency alternating current that is emitted from the tip of a needle electrode placed directly into tissues. The current causes frictional heating and cell death through coagulative necrosis.²⁵

The mechanisms of action responsible for decreased pain include either direct destruction of sensory nerve fibres in the bone surrounding the metastasis or their decreased stimulation by reduction of the tumoural volume. Destruction of tumour cells that produce nerve-stimulating cytokines [such as tumour necrosis factor- α (TNF- α)] and inhibition of osteoclast activity are also incriminated.^{27–29} Pain reduction can occur/develop within the first 24 h in some patients and during the first week in the majority of them.^{26,30–33} Existing pathological fractures and smaller tumour size appear to be predictive parameters of success when selecting patients for this procedure.³³ Successful palliation also appears to be related to the percentage of bone tumour interface.³³ Complications include second-degree skin burn at the grounding pad site, acetabular fracture and neuropathic pain.^{31,32}

Materials and technique

In the hip, the procedure is generally performed under CT guidance^{26,32,33} in patients under conscious sedation^{26,33} or general anaesthesia.^{30–32} Lesion diameter is estimated on a CT scanner before the procedure in order to evaluate the feasibility of electrode positioning and ablation. A single ablation is typically performed for osteolytic lesions inferior to 3 cm in diameter. For sizes over 3 cm^{26,31} or over 4 cm,^{32,33} two or more electrode placements are needed. The RF electrodes currently used are either straight internally cooled electrodes or electrodes with deployable tines. The active tip may be chosen in different lengths or configurations. The equipment used varies depending on the amount of bone destruction required: deployable electrodes need sufficient tumour tissue volume to be opened. Two dispersive electrode-grounding pads are placed on the patient's thighs at equidistant sites from the RF source.

If the cortical bone is preserved, a 14-gauge³² coaxial bone biopsy needle is placed into the lesion to prepare the path for the

electrode. After the core is removed, the inner trephine needle is withdrawn, and the RF electrode is placed directly into the metastasis. For tumours that have destroyed the bone cortex, the RF electrode is placed directly into the metastasis (Figure 5). The energy deposited by the electrode is controlled with a generator. Once the target temperature is obtained (80–110°C), this temperature must be maintained for a minimum of 4 min, with a goal of 5–15 min.

Immediate post-procedural pain must be treated with either epidural or parenteral opioid analgesics.

Cryoablation

Indications

Cryoablation is also effective in treating painful metastases.^{34,35} Percutaneous cryoprobes allow delivery of argon gas, resulting in rapid cooling, reaching -100°C within a few seconds.²⁴ This technique is carefully monitored under CT because of the visibility of the ice ball as a well marginated, hypodense zone, with its outer edge corresponding to 0°C .³⁶ Cryoablation can be performed confidently in close proximity to critical structures owing to the visibility of the ice ball with non-contrast CT imaging. Another advantage of cryoablation relative to RFA is that patients treated with cryoablation do not experience increased pain during the procedure or in the immediate post-treatment period.³⁷ Infection in the treatment area has been reported in one patient.³⁴

Materials and technique

Patients are treated under general anaesthesia or moderate sedation. A single cryoprobe is placed for lesions 2 cm or less in diameter. For larger lesions, two to seven additional cryoprobes can be placed with CT guidance.³⁷ A freeze–passive thaw–freeze cycle is performed with a goal of 10–8–10 min, respectively, for the cycle. CT imaging is repeated every 2–5 min to monitor the location and extent of the ice ball.³⁴ After completion of the final

Figure 5. Image of a patient with a painful metastasis of the right iliac bone. The patient is in the prone position. CT scan image shows the multitoned expandable RF electrode deployment (arrow) in the expansive lytic lesion involving gluteal musculature and iliac muscle.

freeze of the cryoablation procedure, the cryoprobes are warmed with active heating until the temperature reaches $>20^{\circ}\text{C}$. The cryoprobes are then withdrawn.

Microwaves ablation

Indications

Microwave energy is one of the more recent developments in tumour ablation. Microwave ablation refers to the use of all electromagnetic methods for inducing tumour destruction by using devices with frequencies of at least 900 MHz.³⁸ The potential benefits of this technology include consistently higher intra-tumoural temperatures, larger tumour ablation volumes, faster ablation times, ability to use multiple applicators, improved convection profile and less procedural pain.³⁸ Additionally, microwave ablation does not require the placement of grounding pads. A few limited reports of treatment of patients with metastatic disease have been reported with promising results.^{39,40}

Materials and technique

Percutaneous microwave ablation is usually performed with the patient under conscious sedation⁴⁰ although in certain situations when procedural pain is problematic, a general anaesthesia may be required.³⁸ After local anaesthesia, a thin microwave antenna is introduced into the lesion under CT guidance. Then, an electromagnetic microwave is emitted from the exposed, non-insulated portion of the antenna. Thanks to the properties of the electromagnetic wave, the device has not to be grounded which avoids the problem of grounding pad burns.³⁸

MR-guided focused ultrasound surgery

Indications

MR-guided focused ultrasound surgery (MRgFUS) corresponds to a non-invasive thermal ablation method that uses extracorporeal-focused ultrasound energy to heat and destroy tissues without the need for invasive placement of applicators.^{41,42} This technology takes advantage of the bone's high acoustic absorption of ultrasound energy to palliate pain, presumably through destruction of periosteal innervation. MRI is used to target the tumour, and MRI-based thermometry is used to monitor and control energy deposition.^{41–43} This technique combines excellent tumour delineation of MRI for targeting, immediate thermal feedback during therapy monitoring and a completely non-invasive tumour ablation treatment.⁴³ A few studies have shown MRgFUS to produce effective pain palliation in both osteoblastic and osteolytic bone metastases.^{41–43} Potential complications include skin burns, injury to heat-sensitive structures and slight transitory increase in pain immediately after the procedure.⁴¹

Materials and technique

Patients are treated under conscious sedation and analgesia.⁴¹ Coronal, sagittal and axial T_2 weighted MR images are obtained to localize and define the target lesion. The patient is placed in the optimal position.⁴³ The targeted lesion is positioned directly in contact with the MR bed, which contains the high-energy ultrasound transducer to ensure efficient propagation of the ultrasound energy to the target area. The transducer is housed in a water bath in the MR table and is coupled to the patient's skin by using a moistened gel pad.^{42,43} The MRI-guided focused

ultrasound system generates a treatment plan by utilizing imaging data obtained from the MRI sequences and computes the exact number of treatment sonications needed to complete the desired treatment. At the beginning of each procedure a number of low-power sonications are performed to ensure the targeting accuracy in three dimensions. Treatment at therapeutic power levels begins after a mild increase in the temperature at the expected position is detected. Throughout the treatment, each sonication's location and the temperature elevation in the adjacent tissue to the targeted bone are monitored in real time.^{41–43}

Cementoplasty

Indications

Percutaneous cementoplasty with polymethylmethacrylate (PMMA) is an effective palliative treatment for painful unresectable osteolytic hip and pelvis metastases.^{44–46} Its main effect is early and frequently striking pain relief, probably attributable to tumour necrosis and to reduced activity of pain-sensitive periosteal nerves by means of internal trabecular stabilization. The degree of filling of the lesion does not seem to be correlated with the analgesic response. Methyl methacrylate injection of weight-bearing parts of the acetabulum may also allow improvement in walking.^{44–49} The decision to carry out this procedure should be made by a multidisciplinary team including interventional radiologists, orthopaedic surgeons, oncologists and radiotherapists. At least, CT should be performed before the procedure to assess the exact location and extent of the lesion and the presence of cortical destruction or fracture. Contraindications are severe coagulation disorders, systemic or local infection and purely osteosclerotic metastases. This procedure is particularly recommended for acetabular lesions which are not too extensive, allowing a mechanical effect to be expected,⁴⁶ but larger bone destructions can also be treated.^{47,49}

Side effects are transient worsening of pain and fever due to inflammatory reaction,⁴⁴ which can be minimized by the administration of non-steroidal anti-inflammatory drugs. Leakage of bone cement into the joint space is the principal complication associated with this technique. It is favoured by the presence of a cortical destruction and by a liquid consistency of the cement.^{44,45,47} Sciatica due to cement leak in contact with sciatic nerve has also been reported.⁴⁵

Percutaneous trochanteroplasty with the aim of providing pain relief and structural stability has also been reported in osteolytic myelomatous lesions.⁵⁰

Materials and technique

The procedure is performed in patients under deep sedation or local anaesthesia.^{44,45,48,49,51} The patient is positioned on a CT scanner table or a fluoroscopic table. The procedure is performed under strict aseptic conditions. The skin access point and the needle direction are defined on the basis of pre-operative imaging. The skin, the subcutaneous soft tissues and the periosteum are anesthetized. Then, a 10- to 14-gauge diamond-shaped or bevel-shaped needle is advanced into the osteolytic lesion. To avoid major complications, the needle should be kept at a safe distance from large nerves (sciatic and pudendal nerves).⁴⁹ After successful needle placement, the acrylic cement is prepared. To minimize

cement leaks, PMMA must be injected during the pasty polymerization phase. The cement injection is monitored during tumour filling and must be stopped if leakage into the articular space or soft tissues is detected (Figure 6).

At the end of the procedure, the needle is removed carefully to avoid PMMA leakage and a CT scanner is performed for a more precise determination of the filling and to visualize possible PMMA leaks. The patient is asked to remain at rest for 1 h following the procedure and then can gradually increase mobility and weight bearing.

Cementoplasty and radiofrequency ablation

Indications

Cementoplasty may be preceded by RFA.^{52–56} This latter procedure is theorized to reduce pain via local destruction of pain-sensitive nerves as well as through decreased production of cytokines and growth factors through tumour necrosis.⁵⁶ Tumour necrosis allows an easier distribution of the cement within the lesion, thus decreasing the risk of cement leakage. It also produces local thrombosis of the veins, which reduces the risk of embolization of viable tumoural cells displaced by the mechanical effect of cement injection.⁵⁵ Cement extravasation in contact with the sciatic nerve responsible for a transitory mixed sensory disturbance has been reported in one patient.⁵⁶

Materials and technique

The technique is very similar to cementoplasty but substantially longer because of combined procedures. RFA is performed under general anaesthesia or conscious sedation.⁵³ Biplane fluoroscopy, CT or CT with C-arm fluoroscopy can be used for the guidance of the procedure.^{53,56} After local anaesthesia, a RF electrode with active tines forming an umbrella-shaped array or a straight electrode is then advanced up to the farthest part of the osteolytic lesion (Figure 7a). Purely osteosclerotic metastases, which preclude needle introduction and/or RF probe deployment, are contraindicated.⁵⁶ RF temperature is maintained at a maximum of 95° for a minimum of 6–10 min. The energy deposited by the electrode is controlled with a generator (Figure 7b). Immediately after the RFA procedure, PMMA is injected (Figure 7c)

PERCUTANEOUS ABLATION OF OSTEIOD OSTEOMA

Indication

Osteoid osteoma is a relatively common benign osteogenic tumour that occurs more often in children and young adults. The treatment of this tumour is achieved with complete removal of the nidus. Several CT-guided percutaneous techniques have been employed to achieve removal or destruction of the nidus with minimal invasiveness, including thermal

Figure 6. (a–c) Patient with a painful lytic metastasis of the right acetabulum (a). The patient is in supine position. Under CT guidance, a vertebroplasty needle is advanced into the bone to reach the correct position inside the lesion, then polymethylmethacrylate (PMMA) is injected. (b) Coronal CT image obtained after cement injection shows a slight intra-articular PMMA leak (arrow). (c) Sagittal CT image obtained after cementoplasty shows good lesion filling.

Figure 7. (a–c) Images in a patient with a painful metastasis with pathological fracture of the left iliac bone. (a) The patient is in the prone position on CT table. Radiofrequency ablation (RFA) is performed by using a multitined expandable RF electrode. (b) Axial CT after the RFA reveals microbubble formation in the treated area. (c) After RFA, bone cement is injected. Axial CT scan demonstrates the good lesion filling.

destruction by means of laser photocoagulation or RFA.^{57–65}

The hip is the most common location of intra-articular osteoid osteomas. They are usually located at the femoral neck and less commonly at the femoral head or the acetabulum.⁶⁶ The treatment decision is made after multidisciplinary discussion between orthopaedic surgeons and radiologists on the basis of clinical and radiological criteria. Clinical criteria include pain, which worsens at night and rest, and relief after the administration of non-steroidal anti-inflammatory drugs. Radiological criteria include typical findings on radiographs and CT and/or MRI with a clear depiction of a nidus of <1.5 cm in maximum diameter.⁵⁸ The treatment is performed under strict sterile conditions. Contraindications are severe coagulation disorders and systemic or local infection.

Materials and technique

Radiofrequency

RFA is a minimally invasive, safe and highly effective technique for the treatment of osteoid osteomas, for which it has become the treatment of choice.^{58–64}

The procedure is performed under general or spinal anaesthesia and strict sterility. Acetylsalicylic acid should be stopped at least 7 days before the procedure to reduce any antiplatelet effects increasing haemorrhage. Transarticular approaches are avoided in order to minimize the risk of septic joint infection, articular cartilage damage and injury to the adjacent neurovascular bundle.⁶⁶ Two grounding pads are applied to the patient's skin and connected to the RF generator. Under CT guidance, a 20-gauge needle is inserted for periosteal anaesthesia. Osseous access to the

Figure 8. (a, b) CT images of a 19-year-old male with an osteoid osteoma of the right acetabulum. The patient is in the supine position. (a) A 22-gauge spinal needle is inserted into the joint and 10 ml of normal saline mixed with contrast medium is infused into the joint space prior to the delivery of RF into the nidus to reduce thermal injury to the cartilage. (b) The straight RF electrode is in place, in the centre of the nidus. The 22-gauge spinal needle filling the capsule is also seen.

nidus is established with the use of either an 11-gauge bone biopsy needle or a 2-mm coaxial drill system depending on the localization of the nidus relative to the bone surface and the amount of adjacent bone sclerosis.⁵⁹ The position of the instruments is controlled by additional CT scans. A core biopsy can be obtained before RF ablation. A straight rigid electrode with an outer diameter of 1 mm, having an effective length of 5 mm and an internal flexible temperature probe for simultaneous temperature measurement, is introduced via the access path created, or through a hollow needle, which was exchanged for the drill over a Kirschner wire in a coaxial fashion. The non-insulated portion of the electrode is then exposed and positioned within the centre of the nidus.^{58,59} After connection of the electrode with an RF generator, the tip of the electrode is heated to 90 °C for a period of 4–6 min.^{58,59} In patients with a nidus located in the subarticular region such as the acetabular roof, about 10 ml of normal saline is infused into the joint space prior to delivery of RF energy into the nidus to reduce thermal injury to the cartilage (Figure 8). At the end of the procedure, 3–4 ml of 0.5% bupivacaine hydrochloride is injected directly into the hole to reduce post-operative local pain.^{58,59} Post-procedural CT is performed to confirm the lack of soft tissue swelling and haematoma.

CT-guided laser interstitial thermal therapy

Interstitial laser ablation can also be used as a curative treatment of osteoid osteoma.^{57,65} The technique consists of percutaneous insertion of optical fibres into the tumour using a continuous-wave semi-conductor portable diode laser connected to a fibre with a bare tip. It induces direct cellular heating and coagulative necrosis.⁵⁷ The procedure is performed under CT guidance and under general anaesthesia. The fibre is placed in a similar manner as RF probes. For nidus diameters >10 mm, two or more fibres are used to ensure tumour destruction.⁵⁷ In niduses located in the sub-articular region such as the acetabular roof, about 10 ml of normal saline is infused into the joint space prior to delivery of laser energy into the nidus to reduce thermal injury to the cartilage.⁵⁷

PERCUTANEOUS SCREW FIXATION OF ACETABULAR ROOF FRACTURES

Indications

The combination of CT and fluoroscopy guidance can have a place in the therapeutic management of acetabular fractures.^{67–69} This technique can offer several advantages over open reduction: decreased risk of devascularization or denervation related to the soft-tissue disruption, decreased blood

Figure 9. (a, b) Percutaneous screw fixation of an acetabular roof fracture. (a) CT guidance permits the perfect position of the screw which was stopped before perforating distal cortex. (b) Axial CT scan shows the perfect field of view. The procedure is planned so the path of the screw will not injure neuromuscular structures. Courtesy of Dr N Amoretti.

loss, lower risk of infection and more rapid functional recovery avoiding decubitus complications.

This procedure must be scheduled only after an interdisciplinary meeting between interventional radiologists and orthopaedic surgeons.⁶⁸ It is indicated in non-displaced or minimally displaced acetabular roof fractures. In patients with significant subchondral impaction, free intra-articular fragments or displaced fractures, open reduction is the procedure of choice.

Materials and technique

The procedure has been well described by Amoretti et al⁶⁸ It is performed under aseptic conditions in an interventional room using CT and lateral fluoroscopic guidance. Patients are placed in a lateral decubitus position with a special stabilizing device to maintain their position. The direction of screws, which must be perpendicular to the plane of the fractures, and their optimal length

are calculated on the CT images, which also allows assessment of the best approach to avoid neurovascular structures. Using a 20-gauge needle, local anaesthesia (lidocaine 1%; Laboratoire Aguettant, Lyon, France) is administered from subcutaneous tissues to periosteum under fluoroscopic guidance. After CT confirmation of the correct positioning of the tip of the needle, the latter is used as a guide for a 13-gauge 10-cm Trocar which is inserted under fluoroscopy after the hub has been removed.⁶⁸ The trocar perpendicularly transfixes the acetabular fracture line under fluoroscopic guidance and its good progression is confirmed by CT.⁶⁸ Then, a 2.0-mm Kirschner guidewire is placed through the cannula. After withdrawal of the cannula, a 6.5-mm Asnis III screw is placed over the Kirschner guidewire under fluoroscopic guidance. Screw fixation is performed using a hollow screwdriver. Once good positioning of the screw is confirmed by CT, the guidewire is withdrawn⁶⁸ (Figure 9). Two screws are inserted per patient,⁶⁸ although three screws have been used in more complex injuries.⁶⁹

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