Advancements of Hip Arthroscopy in Trauma

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Edited by

Alessandro Aprato

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PREFACE

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In recent decades, the landscape of orthopaedic surgery has undergone a remarkable transformation with the rapid expansion of arthroscopic techniques. This evolution has been particularly pronounced in the realm of traumatic joint pathologies, leading to a proliferation of arthroscopic interventions across various major joints. From knee and ankle soft tissue injuries to tibial plateau and articular fractures, the arthroscopic applications have expanded substantially. This transformative trend also extends to the intricate realm of hip joint pathologies, propelled forward by advancements in surgical technologies and instrumentations. While non-traumatic conditions have traditionally dominated the field of hip arthroscopy, the realm of traumatic intra and extra-articular injuries is now increasingly amenable to arthroscopic treatment.

The foundations of arthroscopic principles have been effectively harnessed to enhance visualization and navigation within the hip joint, even in cases of traumatic injury. Incorporating infusion pumps, specialized hip portals with multiple cannulas, and traction, surgeons have ventured into the realm of traumatic arthroscopy. Yet, the allure of arthroscopic techniques should always be tempered by an awareness of potential complications. In the context of traumatic injuries, these complications can encompass fluid extravasation, pressure wounds, nerve injuries, iatrogenic cartilage damage, and even systemic consequences such as abdominal compartment syndrome and cardiac arrest. Although these complications are relatively rare, surgeons must cultivate a familiarity with hip arthroscopy in non-traumatic scenarios to minimize their occurrence in traumatic cases. This book embarks on a journey to explore the most prevalent trauma-related indications and their corresponding treatment options.

After a traumatic event, such as hip fracture/dislocation, a diverse array of intra-articular conditions may necessitate arthroscopic intervention. The extraction of loose bodies or small intraarticular fragments, reduction and fixation of femoral head or posterior wall fractures or complex acetabular fractures and capsulorraphy are among the most frequent indications warranting hip arthroscopy.

Moving beyond intra-articular injuries, the narrative unfolds into the realm of extra-articular pathologies. The unique attributes of these injuries, often coexisting with traumatic hip trauma, have spurred the development of innovative endoscopic solutions. From anterior-inferior iliac spine (AIIS) avulsion fractures to proximal hamstring injuries, the potential of arthroscopic intervention is harnessed to mitigate the morbidity associated with open procedures.

In summation, this book sets the stage for a comprehensive exploration of hip arthroscopy in the context of traumatic pathologies. The journey embarked upon delves into a realm where surgical innovation meets the exigencies of trauma, offering patients a novel avenue for restoration and recovery. The subsequent chapters will meticulously unravel the intricacies of each indication, equipping readers with a profound understanding of the nuanced world of traumatic hip arthroscopy.

CHAPTER 1

ARTHROSCOPIC FREE-BODY REMOVAL AFTER DISLOCATION OR AFTER BULLET/BOMB SPLINTER PENETRATION

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Introduction

Intra-articular loose bone fragments are quite common after the reduction of a dislocated hip and, unless they are located in the acetabular fossa, they must be removed. Yamamoto et al. first described hip arthroscopy's usefulness in this setting (Yamamoto et al., 2003; Keene et al., 1994; Bagaria et al., 2008). In case of a recent dislocation, apart from removing incarcerated loose bony fragments, hip arthroscopy can be beneficial for managing labral, cartilage and ligamentum teres tears. Furthermore, at the same time, a cam-type femoroacetabular impingement (FAI) deformity, often a concurrent cause for dislocation, can be treated (Byrd et al., 1996).

Foreign loose bodies are small fragments with different shapes, characteristics, and compositions that are not endogenous. These fragments can result from hardware breakage during trauma surgery, bomb splinters or bullets (Ilizaliturri et al., 2007).

Two surgical techniques are available to remove loose bodies: open standard arthrotomy or arthroscopy (Goldman et al., 1987; Meyer et al., 2002; Selmene et al., 2022). In the past, arthrotomy was the preferred technique but now arthroscopy has become the gold standard for its low invasiveness and faster recovery (Catma et al., 2016; Budeyri et al., 2020).

Regardless of the surgeon's preferred technique, endogenous or foreign materials inside the hip joint must be removed to prevent joint arthropathy, cartilage damage (Selmene et al., 2022), local toxicity (Fournier et al., 2019), and septic arthritis (Delaney et al., 2011; Mineo et al., 2003; Kayal et al., 2013).

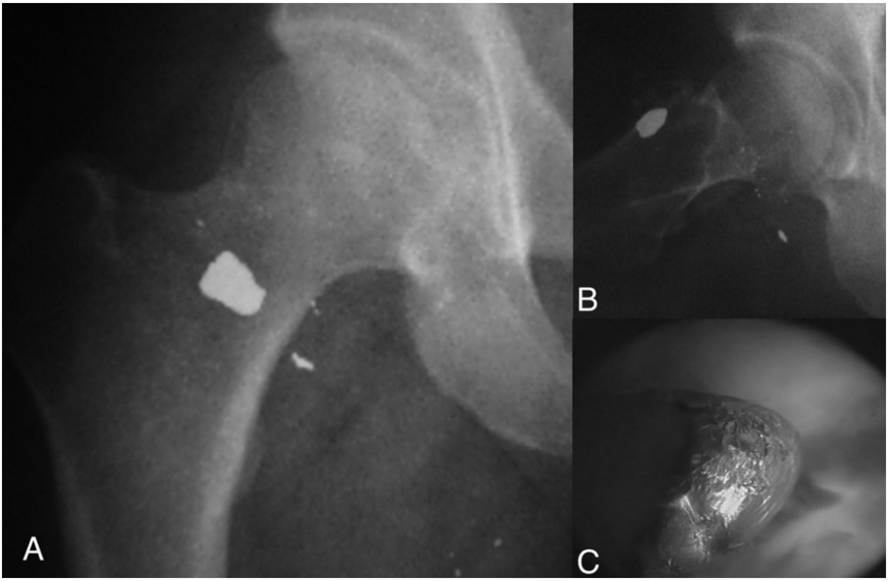

Figure 1: A: Anteroposterior right hip X-ray showing an incarcerated bullet and metal fragments in the peripheral compartment of the anterior neck; B: Cross-leg hip view showing the distal location in the peripheral compartment; C: Intraoperative arthroscopic view showing the metal fragment of the bullet in the medial gout of the peripheral compartment.

Clinical examination

History is always quite clear in these patients: a recent trauma with hip dislocation, a gunshot or a bomb explosion (Fig.1). Hip pain with a limited range of motion is the classical presentation but not the rule. In the case of a loose body inside the capsule but outside the joint, the range of motion can be normal but painful. Due to an unreduced hip joint, different leg lengths can be visible. In cases of gunshot wounds or bomb splinters, neurological and vascular examination and an accurate check of hemodynamic parameters are crucial. If present, it is essential to look for the splinter or projectile's entry points.

Diagnostic

A standard pelvic X-ray with antero-posterior projections and a cross-table axial view can provide an initial assessment. Foreign bodies are usually clearly visible, but bony fragments may not and may prevent the hip from being fully reduced. Computerized Tomography (CT) is the most accurate diagnostic tool. It provides more detailed information about the loose body's size, shape, and location, which is essential for planning surgery and ensuring its success. Magnetic Resonance Imaging (MRI) is rarely used. However, it may be helpful to identify chondral defects on the femoral or acetabulum sides and labral lesions.

Surgical technique

Under general anaesthesia, the patient is placed on a dedicated, well-padded traction table in lateral decubitus (Sozen et al., 2010) or supine (Catma et al., 2016). The hip joint is distracted through controlled traction. The surgeon should look carefully at intra-op X-rays at this stage because loose bodies may move during this manoeuvre. Access to the hip joint is obtained first by creating an anterolateral portal (AL) using a long spinal needle and checked through fluoroscopy. The portal should be modified if the loose body lies on the same trajectory as the standard entrance. Once the needle is confirmed into the joint, 50cc of saline is infused. In case of acute trauma or synovitis, blood reflux is often visible. The second portal is the direct anterior or mid-anterior (MAP), established under direct visualization. If there is too much blood, a good trick is to insert a second needle strictly parallel and anterior or posterior to the first one just for initial joint lavage and visualization of another portal entry site. Usually, a third portal is established. Most of the time, it is the posterolateral (PL) one in a loose bony fragment removal. Those loose bodies tend to lie in the posteroinferior part of the joint or the acetabular fossa. A distal anterior lateral accessory portal (DALA) is needed less frequently.

Once at least two portals are established, the joint is washed, debrided and meticulously viewed with 30—and 70-degree arthroscopes through the usual cannulated set. Maintaining a low-pressure flow (35mmHg), especially in recently dislocated patients or in cases of acetabular fracture, is mandatory to mitigate the risk of excessive fluid extravasation or abdominal compartment syndrome. A hidden ligamentum teres stump often covers part of the joint in a dislocated hip and should be debrided with a bent shaver or ablation system.

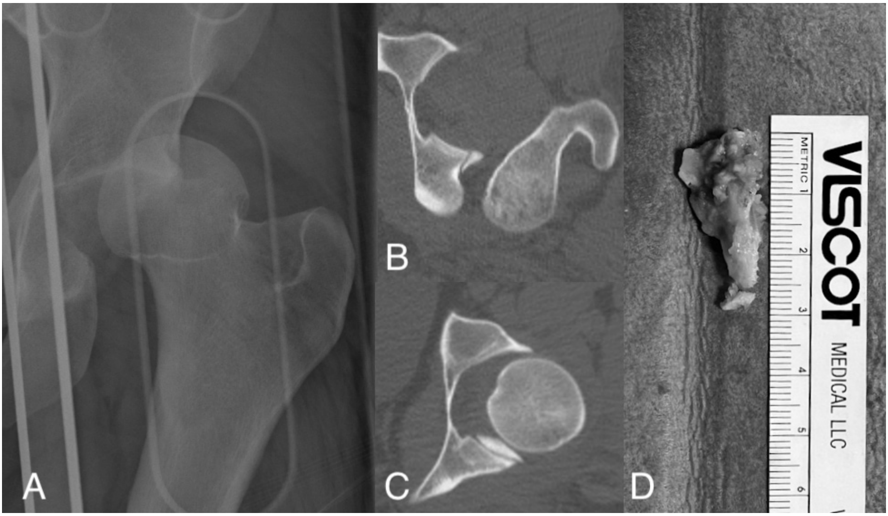

Figure 2: A: Anteroposterior left hip X-ray showing a posterior dislocation; B: Axial CT-scan view showing the posterior dislocation and a fracture of the posterior wall of the acetabulum; C: Axial post-reduction CT-Scan view showing a retained intraarticular fragment of the posterior wall fracture; D: Intraoperative view of the removed fragment of the posterior wall.

Once the loose body is detected, a check of its adherence to soft tissue is performed. Often, a bony fragment of the posterior wall, retained after reduction, is still attached to the capsule or the labrum (Fig. 2). If so, soft tissue is cleaned incompletely using an arthroscopic shaver, a spatula, or a monopolar ablation system. A flexible ablator with a rotating articulated stem is sometimes needed (Sidewinder, Smith and Nephew, USA) to release the fragment from the more hidden part of the joint. Then, the loose body is grasped on his long axis with forceps and completely freed by performing rotational movements. Just before loose body extraction, the surgeon should have widened the portal from the capsule to the skin to reduce the risk of losing it in the periarticular tissues. A wider cannula or a slotted cannula is used to help extract the cannula. It’s necessary to be equipped with grasping forceps of various sizes and with relatively wide branches, especially in the presence of huge fragments. The diameter of the slotted cannula is 8.5mm; if the mobile body is bigger, a larger cannula may be requested to prevent the fragment from being lost in the soft tissues. The extraction of foreign bodies, well visible in X-rays, can be performed under fluoroscopic guidance (Fig.3). In cases where the loose body is small and cannot be grasped easily, a flexible endotracheal catheter connected to the suction system is inserted through the anterior or mid-anterior portal. The suction system allows the loose body to be captured in contact with the tip of the catheter, which is then used to transport the loose through the cannula (Randelli et al., 2010). After removing a loose body, the central compartment must be thoroughly explored for any residual part, cartilage lesion, or labral detachment.

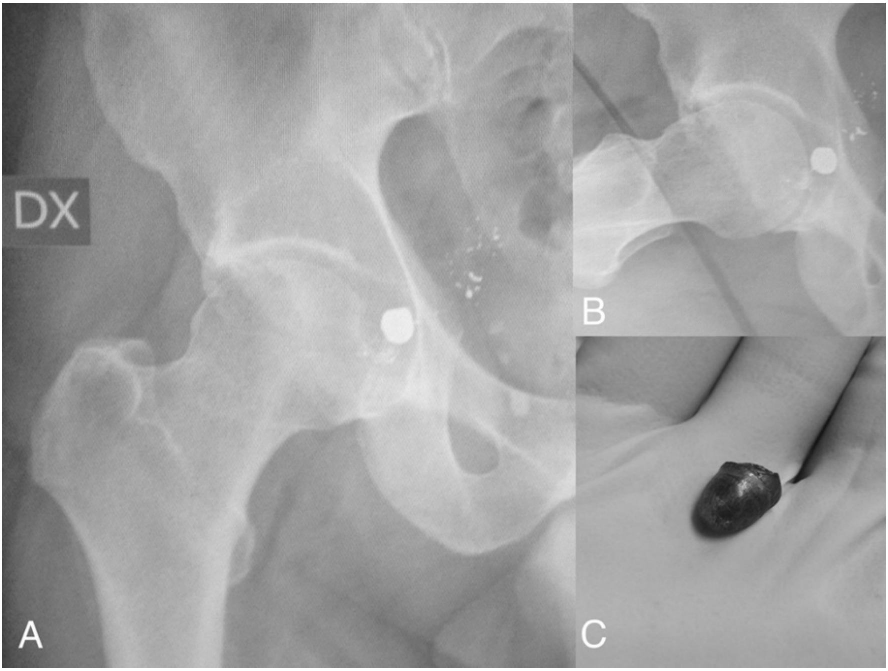

Figure 3: A: Anteroposterior right hip X-ray showing an incarcerated bullet in the acetabular fossa and metal fragment in the pelvis; B: Cross-leg hip view showing the central and deep location in the fossa; C: Intraoperative arthroscopic view showing the removed metal fragment of the bullet

The joint capsule performs an essential function of primary stability, and its closure is usually necessary to restore the native anatomy and physiology (Randelli et al., 2010; Di Benedetto et al., 2020). The capsular suture is rarely recommended at the end of a loose body removal unless a huge capsular opening is needed for extraction. In case of traumatic dislocation, this is not usually performed.

Antibiotics, thromboembolism, and heterotopic ossification prophylaxis are recommended (Catma et al., 2016), and physical therapy must also be scheduled (Al-Asiri et al., 2012).

After surgery, limited mobilization with double crutches and lightweight bearings is indicated, depending on the joint's condition and the type of surgery performed. Once the joint has healed, full weight bearing can be resumed. In case of posterior dislocation, six weeks of limited flexion is required.

Discussion

A bony fragment or a foreign object stuck between the femoral head and the acetabulum can seriously threaten the articular cartilage. The resulting damage can lead to traumatic osteoarthritis (Selmene et al., 2022) or local toxicity (Windler et al., 1978; Rehman et al., 2007), and even septic arthritis (Delaney et al., 2011; Kayal et al., 2013; Sozen et al., 2010) in case of an exogenous fragment. In the case of a bullet or its fragment, synovial fluid can absorb lead, leading to systemic intoxication and multisystem disease (Tzaveas et al., 2023). Furthermore, bullets may provide forensic evidence and can be used by law enforcement (Lee et al., 2008).

Guidewire breakage is a complication associated with cannulated devices used in trauma and orthopaedic surgery (Ilizaliturri et al., 2007). If the fragments are intra-articular, removal is mandatory because they can cause significant harm.

Traumatic hip dislocations are severe injuries associated with considerable morbidity (Weber et al., 2022). They are considered a therapeutic emergency that often requires a reduction of the dislocation (Zengui et al., 2022; Xu et al., 2022; Wang et al., 2023) since the delayed recognition of fracture dislocations and neurovascular deficits have been proposed as causes that lead to harmful long-term clinical outcomes (Weber et al., 2022). Indeed, at least two years of postinjury follow-up is recommended to monitor for signs of femoral head osteonecrosis (Wang et al., 2023).

When removing foreign bodies, it is always preferable to use a less aggressive surgical technique. Hip exploration aims to examine the hip joint, which is traditionally done through an open arthrotomy. This approach requires a large incision to access the joint cavity (Chernchujit et al., 2009). If a dislocation is needed, the procedure requires a trochanteric osteotomy that should be fixed at the end. Despite being a standardized method today, arthrotomy with dislocation carries a higher risk of complications. Potential hazards include nervous and vascular injuries, avascular necrosis of the femoral head, trochanteric pseudoarthrosis, and heterotopic ossification (Tzaveas et al., 2023; Chernchujit et al., 2009). Arthroscopy is a minimally invasive surgical procedure with several advantages over open surgery (Goldman et al., 1987; Cory et al., 1008). Compared to open surgery, arthroscopy allows patients to experience less pain and a quicker recovery (Selmene et al., 2022; Mineo et al., 2003; Sozen et al., 2010). Furthermore, hip arthroscopy minimizes soft tissue disruption, reducing the risk of postoperative complications such as stiffness and avascular necrosis (Selmene et al., 2022; Sozen et al., 2010). Arthroscopy also yields a better cosmetic appearance (Goldman et al., 1987; Cory et al., 1998). Conversely, hip arthroscopy is a complex procedure that requires a steep learning curve. Accessing the hip joint after a hip dislocation or in the case of foreign body removal can be particularly challenging (Budeyri et al., 2020). Hip arthroscopy, like any surgical procedure, can lead to complications (Kayal et al., 2013; Mullis et al., 2006), and a well-known complication of hip arthroscopy in acetabular fractures is abdominal compartment syndrome (Sozen et al., 2010) due to fluid extravasation directly into the abdomen through the fracture gap. In such cases, the procedure should be suspended immediately, and a needle decompression should be performed. If the evacuating fluid presents blood traces, an urgent laparotomy could be indicated (Selmene et al., 2022).

Hip arthroscopy remains the gold standard for removing bony fragments or foreign materials from the joint despite these risks. Open surgery should be considered only for more complicated cases or in case arthroscopy fails (Catma et al., 2016). Many authors have successfully used hip arthroscopy to treat various pathologic conditions of the hip. Bony fragment and foreign body removal results are satisfactory. Goldman (Goldman et al., 1987) was the first to publish arthroscopic bullet removal from the hip, with good results. Cory (Cory et al., 1998) removed an arthroscopic bullet from the femoral head together with osteochondral loose bodies, as did Teloken (Teloken et al., 2022), both with favorable outcomes. On the other hand, Mineo (Mineo et al., 2003) reported arthroscopic bullet removal from the acetabular side, with a full range of motion without crepitus or pain and no radiographic evidence of avascular necrosis was referred at an 18-month follow-up. Satisfaction is also reported by Sozen (Sozen et al., 2010); indeed, they reported excellent early results, with the patient being mobilized on the day of the operation and returning to daily activities and occupations two months after surgery. Conversely, Catma (Catma et al., 2016), in the 2nd year of the follow-up period, showed how a patient treated for a projectile removal from the femoral neck had increasing groin pain that required a safe dislocation for femoral chondral injury.

As previously discussed, several studies and case reports have also shown the usefulness of hip arthroscopy in removing retained intraarticular fragments after hip dislocation (Yamamoto et al., 2003; Keene et al., 1994). In one of the most extensive reported series, Yamamoto (Yamamoto et al., 2003) performed hip arthroscopy in 11 cases of hip dislocation and removed intraarticular fragments in 9 cases; after a mean postoperative follow-up period of 9 years and six months, no abnormalities were observed in 9 joints. One case developed osteoarthritis, and one showed aseptic osteonecrosis of the femoral head. Also, Hari Krishnan (Hari Krishnan et al., 2015), despite the difficulties of performing an arthroscopic hip procedure, reported good results in treating a 21-year-old male with an intraarticular fragment fracture after hip dislocation. No symptoms such as pain, swelling, or deformity at 6 weeks postoperatively were reported. Bagaria (Bagaria et al., 2008) successfully reported a case of posterior dislocation of the hip with associated acetabulum fracture, with retained fracture fragments after a successful closed reduction. The fractured fragments were removed by arthroscopy of the hip, and at 10-month follow-up, the patient was asymptomatic. The follow-up radiograph and MRI scan showed no changes in avascular necrosis. Finally, no complications in the early post-operatory phase related to surgery were reported by Keene (Keene et al., 1994), who arthroscopically treated two patients who underwent posterior dislocation hip.

Overall, a systematic review (Mandell et al., 2018) analyzing thirty-one studies reported no major complications directly attributed to arthroscopic surgery. The review also showed that 75 out of 151 patients were followed up for a median of 2 years after the surgery, with osteoarthritis reported in 4.0% and avascular necrosis in 2.7%.

Conclusion

Stuck bony fragments or foreign bodies in the hip joint must be removed. Hip arthroscopy is the gold-standard procedure today. A dedicated technique with specific instrumentation, tips, and tricks is often necessary to perform a successful arthroscopy in this setting.

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CHAPTER 2

ARTHROSCOPIC ASSISTANCE IN COMPLEX ACETABULAR FRACTURE

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Introduction

Complex acetabular fractures are challenging for pelvic trauma surgeons and often extensively involve the articular cartilage. Except for the cases suitable for surgical dislocation, one of the main problems dealing with these fractures is the challenge of the indirect reduction, leaving the intraoperative evaluation to fluoroscopy (Söylemez et al., 2022). Hip arthroscopy emerged in trauma surgery in the last decade; however, it still has a side role with narrow indications. Arthroscopic-assisted reduction in complex acetabular fractures can be an important aid in restoring the articular surface, improving the quality of reduction and thus delaying the onset of post-traumatic osteoarthritis. In the literature, the importance of reduction is well described, especially gaps wider than 3 mm and steps above 4 mm seem to be the worst prognostic factors.

The presence of articular impaction in the dome area, especially in the case of a free fragment, is usually the main indication for arthroscopic assistance in the reduction of this type of fracture, as they are typically difficult to manage with the conventional approaches and under fluoroscopic control only (Niroopan et al., 2016).

A computed tomography (CT) scan with 3D reconstruction is mandatory in the preoperative workup to allow a complete evaluation of the fracture pattern, articular surface, and possible impaction (Fig.1) (Aprato et al., 2021). The choice of the surgical approach is based on Letournel's principles (Pohlemann et al., 2020). If arthroscopic assistance is needed, usually an anterior approach is performed (ilioinguinal or the combination of the lateral window of ilioinguinal and modified Stoppa), or the pararectus.

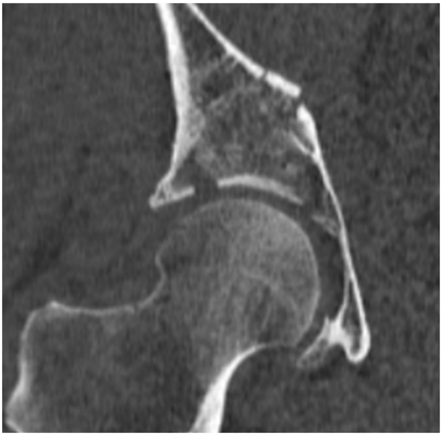

Figure 1. Preoperative CT scan with acetabular roof impaction

Surgical technique

The arthroscopic column and C-arm are positioned on the opposite side of the injured hip. Standard arthroscopy devices and instruments for the open surgery are prepared. Further devices that have to be available for this technique are a cannulated ram, 1.6 K-wire, around 6.5mm cannulated screws, and synthetic bone graft.

The patient is placed in supine position on a full radiolucent traction table with both limbs on traction arms, a postless technique is preferred, with the use of a specific pad. Skin preparation and disinfection are made, and the hip is draped from the inferior half of the abdomen to approximately the superior half of the thigh.

The planned approach is performed, and the fracture is exposed. Traction is applied to the affected limb and the arthroscopic portals are made. The anterolateral portal is made following the standard technique (17-gauge 6-inch spinal needle is inserted in the joint space under fluoroscopic control and, after changing nitinol guide wire, trocar, and cannula, the arthroscope is inserted into the hip). Caution should be made in advancing the nitinol wire as it may be pushed beyond the joint if it engages the fracture (Aprato et al., 2019). Under direct visualization, the mid-anterior and posterolateral portals are added. The fluid pump is used at a maximum pressure of 50 mmHg for hematoma evacuation and to limit fluid extravasation. In the case of severe displacement, fluid is drained, and a dry arthroscopy of the central compartment is performed until a proper sealing effect is obtained through reduction. During the arthroscopic step before reduction, the whole joint space is assessed to identify associated lesions, such as chondral lesions, and labral tears, and to remove free intrarticular bodies.

After identifying the impacted fragment(s) (Fig. 2), the edges are cleared, and the fragment is gently mobilized. A supracetabular 1.6-mm K-wire is placed under fluoroscopic and direct view through the previous open approach to reach the impacted fragment outside-in. When the K-wire is in the correct position, the fragment is reduced using a cannulated ram or a ball-spike pusher (Fig. 3). The whole procedure is performed under arthroscopic control. A slight overcorrection of the impaction is desired to prevent secondary depression after traction release. After achieving a satisfying reduction (Fig. 4), cancellous graft bone can be used to fill the gap over the impaction to give support to the fragment, preventing further displacement. Eventually, the fragment is stabilized with a 6.5mm cannulated screw as a raft screw (Aprato et al., 2023) (Fig. 5). Once the arthroscopic procedure is completed, reduction and fixation of the fracture are performed with the preferred technique, depending on the pattern. The quality of the reduction can be directly checked by intrarticular arthroscopic view (Fig. 6). In the end, traction is released, and the final fluoroscopic check is taken. At the end of surgery, final X-rays are taken (Fig. 7).

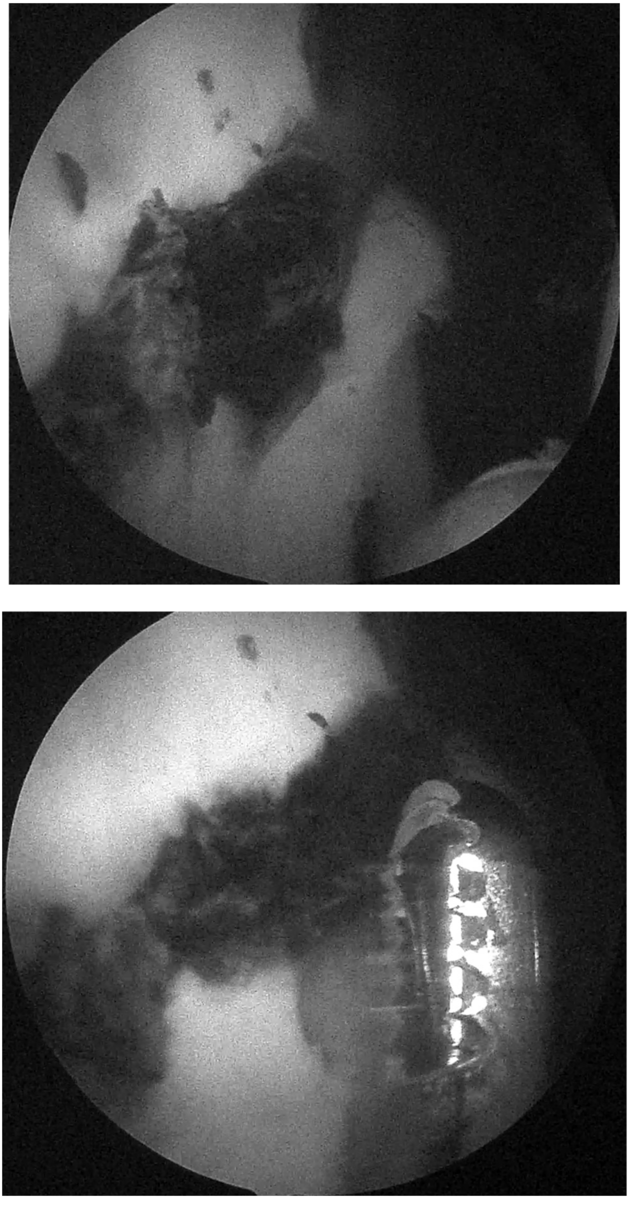

Figure 2. Arthroscopic fracture identification

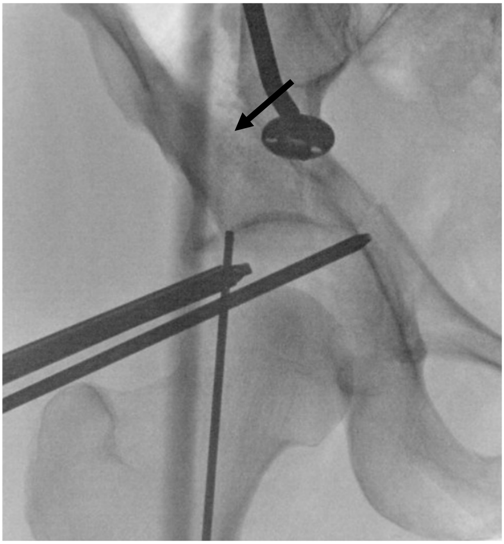

Figure 3. Fragment reduction with ball-spike pusher

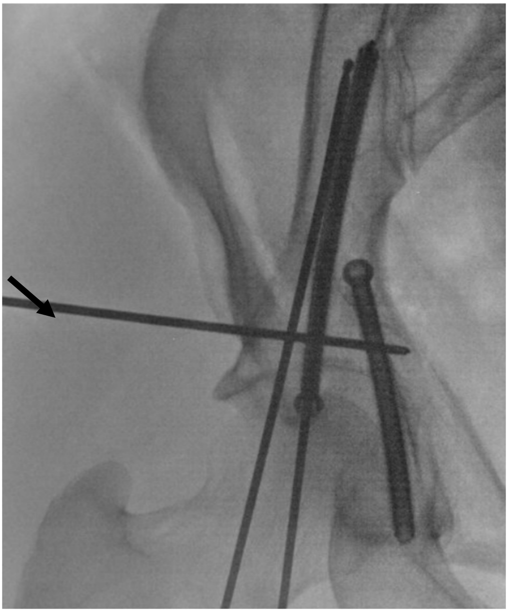

Figure 4. Supracetabular K-wire placement

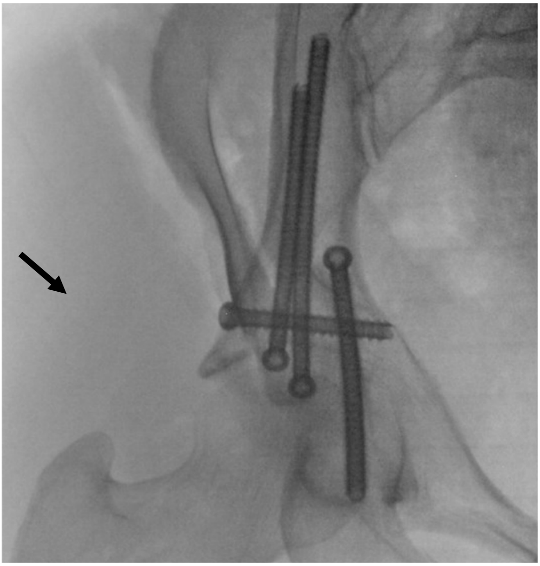

Figure 5. Final post-operative fluoroscopy after screws placement

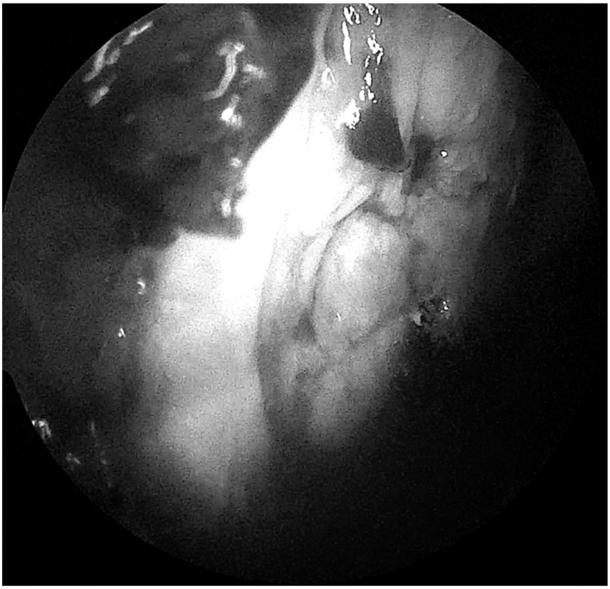

Figure 6. Dry arthroscopy after reduction and fixation. Note the traumatic chondral damage.

The aid of an arthroscopic look doesn't change the usual post-operative indications that avoid weight-bearing on the side of the fracture for 12 weeks and limit hip flexion for 6 weeks after surgery, depending on the type of fracture. Usually, a post-operative CT scan is taken to better assess the quality of reduction and the screws' position (Fig. 8).

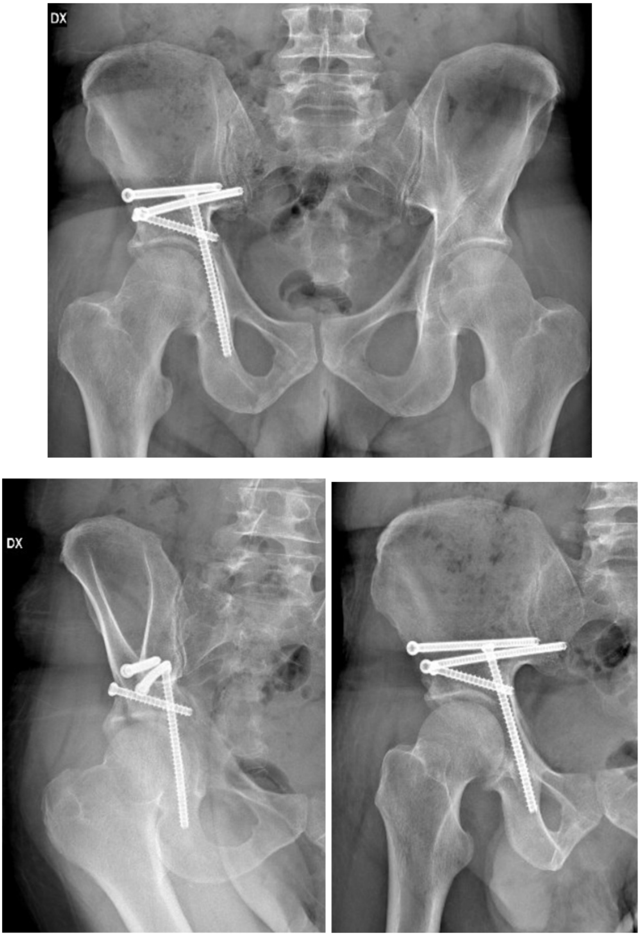

Figure 7. Post-operative X-rays

Figure 8. Post-operative CT scan

Discussion

Currently, most studies in the literature are focused on posterior wall fracture and there are few case reports on the arthroscopic treatment in the setting of other acetabular fractures (Kim et al, 2020; Götz et al., 2013). These studies reported the execution of hip arthroscopy along with fracture reduction and fixation, as an aid in reduction quality and loose bodies removal.

The main advantage of the arthroscopic-assisted techniques is the possibility of the direct view and evaluation of the articular reduction. Other benefits could be in specific cases the sparing of extensile approaches, or the limited exposure needed for the reduction of articular impaction, if compared to standard techniques.

Arthroscopy is becoming a useful tool in the management of acetabular fracture, risks and possible complications should be considered, especially in the traumatic setting (Seijas et al., 2017). Minor complications are the most reported in the literature and they can be grouped as follows: neurologic (perineal neuropathies, lateral femoral cutaneous nerve affection, and painful scars), soft tissues (burns, heterotopic ossification, and iliotibial band syndrome), surgical equipment breakage (nitinol wire, anchors and radiofrequency heads) and osteochondral damages (iatrogenic lesion). Even if major complications are much rarer (0.58% VS 7.5%), they can be life or limb-threatening and must be recognized promptly. Among them are infections, deep vein thrombosis, blood loss, pneumonia, sepsis, and multiple organ failure. In particular, one of the well-known main complications in hip arthroscopy is fluid extravasation, which can lead to abdominal compartment syndrome, cardiac arrest, pleural effusion, metabolic acidosis, and hypothermia. Two case reports (Shakuo et al., 2022; Bartlett et al., 1998) have been already published on fluid extravasation during acetabular fracture treatment and both surgeries reported about 2 hours of operative time and one of them reported a pump pressure of 100 mmHg (risk factors for fluid extravasation). In both cases, fluid extravasation led to abdominal compartment syndrome, and one of them also to cardiac arrest. The authors have not experienced this complication, and they believe that a simultaneous open approach can help drain the fluid before entering the peritoneal cavity.

The only other approach for complex acetabular fractures that can lead to direct visualization of the articular cartilage is the safe surgical hip dislocation, and nowadays it is the most reproducible method by the pelvic trauma surgeon to treat specific fracture patterns (Masse et al., 2013). This approach allows the surgeon to have a 360° view of the acetabulum and to evaluate the quality of reduction, loose bodies removal, and roof impaction, as hip arthroscopy. Even with its great potential, the main issue with the safe surgical dislocation is the limitation in treating the anterior column, especially in reaching its sufficient rigid fixation. Both these techniques have pros and cons, but some limitations of hip arthroscopy are related to the need for surgeons with specific skills and longer operative times. Due to these limitations, this technique may be best reserved for referral centres with high acetabular fracture volumes and an expert treatment team familiar with elective hip arthroscopy.

Conclusion

Hip arthroscopy is getting a large interest in pelvis trauma and the possibility of assessing and treating articular surface reduction without surgical hip dislocation may reduce invasiveness. Furthermore, it is a useful aid in treating secondary lesions, such as free loose bodies and labral lesions.

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