Hip Arthroscopy: The Peripheral Compartment

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Introduction

When performing hip arthroscopy, the hip can be divided into three compartments: central, peripheral, and peritrochanteric. The central compartment is intra-articular, and is made up of the acetabular fossa and lunate cartilage, ligamentum teres, and the loaded articular surface of the femoral head. The peripheral compartment of the hip is separated from the central compartment by the labrum. The peripheral compartment is extra-articular yet intra-capsular, and consists of the femoral head's unloaded cartilage, femoral neck with synovial folds (anterior, medial, and lateral), and the articular capsule of the hip joint. The zona orbicularis, also known as ligament of Weibrecht, is a thickening of the hip joint capsule which wraps around the femoral neck, forming a ring around the neck's circumference, and is the narrowest area within the capsule [1]. It is thought to enhance hip stability with distraction and is an important landmark in peripheral compartment arthroscopy. There are also four capsular-ligamentous complexes (iliofemoral, quadrupedal, ischiofemoral, posterior) that contribute to hip stability, that have ill-defined borders [2]. The peritrochanteric compartment lies between the iliotibial band and the proximal femur providing access to the insertion of the gluteus medius and minimus.

Arthroscopic evaluation of the hip joint must include both the central and peripheral compartments to properly diagnose and address pathology. In regards to labral refixation techniques, due to its attachment to the bony rim of the acetabulum, one might consider the base of the labrum to be part of the peripheral compartment but in order to pass sutures it is necessary to visualize the central compartment.

Arthroscopy of the peripheral compartment is performed without traction, with the hip flexed between 30° and 45°, unlike the central compartment and is used to address the following pathology:

- femoral head-neck junction pathology
  - loss of femoral offset (CAM type femoroacetabular impingement)
  - impinging osteophytes of the femoral head-neck junction
  - hypertrophy of femoral neck synovial folds
- synovial pathology and tumors
  - primary or reactive synovitis
  - synovial chondromatosis
  - pigmented villonodular synovitis
  - chodromas/osetochondromas
- peri-articular structures
  - psoas tendon sheath

Pre-operative diagnostic imaging is imperative to properly evaluate the extent of bony deformities as well as rule out other possible pathologies. This includes a full set of standardized radiographs to assess acetabular depth, femoral head coverage, head sphericity and offset, as well as the degree of degenerative changes. At our institution, this includes an AP pelvis, false profile views of both hips, and Dunn views of both hips (Fig. 15.1). On the anteroposterior radiograph, the center edge of Wiberg, Tonnis angle, presence of cross-over sign or ischial spine sign are evaluated. Magnetic resonance imaging (MRI)is then used to further evaluate labral pathology and peri-articular soft tissues as well as ruling out other diagnoses such as stress fracture, osteonecrosis or a neoplasm (Fig. 15.2). By carefully evaluating the pre-operative diagnostic imaging, the surgeon can plan for either a solely arthroscopic treatment, combination of arthroscopic and mini-open anterior approach, or surgical hip dislocation.

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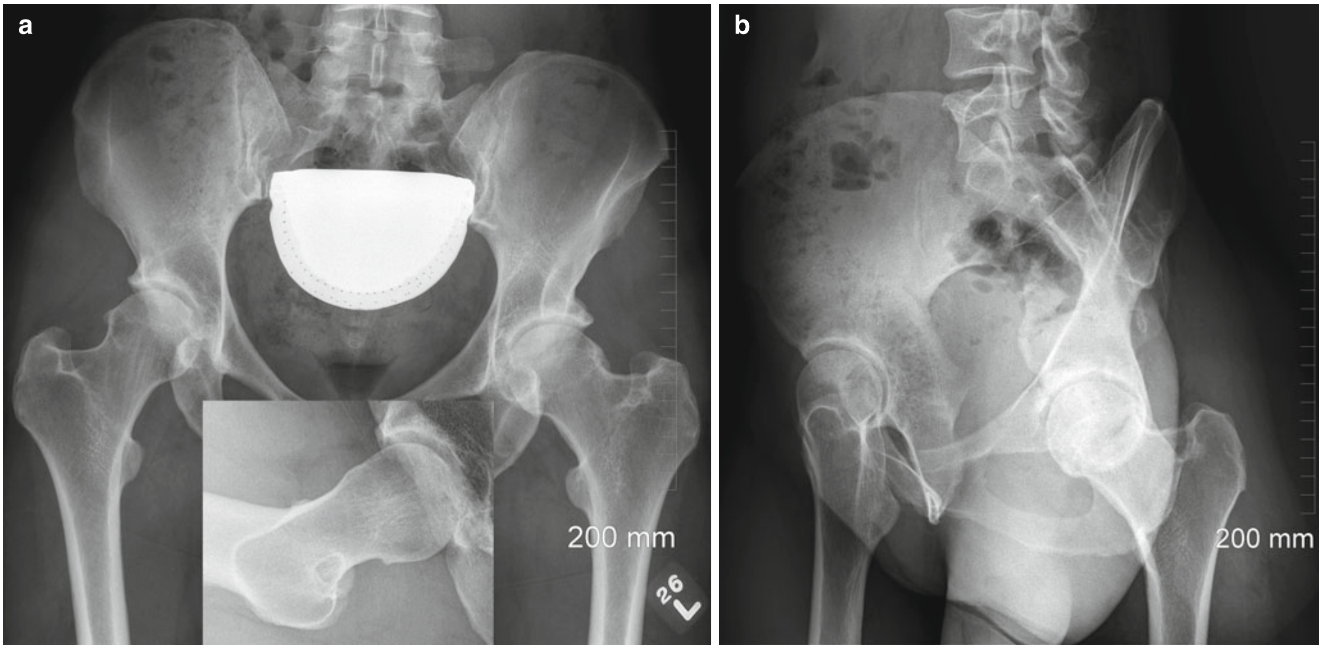

Fig. 15.1 Healthy 35 year old female who presented with bilateral hip pain, right worse than the left hindering her activities of daily living and recreational activities. Physical examination was consistent with hip impingement signs bilaterally, right worse than left. (**a**) Pre-operative AP pelvis and Dunn view (*inset*) of the right hip consistent with cam type impingement. (**b**) False profile view of the right hip demonstrating adequate coverage and good posterior joint space

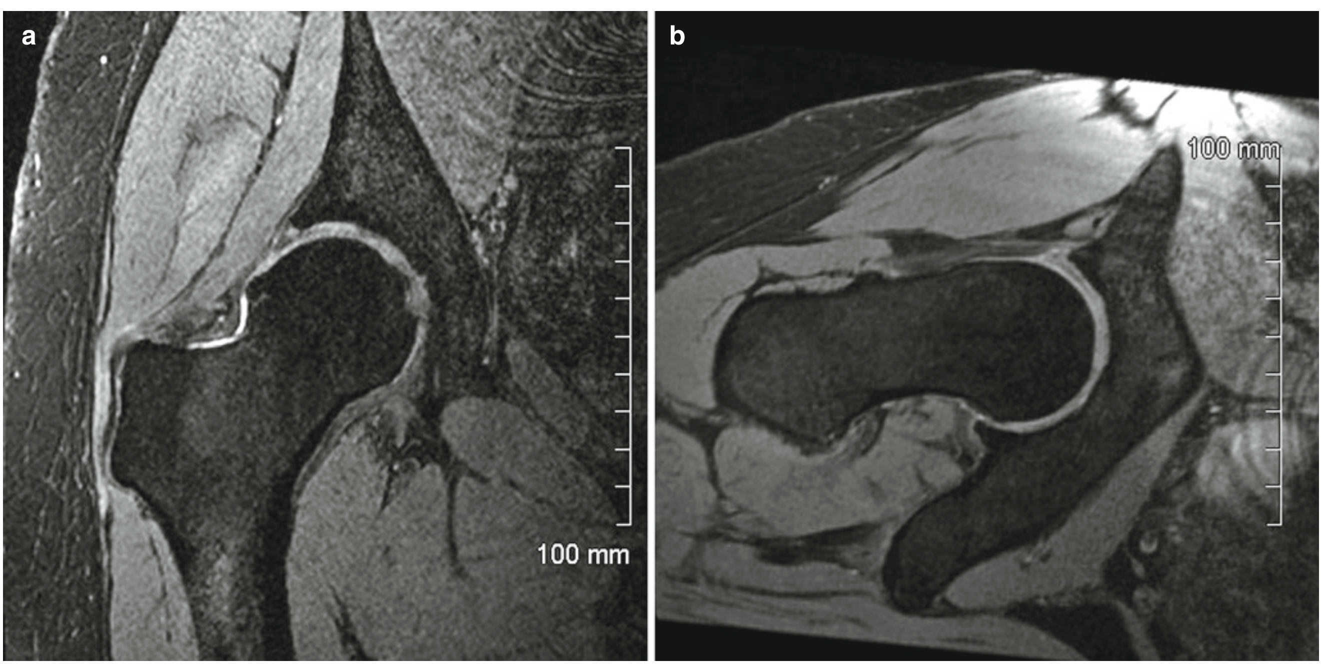

Fig. 15.2 Healthy 35 year old female patient with clinical and radiographic CAM type FAI whose radiographs are shown in Fig. 15.1. Selected cuts from coronal (**a**) and radial (**b**) MR imaging of the patient's right hip further delineate her CAM lesion and labral pathology

Surgical Technique

Positioning and Set-Up

Performing hip arthroscopy in the lateral decubitus or supine position is well accepted and is based on surgeon preference. At our institution, we use the supine approach on a positioning table. Although peripheral compartment hip arthroscopy is performed without traction, the traction table gives the flexibility of switching between the peripheral and central compartment. Furthermore, at our institution we perform the central compartment hip arthroscopy first. The foot is kept in the traction boot and an unscrubbed assistant provides or releases traction as necessary and is able to move the hip into flexion and extension by moving the traction boot along the extension bar. This is necessary to move between compartments and also properly visualize all aspects of the femoral head neck junction. The patient is positioned on the operating room table with a well-padded perineal post placed as far lateral as possible on the operative hip, resting against the medial thigh, to provide an optimal vector for distraction once traction is applied. Counter traction on the non surgical limb is critical. We prefer the patient to be under general anaesthetic with full muscle paralysis to ensure that the hip can be distracted with the minimal amount of traction. Arthroscopic monitor and towers and C-arm image intensifier are positioned on the opposite side of the surgical hip. The fluoroscopy monitor is placed at the foot of the bed on the opposite side of the surgical hip. After adequate distraction is confirmed using fluoroscopy (combination of traction first then adduction of the operative extremity), the extension bar is locked and the operative hip is prepped and draped widely to allow for proper portal placement.

Portals and Capsular Release

A standard anterolateral portal (laterally over the superior margin of the greater trochanter at its anterior border) is established first with the use of fluoroscopy with the hip distracted. Great care is taken not to penetrate the labrum. To minimize the risk of penetrating the labrum, once the spinal needle is inserted, normal saline is injected to further distract the joint and then re-inserted as close as possible to the femoral head. An anterior or mid-anterior portal is then made under direct arthroscopic visualization through the anterolateral portal. The anterior portal is placed as described by Byrd; at the site of intersection of a line drawn distally from the anterior superior iliac spine and line drawn transversely across from the tip of the greater trochanter [3]. The mid-anterior portal is placed distal and lateral to the anterior portal placement site at an intersection of approximately 45° from the anterolateral and anterior portal sites [4, 5]. We have tended to use the mid-anterior portal in the majority of cases where the central and peripheral compartments were both visualised, as this portal gives us a better angle for both labral repair and femoral head neck osteochondroplasty. A more anterior portal can be used if labral debridement or resection is planned or for access to the medial recess. To facilitate the essential working space required for peripheral compartment work, a partial capsular release between the anterolateral and mid-anterior portal is made using an arthroscopic blade along the acetabular rim from medial to lateral. The proximal to distal placement of the capsulotomy i.e. distance from acetabular rim, will aid visualization of either the labral-capsular recess (more proximal) or femoral head/neck junction (distal) as required. Some have advocated the use of T-shape extension for the capsulotomy but this may pose more difficulties in regards to proper healing and/or repair of the hip capsule.

Once inspection and management of the central compartment is complete, access to the peripheral compartment is further facilitated by performing a more extensive anterolateral capsulotomy. The 70° arthroscope is placed in the anterolateral portal to visualize both the central compartment and peripheral compartment. Subsequently an unscrubbed assistant releases traction, gradually moving the hip into flexion and slight abduction, with the foot remaining in the traction boot. As traction is released and the femoral head is visualized reducing within the acetabular fossa, a capsulotomy usually needs to be performed with a shaver and/or a radiofrequency ablation device through the anterior or mid-anterior portal to ensure full visualization of the femoral head neck junction. Further synovectomy is also performed to adequately visualize the femoral head neck junction. Once this is completed, one should be able to move easily between the two portals providing a complete visualization of the femoral head/neck junction. The extent of the capsulotomy can be limited if the hip is flexed, thereby reducing tension of the anterior capsule and ligaments and allowing easier mobility of instrumentation. However, in some patients who have “tight” hip joints (narrow compartments, significant loss of rotation), a more extensive capsulotomy and even partial capsulectomy is performed to include not only the zona orbicularis, but the iliofemoral ligament as well. Care must be taken, however, not to resect the posterolateral synovial fold, as this carries branches of the posterior femoral circumflex vessels, which supply the femoral head. This process is further aided with the use of fluoroscopy to confirm the location of the entire CAM deformity (Fig. 15.3).

Proximal or distal accessory portals can also be made to further visualize the peripheral compartment. A proximal anterolateral portal is known to give a comprehensive view of the peripheral compartment. This portal is established

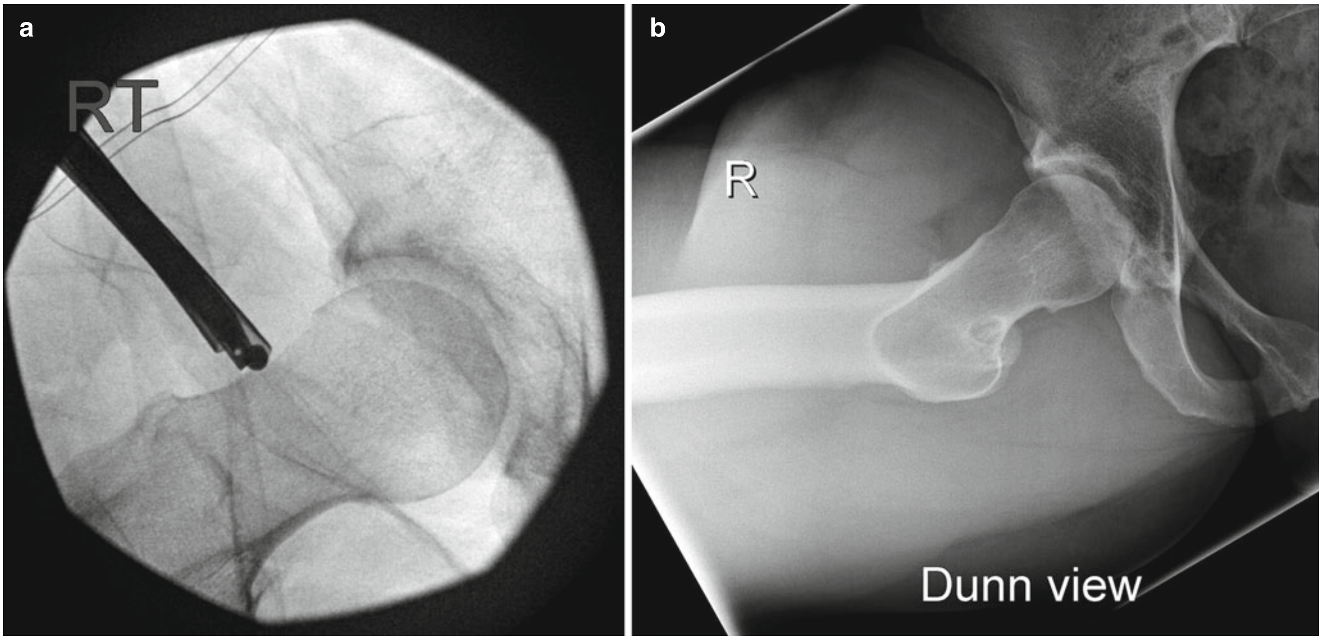

Fig. 15.3 Healthy 35 year old female patient with clinical and radiographic CAM type FAI whose pre-operative radiographs and selected MRI images are shown in Figs. 15.1 and 15.2. (**a**) Intra-operative fluoroscopic Dunn view of the right hip confirming position of the arthroscopic shaver on the femoral head neck CAM lesion. (**b**) Post-operative Dunn view of the right hip confirming resection of the CAM lesion

approximately 3–4 cm proximal to the standard anterolateral portal in the same line. That being said, there is a risk associated with this portal placement of damaging the branch of the superior gluteal nerve which supplies the tensor fascia muscle. Other authors have described it as the "soft spot" one third of the distance along the line drawn from the ASIS to the tip of the greater trochanter [6]. A similar proximal mid-anterior portal can also be made in the same line as the mid-anterior portal. Furthermore, a distal anterolateral portal can also be established 4–7 cm distal to the anterolateral portal as an access portal [4]. Each of these portals can be used as either a visualization or working portal to allow adequate visualization of the peripheral compartment or to address pathology (e.g. performing a femoral head neck osteochondroplasty).

We only use the posterolateral portal (placed along the inferior margin of the greater trochanter or at its posterior border under direct arthroscopic visualization), during work in the central compartment and acetabular rim.

Diagnostic Arthroscopy of Peripheral Compartment

A systematic approach to viewing the peripheral compartment must be developed to accurately diagnose all pathology. Dienst et al. published a sequence of systematically viewing the peripheral compartment by dividing the compartment into seven areas: anterior neck, medial neck, medial head, anterior head, lateral head, lateral neck, and posterior [6]. The authors noted that the peripheral compartment could be best viewed starting from the anteromedial surface of the femoral neck where the zona orbicularis and anterior and medial synovial folds could be seen. Similarly, Bond et al. describe a systematic approach to the peripheral compartment starting from the medial femoral neck but ending at the anterior femoral neck and anterior synovial fold [7]. Regardless of which approach is taken, the important aspect is applying a systematic routine and identifying common landmarks. The zona orbicularis and medial synovial fold are landmarks to gain access to the psoas tendon. The medial synovial fold serves to approximately mark the 6 o'clock position of the femoral head neck junction, and is usually the medial extent of a CAM lesion. Similarly, the lateral synovial fold can be used to roughly mark the 12 o'clock position, and as mentioned, is important not to resect to avoid iatrogenic injury to the retinacular blood vessels supplying the femoral head.

During the diagnostic arthroscopy of the peripheral compartment, each of the areas is inspected thoroughly and any synovial pathology or tumors (i.e. chondromas/osteochondromas) are treated.

Arthroscopic Femoral Head Neck Osteochondroplasty

Treating CAM lesions arthroscopically requires addressing both the central and peripheral compartment pathology. We first address the central compartment pathology performing chondroplasty for loose chondral flaps, microfracture for any chondral changes equal to or greater than Outerbridge four and labral debridement or restabilization for tears. Once this is complete, attention is turned to the peripheral compartment. Access is gained as described previously. Once the femoral head-neck junction is visualized, especially anterolaterally where the majority of CAM lesions occur, the hip can be flexed, abducted or adducted, and rotated to demonstrate the area of impingement arthroscopically and confirmed using fluoroscopy. Occasionally, the area of impingement is well demarcated at the osteochondral junction found at the base of femoral head and proximal aspect of the femoral neck and the articular cartilage and bone may have irregular discoloration [8]. It is important to have an idea of where the patient's CAM lesion is located, based on pre-operative diagnostic imaging, as each patient has a slightly different location of the lesion. Therefore, the amount of femoral head neck osteochondroplasty required must be tailored to each individual patient. The use of three-dimensional computer tomography imaging may be useful in helping to determine the area of resection.

The goal is to restore the "normal" anatomy and offset for the patient. Determining the "ideal" amount of bone to resect has not been definitively established in the literature. It is important not to over resect as this may result in loss of the seal effect between the labrum and femoral head [9]. Furthermore, early clinical outcomes of decompression of the CAM lesion do not correlate with the ability to restore a normal alpha angle [10, 11]. It must be noted that the alpha angle does not represent the full extent of the cam pathology, as it only measures the loss of anterior concavity, whereas clinically, can appear either laterally, anteriorly, or a combination of the both. As a result, resection should be started between 7 and 10 mm from the labral edge and continued distally to ensure that all of the offending impinging area is addressed. Similarly, the medial to lateral resection should do the same, keeping in mind the medial and lateral extents mentioned above (medial and lateral synovial folds). The depth of resection is also another area of debate with a general guidelines suggestion of 1 cm [5, 12]. Using a cadaveric model, Mardones et al. determined that resection of greater than 30 % of the femoral head-neck junction diameter significantly decreased the amount of energy required to produce a femoral neck fracture [13]. At our institution we use a combination of fluoroscopy and dynamic hip range of motion during arthroscopy to ensure that an adequate resection of the CAM lesion is achieved (Fig. 15.3).

Post-operative rehabilitation is completely variable in the literature after arthroscopic management of CAM type FAI. At our institution, the patient is kept 50 % weight bearing on the operative extremity with crutches. The patient is also given heterotopic ossification prophylaxis in the form of indomethacin for 1 month (25 mg dose three times daily). Hip range of motion is started immediately as tolerated with simple exercises that the patient does individually. Formal physiotherapy for progressive hip range of motion, stretching, and strengthening, starts at the 2 week follow up visit.

Psoas Tendon Release

The psoas is located directly anterior to the anterosuperior capsulolabral complex at the 2–3 o'clock position [14]. The psoas tendon lies anterior to the hip joint capsule, in line and anterior with the medial synovial fold, between the anterior zona orbicularis and the anterior labrum proximally. Depending on the thickness of the capsule, the psoas tendon may be visible. Furthermore, there is a direct connection between the hip joint and the iliopsoas bursa in approximately 15 % of patients [15].

Arthroscopic release of the iliopsoas tendon for the treatment of internal snapping hip syndrome has been performed either at the level of its insertion on the lesser trochanter or at the level of the hip joint via a transcapsular approach [16–18]. The transcapsular approach can be performed from either the central or peripheral compartment. Regardless of approach, treatment seems to be effective and results reproducible [19].

Access to the psoas tendon via the peripheral compartment can be made using the existing portals described and by making accessory portals distal to the anterior or mid-anterior portals (with the aid of fluoroscopy to ensure that the portals are directed towards the lesser trochanter). A capsulectomy is performed at this level to gain access to the iliopsoas bursa and tendon, and synovial tissue around the tissue is resected using a shaver. Once the tendinous portion of the iliopsoas is identified, it is released with a radiofrequency hook probe, ensuring that the underlying iliacus muscle fibers remain intact. Wettstein et al. have also described psoas tendon tenotomy through a peripheral hip arthroscopy, without traction and using a proximal anterolateral portal for visualization [18].

Complications

The largest series in the literature report complication rate following hip arthroscopy anywhere from 0.4 to 1.4 % [20, 21]. In the largest and most recent series, the authors describe that complication rate declined from 15 % over the first 60 cases to6.2 % over the next 500 cases, and 0.5 % over the last 500 cases, citing that safe traction and experience helped reduce the complication rate [21].

Neuropraxias are the most prevalent complication (0.4–2 %) with injury to the pudendal (most common), sciatic, peroneal and femoral nerve all being reported. Nearly all neuropraxias in the literature have been transient [20, 21]. Other rare traction complications such as perineal hematomas and vaginal/labial tears have also been reported [20, 22]. Although these traction related complications should not be a factor with peripheral compartment arthroscopy, given the fact that most hip arthroscopies will involve visualizing both the central and peripheral compartments, traction related complications can be avoided by minimizing the traction time (common recommendation is less than 2 h although there is no good evidence to support this), minimizing the traction force (e.g. ensuring that the patient is adequately paralyzed), and carefully positioning a large well-padded perineal post laterally.

Inaccurate portal placement can also lead to nearby neurovascular structural damage. The standard anterolateral and proximal anterolateral portals are within the safest zones during hip arthroscopy [4]. The anterior portal is close to branches of the lateral femoral cutaneous nerve, and using a mid-anterior portal can decrease the chance of injury to this nerve. Portal bleeding and hematoma are rare complications [20].

Iatrogenic damage of the acetabular cartilage and labrum as well as the femoral head weight-bearing cartilage is usually not an issue during peripheral compartment arthroscopy as long as the instruments are not too close the joint space. Moving the hip joint during peripheral arthroscopy so that the femoral head cartilage is hidden underneath the labrum in the acetabular fossa will also prevent inadvertent damage to the cartilage. Sampson reported three cases out of 1,001 which had significant femoral head scuffing because of inadequate distraction [21]. The author also states that most hip arthroscopies will result in minor scuffing from needle placement and instrument maneuvering. In the 1054 cases reported by Clarke et al., 30 cases could not be entered with the arthroscope but there was no mention of iatrogenic damage [20]. Both of these reports imply that the incidence of iatrogenic damage to the femoral head and labrum is under reported in the literature.

Theoretically, arthroscopic CAM resection could compromise femoral head blood supply if the deep branch of the medial femoral circumflex artery is damaged as it enters the hip capsule. As mentioned, keeping the osteochondroplasty limited to areas medial to the lateral synovial fold will also help protect the femoral head blood supply. To date, there have been no reports of femoral head osteonecrosis following arthroscopic CAM resections. However, there have been two reports in the literature of avascular necrosis following hip arthroscopy. Sampson reported only one case in a cohort of 1001 hip arthroscopies [21]. The author speculates that the one case may have been at risk of osteonecrosis secondary to the trauma the patient suffered prior to the surgery, and that distraction and partial capsulectomy performed at the time of hip arthroscopy may have contributed to the development of AVN. Scher et al. reported on one case that that did not have any significant underlying factors other than a traction of 10 mm was held for 90 min intra-operatively [23].

Extravasation of irrigation fluid into the abdominal and/or retroperitoneal compartments causing cardiac arrest and intra-abdominal compartment syndrome has also been described [24]. Fluid may track along the psoas tendon if there is damage to the sheath allowing for fluid to pass into the retroperitoneal space. Fluid extravasation can also significantly decrease the space in the peripheral compartment. Minimizing capsular resection and performing work that requires capsular resection at the end of procedures can help limit the amount of fluid extravasation that occurs. Careful attention to the pump and outflow during predictably long cases or extra-articular cases will further reduce this problem. Sampson also reports that changing to an outflow dependent pump nearly eliminated extravasations in their institution [21].

Infection has been an extremely rare complication, only reported in one study [20]. Similarly complications such as myositis ossificans [25], trochanteric bursitis [20] and reflex sympathetic dystrophy [22] are also just as rare. Femoral neck fracture after arthroscopic management of CAM lesions has also been reported [20]. Limiting the amount of femoral neck resection [13] and modifying weight bearing status post-operatively can help prevent this serious complication [26].

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