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TECHNICAL NOTE

Hip arthroscopy technique and complications

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Complications

Summary Hip arthroscopy is not a new technique but the seemingly limited indications and technical challenges involved have discouraged many since Burman documented his initial experiences (Burman, 1991 [1]). The current renaissance is largely driven by the expanding indications particularly in the management of femoroacetabular impingement. The figures from our own unit illustrate this well with 40% of hip arthroscopies in 1990 being purely diagnostic as compared with less than 5% at the present time. The focus of this chapter is the technical aspects of hip arthroscopy and the potential complications that can occur.

Theatre layout and equipment

Much will depend on whether the supine or lateral decubitus position is chosen, both have their supporters [2,3]. The decision depends on personal preference, local equipment availability and, perhaps most importantly, where and by whom the individual surgeon was trained. Our institution uses the lateral decubitus position and this will be the default for this discussion. Where important differences exist these will be highlighted.

Our preference is to perform hip arthroscopy under general anaesthetic but many institutions use spinal or epidural techniques. Pre-operative imaging continues to improve but remains poor and the prospective arthroscopic surgeon should be mindful of the potential for unexpected findings that may significantly prolong any procedure. Further complete muscle relaxation is beneficial in reducing the forces required to distract the hip.

The physical act of positioning requires a minimum of three assistants to be performed safely. One to support the patient's hip and shoulder while the second supports the patient's lower limb in an abducted externally rotated position to allow the third assistant and surgeon to place the peroneal post (Lateral Hip Positioning System, Smith & Nephew Inc, Andover, Massachussets, USA). Care must be taken not to crush the contralateral thigh between the post and the table. Everted labia and trapped testis must also be avoided and formally checked by the operating surgeon before and after traction has been applied. The ipsilateral foot is wrapped in wool and placed in a foam boot prior to being firmly secured in the distraction boot. Lifting of the heel within the boot is undesirable so the construct is further secured with tape, Fig. 1; ensuring space is left to allow the heel to be palpated.

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Figure 1 The lateral decubitus position with the distractor in position (Lateral hip positioning system, Smith & Nephew, Andover, Massachussets, USA).

Figure 3 Patient in the lateral decubitus position, viewed from behind.

Initially, traction is applied by a single assistant taking care not to be overly forceful in the smaller or ligamentously lax patient. The image intensifier is brought into position, as shown in Fig. 2. If further traction is required this is cautiously applied using the distractor's traction handle. Confirmation of the hip's distractability is ideally confirmed before preparing the skin and draping so that any adjustments to the set-up can be made with ease. Should a hip prove to be very resistant the set-up is checked and in particular the heel is assessed for lifting. If all is correct then the problem is noted and considered further after fluid distension of the central compartment. The traction applied using the traction handle is released prior to skin preparation and draping. We use chlorhexidine to prepare the skin and drape using a combination of paper and clear drapes (Steri-Drape Ioban 2, 3M Health Care, St Paul, Minnisota, USA).

Fig. 3 shows a patient positioned and draped prior to commencing a procedure. The image intensifier is purposefully positioned obliquely across the patient to increase the space available for the surgeon, who stands behind the patient. The X-ray beam is directed away from the surgical team, posterior to anterior across the patient. X-ray, radiofrequency (RF) and shaver peddles are all placed for ease of access by the operating surgeon.

The scrub nurse is positioned behind the operating surgeon with the instruments placed on a large table between the two. Fig. 4 shows the instrument table in the preparation room just prior to a procedure. A draped Mayo stand is positioned at the patient's shoulder level to act as a surface for receiving the arthroscope, radiofrequency probe and shaver when not in use.

Figure 2 The image intensifier in position, note oblique AP alignment.

Figure 4 Instruments laid out in the preparation room prior to the start of a procedure.

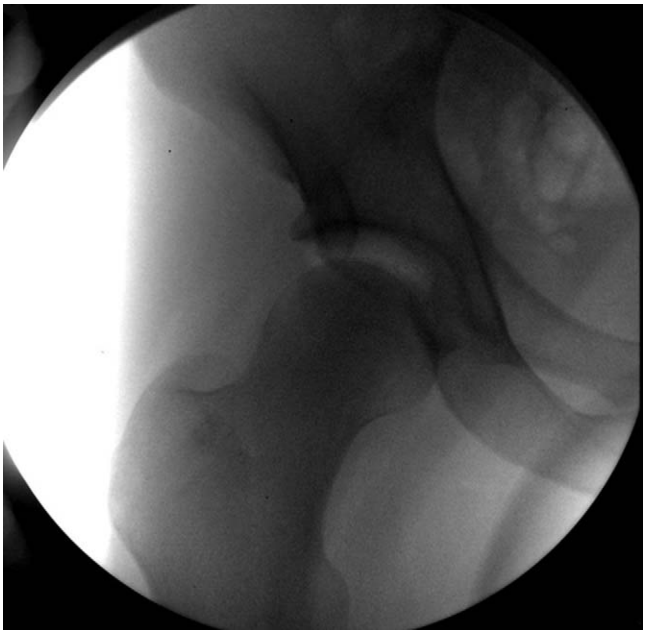

Figure 5 A vacuum sign in a distracted right hip.

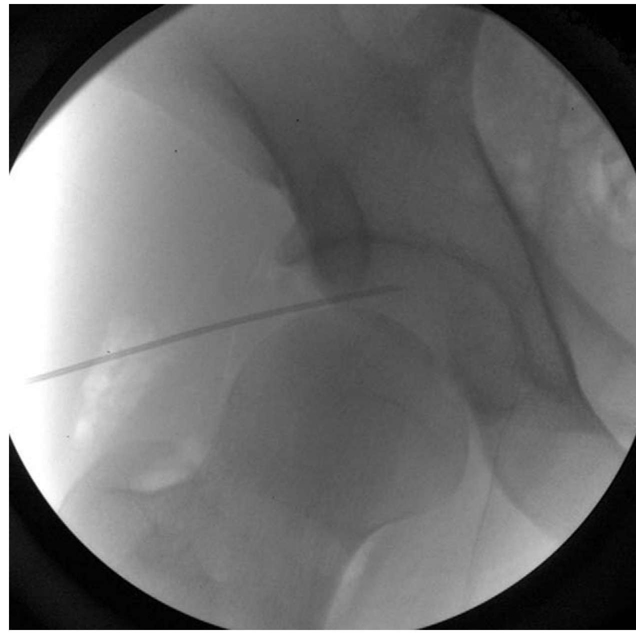

Figure 7 Capsular distension and further distraction using normal saline solution introduced under manual pressure.

Central compartment

Traction is now reapplied and an ideally an image similar to that in Fig. 5 is obtained. A 1.2 × 205 mm spinal needle is then passed into the joint under image intensifier control, an air arthrogram confirms the needle's intra-articular position, Fig. 6. Note that the joint has distracted further with the ingress of air and loss of the intra-articular vacuum. Further distraction is achieved by forcibly injecting normal saline into the central compartment, Fig. 7. Typically 40 ml of normal saline is used but this can vary. The 1.2 × 205 mm spinal is then removed.

Figure 6 Loss of the vacuum seal allows further distraction without an increase in the traction force.

Anatomical studies have been performed by multiple authors to establish the safety of the commonly used portals [4,5]. Specific portal selection and the order of placement varies widely. Our practice is to routinely use the posterolateral and anterolateral portals for visualising the central compartment. The posterolateral portal is established first. The greater trochanter is palpated and a 17-gauge × 6-inch spinal needle is inserted above and slightly posterior to it, Fig. 8. The needle is advanced towards the joint under image intensifier control with the bevel facing the femoral head.

As the joint is approached, care is taken to ensure the needle is as far distal to the acetabular margin as possible without damaging the femoral head. Experience proves this

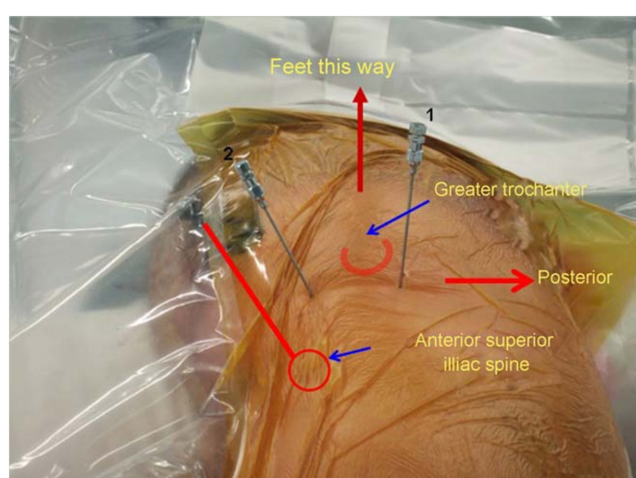

Figure 8 Surface markings together with the posterolateral (1) and anterolateral (2) entry points.

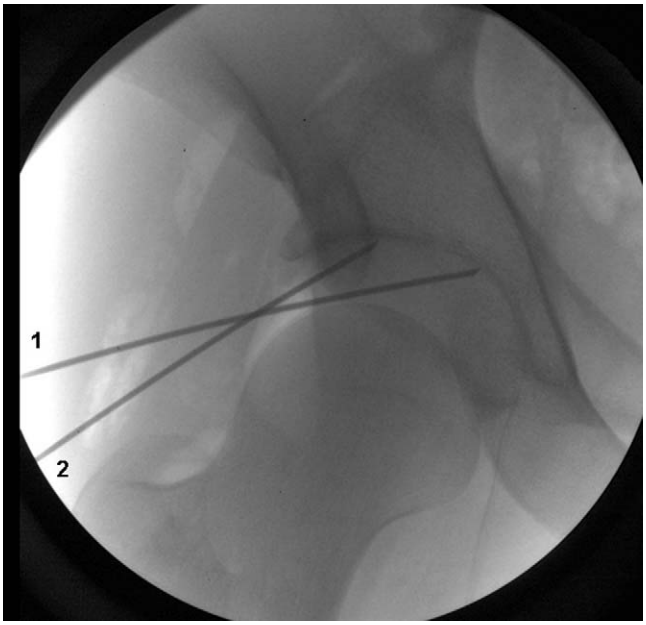

Figure 9 Posterolateral (1) and anterolateral (2) spinal needles for entering the central compartment, as viewed on an image intensifier.

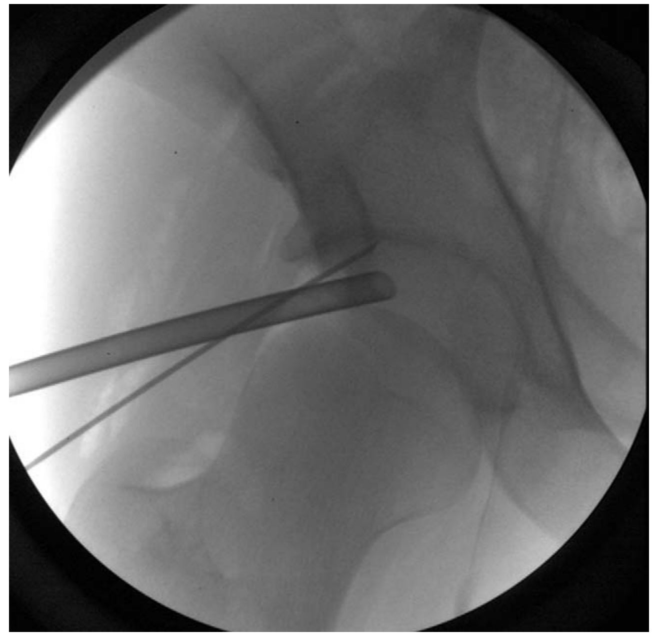

Figure 10 X-ray intensifier image of a posterolateral 5.0 mm access cannula and an anterolateral spinal needle.

to be a truly tactile process, rather than purely visual, as the increased resistance felt on passing the spinal needle through a labrum is very different compared to the quick and easy passage through normal capsular tissue.

Once the first needle is satisfactorily positioned, it is our practice to place the second spinal needle before proceeding further. We believe this saves time as with repetition accuracy in placement is rapidly achieved. Further, when the arthroscope is introduced, this second needle allows through flow and greatly enhances the clarity of vision. The second 17-gauge × 6-inch spinal needle is placed midway between the first needle and a line drawn directly inferiorly from the anterior superior iliac spine, Figs. 8 and 9. The needles should be separated by at least three finger-breadths, with the wider arc facilitating manipulation within the central compartment. A slightly more distal placement of this portal is useful when anterior labral pathology is suspected. The initial capsular distension with normal saline can result in the trochar of any subsequent spinal needle being forcibly expelled on piercing the hip capsule with an associated jet of normal saline into the face of the uninitiated!

A modification of the Seldinger technique [6] is used for cannula placement. A 1.2 mm × 450 mm nitinol guide wire is introduced into the posterolateral spinal needle. The skin around the needle is incised using an 11 blade and the needle removed. A 5.0 mm hip access cannula and obturator are fed over the guide wire and carefully introduced in line with the guide wire. Intensifier imaging assists with entry. Once the capsule is reached the guide wire is gradually retracted as the 5.0 mm cannula is introduced to avoid kinking the wire and creating an iatrogenic loose body. The cannula is eased into the joint with the surgeon remaining receptive to tactile feedback. Excessive force should not be required and may represent accidental labral cannulation. Furthermore, the edges of the space being entered can be felt and the cannula eased between them rather than forced into either the acetabular or the femoral articular cartilage, Fig. 10. Many surgeons prefer to use sequentially larger cannulas to dilate the tract but this is not our current practice. The 70° arthroscope is then introduced into the posterolateral cannula. The entry point of the remaining 17-gauge spinal needle is assessed under direct vision and any minor adjustments made before introducing the second portal, again under direct vision, using the technique described for the first, but with a 5.5 mm hip access cannula.

With both portals successfully established, the next step is to perform a capsulotomy to join the two portals to enhance manouverability of the instruments within the joint and potentially also distraction. A beaver blade is introduced anterolaterally and used to make the initial capsular incision. The slotted cannula or Victor is then used to exchange the beaver blade for a 90° radiofrequency tissue ablator (Dyonics RF-S Whirlwind, Smith & Nephew Inc, Andover, Massachussets, USA). The aim should be that the slotted cannula freely falls into the joint on introduction and should this not be the case then further capsular division is required. The capsulotomy is further extended with the RF ablator aiming to produce an incision in the capsule that parallels the labral margin.

With access and through flow established the next step is to perform a systematic assessment of the central compartment. The anterior, superior and posterior chondrolabral complex are assessed using an arthroscopic hook for tears. The acetabular articular surface is similarly interrogated. The ligamentum teres is viewed and dynamically assessed whilst rotating the limb into maximum internal and then external rotation. The femoral head is also assessed. This information is recorded and pathology treated as appropriate with additional portals sited if required. While our default-viewing portal, for the central compartment, is posterolateral this is changed when indicated.

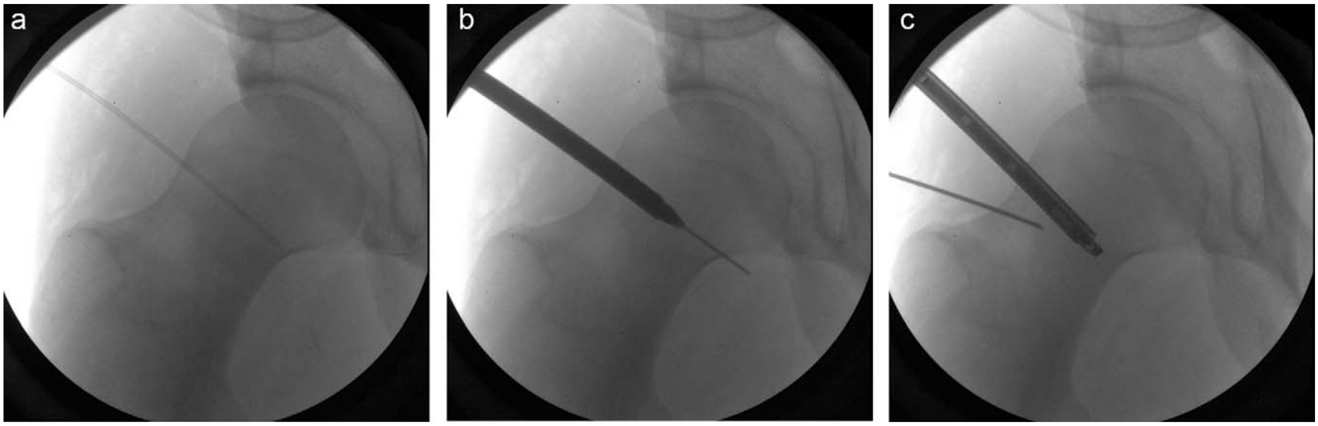

Figure 11 a: a 17-gauge spinal needle with trochar removed within the peripheral compartment; b: a 5.0 mm cannula with cannulated obturator advancing over guide wire to establish the peripheral compartment viewing portal; c: a 17-gauge spinal needle introduced through the anterolateral portal and guided towards the arthroscope under image intensifier control and direct vision.

Peripheral compartment

Multiple techniques exist for accessing this compartment. It is our practice to establish a superolateral viewing portal. All instruments are removed. The anterior capsule is relaxed by releasing the traction and flexing the hip 20—30°. A 17-gauge × 6-inch spinal needle is then placed through the skin at the superior apex of an equilateral triangle formed with the existing posterolateral and anterolateral portals. The needle is directed under image intensifier control to the superior head neck junction. The bevel is rotated such that it is opposed to the bony surface. The spinal needle is then advanced with the bevel sliding along the anterior surface of the femoral neck. On removal of the trocar correct positioning is confirmed by a trickle of fluid from the needle. The final position prior to inserting the guide wire is shown in Fig. 11a. The portal is then established in the usual manner. The nitinol guide wire should come to rest against the medial wall of the capsule, which should provided springy resistance to further gentle advancement. The guide wire is sequentially retracted as the 5.0 mm hip cannula and obturator are advanced, Fig. 11b. Care must be taken to prevent the guide wire penetrating the medial capsule. Similarly, breakage of the guide wire should be assiduously avoided as successfully finding and removing the loose body so formed is an exceptionally arduous task. The arthroscope is introduced and the second portal established under direct vision and image intensifier control. A 17-gauge × 6-inch spinal needle is placed through the existing anterolateral portal and directed towards the tip of the arthroscope trying to enter the compartment well below the zona orbicularis, Fig. 11c. Once the second portal is established, a RF ablator is used to join the portals and extend them to assist with the free movement of both the arthroscope and the instruments.

One alternative to this practice is to enter the peripheral compartment from the central compartment using a swing-over technique. Here, the existing central compartment portals are used. The arthroscope in the posterolateral portal follows the RF ablator or tissue shaver as it progresses distally and laterally to the head neck junction. The traction is released and the hip flexed during this process to assist progression. This technique is especially useful in the management of superior and posterosuperior peripheral compartment pathology.

The peripheral compartment is systematically assessed. Image intensifier images are very useful in ensuring a complete assessment of the peripheral compartment and in particular to confirm progression superolaterally and inferomedially as arthroscopic views can be deceptive with regard to one's true location on the femoral neck. The hip should also be assessed dynamically particularly in the assessment of cam type femoroacetabular impingement.

Invasive distraction

This is an alternative to the use of a traction table, in cases where longer traction times, i.e. longer than 2 h are needed for complex reconstruction in the central compartment. Indeed, as more and more complicated cases are treated with hip arthroscopy, this method has proved itself useful in these cases. Invasive distraction (DR Hip Distractor, DR Medical AG, Solothurn, Switzerland) had initially been used in the steep learning curve of hip arthroscopy where traction times exceeding the 2 h time barrier were needed, leading to neurological complications and pudendal skin lesions. By avoiding traction on the entire lower limb (Figs. 12 and 13), there is no necessity for the use of a pudendal post and thus no pudendal nerve lesions nor skin lesions are provoked. Since the distraction is centered on the hip joint, no useless distraction of the knee and ankle joints are made and hence no sciatic nor femoral lesions are provoked (see Complications section).

This variant of distraction has proven itself very useful in the beginner setting where the treatment of femoroacetabular impingement correction with labral suturing or reconstruction can be time consuming. It has also removed the 2 h time barrier for the even more complex cases where not only the anatomical bone anomalies are treated in conjuction with the labral pathology but also the chondral lesion are addressed with advanced techniques including fully arthroscopic cartilage transplantation (Figs. 14—17).

Figure 12 Left hip arthroscopy in the lateral decubitus position using invasive distraction. Hip is abducted by 20—30° and slightly flexed. Image intensifier is horizontally positioned and under the table. Surgeon is posterior and distal to the image intensifier.

This distraction variant can be used in the supine or lateral position. The illustrations are in the lateral position (Figs. 12 and 13). The image intensifier is below the table and similarly to the technique with the traction table, the surgeon is behind the patient and distal to the image intensifier while the assistant is proximal to it. The image intensifier stays in place during the whole procedure and the surgeon and the assistant can use it as an arm-rest. The rest of the set-up is similar to the lateral position described in the previous section. The distraction space obtained is often superior to the one obtained on a traction table due to the concentration of the traction forces only on the femoroacetabular joint line.

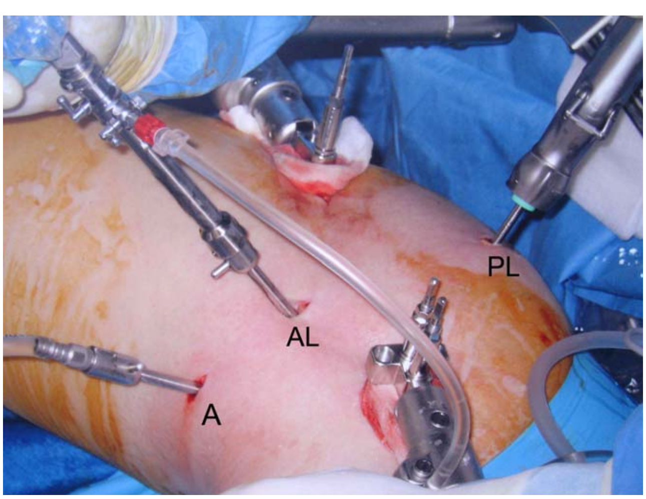

Figure 13 Invasive distraction with the standard posterolateral (PL), anterolateral (AL) and anterior (A) portals.

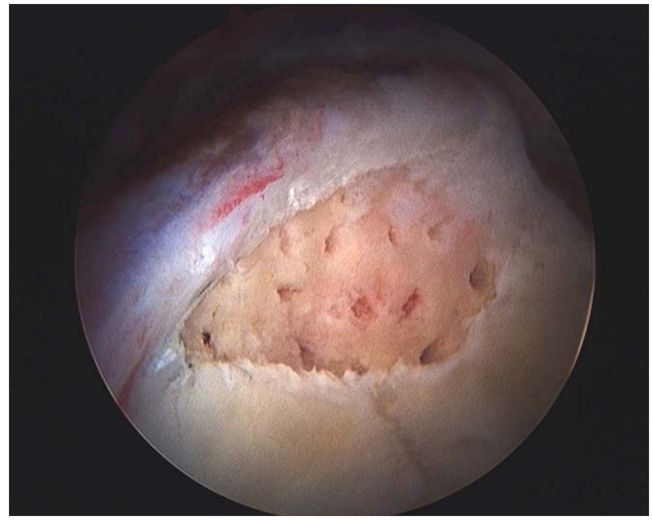

Figure 14 Complex central compartment reconstruction: autologous matrix induced chondrogenesis (AMIC), microfracture before application and suturing of the 3D protective matrix.

Instrumentation

The choice of instruments available continues to increase almost exponentially. This section will consider those most commonly used in our practice.

Hand instruments are still widely used. The initial capsulotomy in the central compartment is performed using a beaver blade, Fig. 18, allowing for the subsequent easy exit and entry of other instruments. A variety of graspers are available to cover tasks from removing loose bodies to retrieving sutures. Indeed many instruments designed for other joints have been found new roles within the hip. A straight curved meniscal up-biter (Duckling Up-biter, Smith & Nephew Inc, Andover, Massachussets, USA) is particularly useful for compressing chondral flaps following the injec-

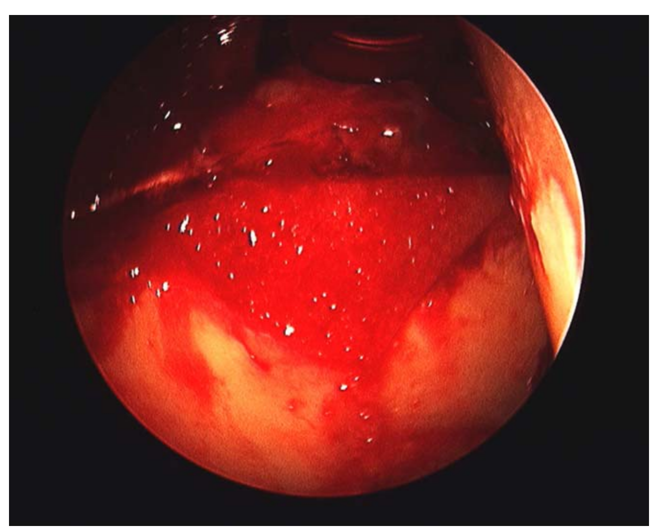

Figure 15 Complex central compartment reconstruction: autologous matrix induced chondrogenesis (AMIC), application and suturing of the 3D protective matrix.

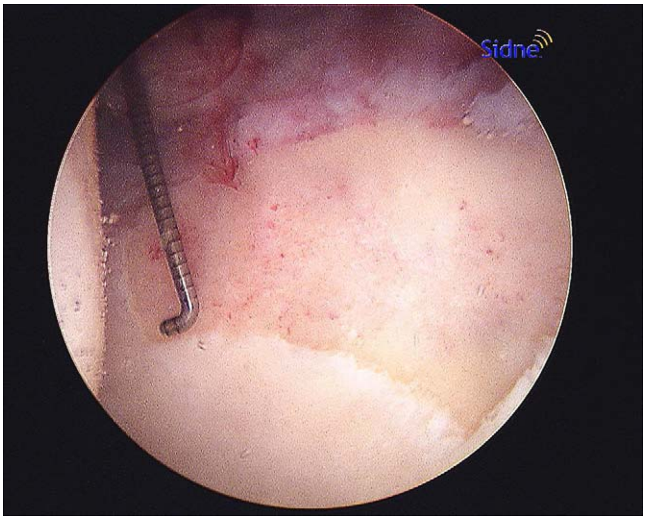

Figure 16 Complex central compartment reconstruction: autologous cartilage transplantation (ACT), larger than 3 cm^2 grade IV chondral lesion of the acetabular anterior wall.

tion of fibrin underneath acetabular delamination injuries. A wide range of suture passing instruments are used for tasks such as labral repair and capsular plication. Fig. 19 shows a microfracture awl being used to treat a full thickness acetabular chondral defect.

Powered instruments, as with the knee and shoulder, include soft tissue shavers and a variety of bone burrs, Fig. 20. These are largely generic arthroscopy tools but several manufacturers are now developing task specific attachments for hip arthroscopy.

Radiofrequency probes are increasingly becoming specialised for specific roles. However, with care, a standard radiofrequency ablatior can be used for such tasks as capsular debridement, chondroplasty and labral repair. Flexible probes are of particular use when treating pathology

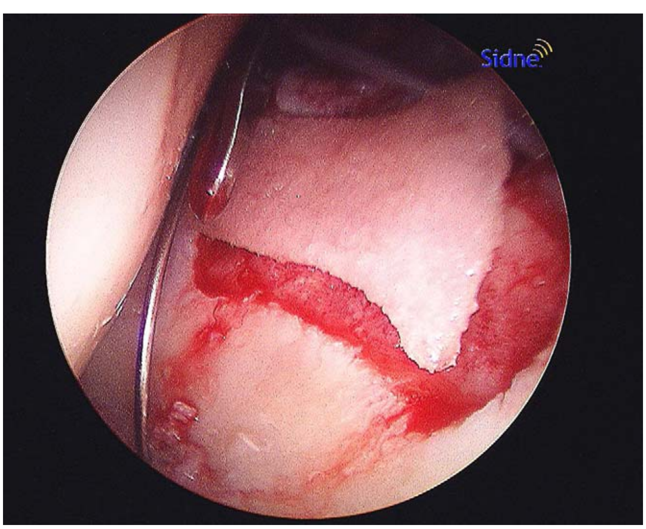

Figure 17 Complex central compartment reconstruction: autologous cartilage transplantation (ACT), 3D matrix transplant containing the chondrocytes sutured along with the labrum.

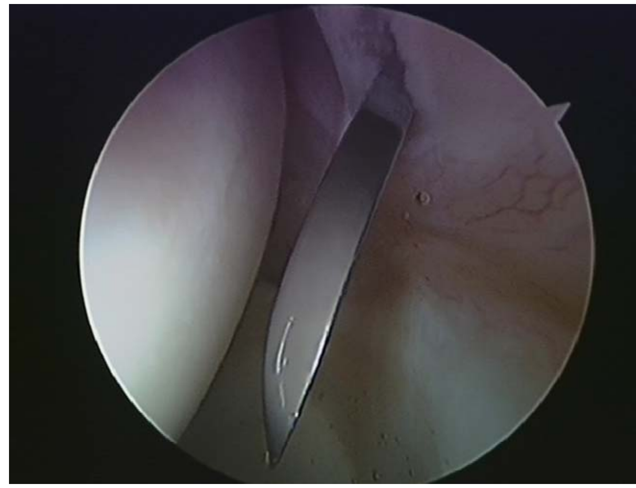

Figure 18 A beaver blade incising the capsule parallel to the labrum having been introduced through an anterolateral portal.

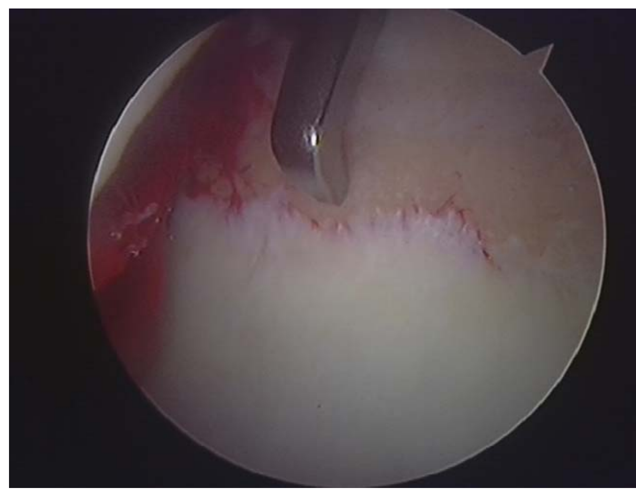

Figure 19 An acetabular microfracture underway.

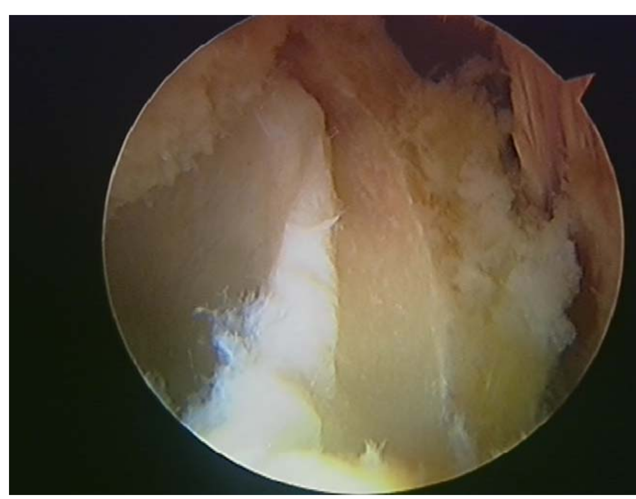

Figure 20 An acetabular recession performed using 4.0 mm burr.

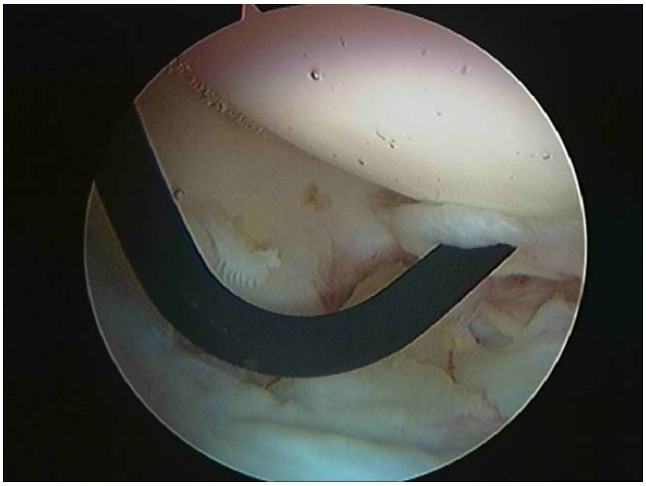

Figure 21 Debridement and thermal shrinkage of the ligamentum teres underway using a flexible RF probe (Dyonics Eflex Ablator, Smith & Nephew, Andover, Massachussets, USA).

involving the ligamentum teres and the cotyloid fossa, Fig. 21.

Historically anchors have been favoured for treating labral tears. However, other options exist. These include the ultra fast-fix system (Smith & Nephew, Andover, Massachussets, USA), initially developed for treating menisci in the knee, and fibrin tissue adhesive (Tisseel, Baxter, Newbury, UK). Larger bone cysts can undergo curettage and grafting. The future is difficult to predict accurately but it seems likely that chondrocyte delivery systems will be part of this and ultimately biological resurfacing.

Complications

This is the most important section. Being mindful of the dangers is a key step in avoiding them occurring with undue frequency [7]. Rather than approach this subject in order of frequency, we shall instead look at the complications associated with different stages within a procedure.

Traction and the means of distraction remains a potent source of problems for the unwary. It is important to ensure that the peroneal post is well padded with one paper, in addition, suggesting a diameter of greater than 9 cm significantly reduces complications [7]. Testicular and labial injury can be minimised with care during positioning and re-checking for trapped testes or everted labia once traction has been applied [8]. Care must also be taken to ensure that the lateral force provided by the peroneal post is not excessive as vaginal tears have been reported [9].

Nerve palsies related to traction force and duration are the commonest occurring complication. These appear to be significantly reduced by limiting traction time to under 2 h [7,10]. In the extremely rare situation where longer periods are required, the traction should be released for a period and then reapplied. The technique described above of reducing the traction force whilst prepping and draping usefully reduces traction times and is strongly recommended. We do not routinely use tensiometers but in every case seek to use the minimum distraction force necessary to safely enter the central compartment. The vast majority of traction injuries recover fully and within hours of surgery. Sampson [7] reported 20 neuropraxias in 1000 cases with the peroneal nerve accounting for 10 of these. Of these 20 only one lasted longer than three days, with resolution within a week, and was associated with a 4-h operation; though traction was released intermittently.

Catastrophic nerve damage can occur during portal placement and it is therefore important to have detailed knowledge of the local anatomy. The nerve perceived to be at greatest risk during portal placement is the lateral femoral cutaneous nerve (LFCN). This is particularly true when siting the anterior and, to a lesser extent, mid-anterior portals [5]. Due the LFCN's superficial course care must be taken when incising the skin not to extend into the subcutaneous fat where the nerve and its braches can be disrupted. There has been a move laterally over time away from the original anterior portal partly due to concerns over injury to LFCN. The proximity of both the sciatic nerve and femoral neurovascular bundle must also be considered with Robertson and Kelly [5] reporting that the former can be as close as 11 mm (mean 21.8 mm) to the posterolateral portal. Neutral positioning of the limb is important during portal placement to ensure anatomy is not distorted. Key bony landmarks such as the anterior superior iliac spine (ASIS) and borders of the greater trochanter must be clearly identified for every case. While surgeons must not be complacent it is reassuring that Byrd in a combined review of 1491 cases reported only one permanent nerve injury [10].

Iatrogenic chondral and labral injuries are under-reported in the literature. Labral cannulation can be avoided with sound technique and experience as described above. However, some surgeons perform assessment of the peripheral compartment first to allow for guide wire placement into the central compartment under direct vision. Adequate distraction aids in the avoidance of articular scuffing and gouging but the surgeon must also ensure that access cannulae are introduced in a slow controlled manner. Such that one feels the cannula into the available three-dimensional space as opposed to relying on a two-dimensional X-ray image. While uncommon it must be accepted that up to 2.8% of hips will not be suitable for central compartment assessment and a further 18% will prove difficult [9]. It is our experience that arthritic hips are more resistant to distraction and we believe this to be related to the thicker capsule that is associated with this disease process. Consideration may be given to a large peripheral compartment capsulotomy before defeat is accepted!

These limitations are valid for distraction on a traction table. However, invasive distraction as described above will allow all hips to be examined by providing selective powerful hip distraction after adequate capsular releases are performed. No major neurological lesions (i.e. pudendal, femoral or sciatic) have been encountered and pudendal skin sufferance has been avoided using this technique in over 2000 cases even when traction periods have exceeded 2 h. The maximum traction time applied with this technique has been 270 min.

Iatrogenic loose bodies in the form of broken instruments or guide wires occur infrequently. Clarke et al. [9] reported two episodes in 1054 arthroscopies while Sampson [7] identified three in 1000. Ensuring that the guide wire is retracted sequentially during careful and controlled cannula insertion minimises the risk of breakage considerably. Similarly care must be taken with instruments, particularly when they are being used for novel tasks for which they were not overtly designed.

During acetabular rim recession care must be taken not to recess to the point of destabilising the hip. Cases of post-operative dislocation and subluxation have been reported [11,12]. This seems particularly relevant in dysplastic hips with an already reduced centre-edge angle and where the labrum is typically much enlarged, probably to assist with containment and load transmission. Similarly their have been cases of femoral neck fracture associated with femoral cam lesion excision [7].

The most alarming complication to date has been that of intra-abdominal or retroperitoneal fluid extravasation. The reported incidence varies widely amongst surgeons with Sampson [7] reporting an incidence of 1%. In extreme cases this can be life threatening [13,14]. These extreme cases all occurred in longer procedures, 2 h or more. Another risk factor is hip arthroscopy acutely following an acetabular fracture. Reducing procedure time, minimising fluid pressures and strict fluid balance monitoring peri-operatively appear to be sensible precautions.

Another potentially catastrophic occurrence is that of postoperative infection. This has been very rarely been reported in the literature [7—9]. Clarke et al. [9], in their series of 1054 cases, reported one infection, which presented 26 days after surgery. Due to the potential implications, both for the joint and the patient systemically, it must always be considered and aspiration of the joint performed if inflammatory markers are elevated.

Bleeding can peri-operatively obscure the surgeon's view but can usually be overcome with a transient increase in fluid pressure and RF coagulation to the source. Post-operatively bleeding can occur but this is something we have only very rarely seen. We have had one patient present several weeks post-surgery with an acute bleed presumed to have come from a branch of the superior gluteal artery, which we treated conservatively. Pressure necrosis occurs with prolonged traction and insufficient padding. Other rare complications include impotence, trochanteric bursitis and chronic regional pain syndrome (CRPS).

Perhaps the commonest complication from the patient's perspective is the failure to improve their symptoms and on occasion make them worse. In the absence of gross arthritic change and a positive clinical examination for labral pathology, we will typically quote patients an 80% chance of improvement at one year. Furthermore, we warn them that at a year approximately 15% of our patients fail to find a symptomatic benefit while around 5% will be worse. Where significant osteoarthritis is found, often not previously diagnosed by either X-ray or MRI, patients often find the post-operative rehabilitation particularly difficult. For those who do not settle joint arthroplasty is offered with the reassurance that every effort has been made to spare the joint and that the diagnosis is at least known prior to their definitive surgery.

For the hip arthroscopist, as with all surgeons, having the insight to realise one's own limitations and avoiding the temptation of straying beyond them remains central to both successful surgery and keeping our patients best interest foremost.

Conflict of interest statement

James Simpson: none. Hassan Sadri: none. Richard Villar: executive committee member International Society for Hip Arthroscopy (ISHA) and paid consultant Smith & Nephew Endoscopy.

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