Technical Note

Hip Arthroscopy and Core Decompression for Avascular Necrosis of the Femoral Head Using a Specific Aiming Guide: A Step-by-Step Surgical Technique

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Abstract: Avascular necrosis of the femoral (AVN) head is a disabling disease that affects function, mobility, and quality of life in the young adult. Its pathology involves blood circulation disruption of the femoral head and subchondral infarction. This leads to cartilage thinning, femoral head depression, and cartilage breakage, which results in hip osteoarthritis. In the past decade the prevalence of intraarticular pathology has been almost 95%, this revealed with hip arthroscopy (HA). HA and core decompression (CD) of the femoral head can be used effectively and concomitantly to treat AVN with excellent results, HA allows for excellent visualization of the hip joint cartilage, allowing treatment of femoroacetabular impingement syndrome (FAIS) and intra-articular pathology. Our technique demonstrates that retrograde core decompression with allograft and mixed bone matrix is an excellent choice of treatment in the early stages of AVN/ONFH. The femoral head–specific aiming guide is very reliable, is simple to use arthroscopically if placed in the posterolateral portal of the hip, and offers exact pin placement at the necrotic site, as well as less operative time and less radiation to the patient and surgical team.

Osteonecrosis of the femoral head (ONFH) also called avascular necrosis (AVN) of the femoral head is a disabling disease that affects function, mobility, and quality of life in the young adult. Its pathology involves blood circulation disruption of the femoral head and subchondral infarction. This leads to cartilage thinning, femoral head depression, and cartilage breakage, which results in hip osteoarthritis.[1,2]

Various causes have been identified, as the causative agents of ONFH like systemic, trauma, iatrogenic and multifactorial and many more.[3,4] It is known that 5% to 18% of diagnose patients with ONFH are surgically intervened with total hip arthroplasty (THA). Patients with ONFH are generally younger adults between 25 to 55 years of age; it is known that males are affected up to 3 times more than females, and bilateral femoral head osteonecrosis is found in up to 75% of cases.[5-8]

Diagnosis, Clinical Assessment, and Radiographic Imaging

Typical ONFH is asymptomatic in the early stages of the disease, and clinical examination of the hip can be normal. Later, patients develop mild to moderate groin pain that can irradiate to the knee or buttock. By the time of presentation, patients often complain of pain when walking, and most of them attend the first consultation limping or with crutches. Patients usually present with a limited range of motion of the hip and pain may be provoked particularly with forced internal rotation and forced abduction. X-ray films are critical and should include an anteroposterior (AP) of the

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pelvis, a 45° Dunn view, and frog views of both hips. Radiographs may show a normal appearance in early stages of ONFH (Fig 1).[9-11]

The arrival of magnetic resonance imaging (MRI) gave rise to the Steinberg or University of Pennsylvania osteonecrosis classification system, which differentiates subchondral collapse from femoral head articular cartilage collapse (flattening). MRI has become the imaging modality of choice, because it is highly sensitive (99%) and specific (98%) for ONFH but compared to HA, its sensitivity (70%) and specificity (84%) decrease. Computed tomography scanning is less sensitive than MRI in detecting osteonecrosis but has a significant radiation burden.[12-14] There is a variety of treatment modalities in hip preservation for ONFH from the most conservative (electrical stimulation, magnetic therapy, hyperbaric therapy, ozone therapy, mesenchymal stem cell therapy) to more invasive surgical procedures (surgical hip dislocations with osteochondral transplantation, proximal femur rotational osteotomies, osteochondral autologous transplantation, core decompression with curettage, and placement of cement or with nonvascularized cancellous or cortical bone grafting, free vascularized fibular grafting, sartorius pedicle grafting, bone matrix, and retrograde allograft impaction).[15,16] The newer and minimally invasive surgical treatments are aimed to perform smaller femoral decompression tunnels that can be aid with hip arthroscopy (HA).[17-19] The advantages of applying HA to the femoral core decompression are that it can stage the disease, treat concomitant femoroacetabular impingement morphology, repair cartilage tears repair, repair labral tears, and avoid cartilage penetration while reaming toward the femoral head.[20]

Surgical Technique

HA is performed with the patient in the modified supine position and supported on a standard operating room table. The hip is distracted with a specialized hip distractor (ArthroMX, San Pedro, Garza Garcia, Mexico) with the patient under general anesthesia, and no muscle relaxants are used, although they may be added. The upper body of the patient is prepared in a Tutankhamun fashion, with both arms placed over the chest in a figure-8 or X position. Bony prominences are protected with egg crate foam at the level of the elbows and wrists. The hands are left free for intravenous line for medication passage, which is double-checked by the anesthesiologist. A long blanket is placed around the upper body. Heavy-duty duct tape (3M Corp, St. Paul, MN) is placed in an X or figure-8 fashion posteriorly, securing the patient's upper body on the operating room table. The duct tape is wrapped around the patient several times (4 to 6 times), and the tape is stuck to the metallic edges of the operating room table. Observation of the patient's thoracic motion, chest respiration, and intravenous line passage is done by the anesthesiologist. A trial traction is performed posteriorly with the image intensifier, first manually and then with the hip distractor.

The nonoperative hip is positioned in flexion, abduction, and external rotation to permit the passage of the image intensifier and take perfect fluoroscopic images (Fig 2). The hip is prepped and draped in a standard fashion, and anatomic landmarks are marked on the patient's operative hip, with 3 to 5 portals established to assess the peripheral and central compartments. An anterolateral portal (AL) is used for vision, immediately to the trochanteric tip. A peritrochanteric space portal is used as a working portal, a

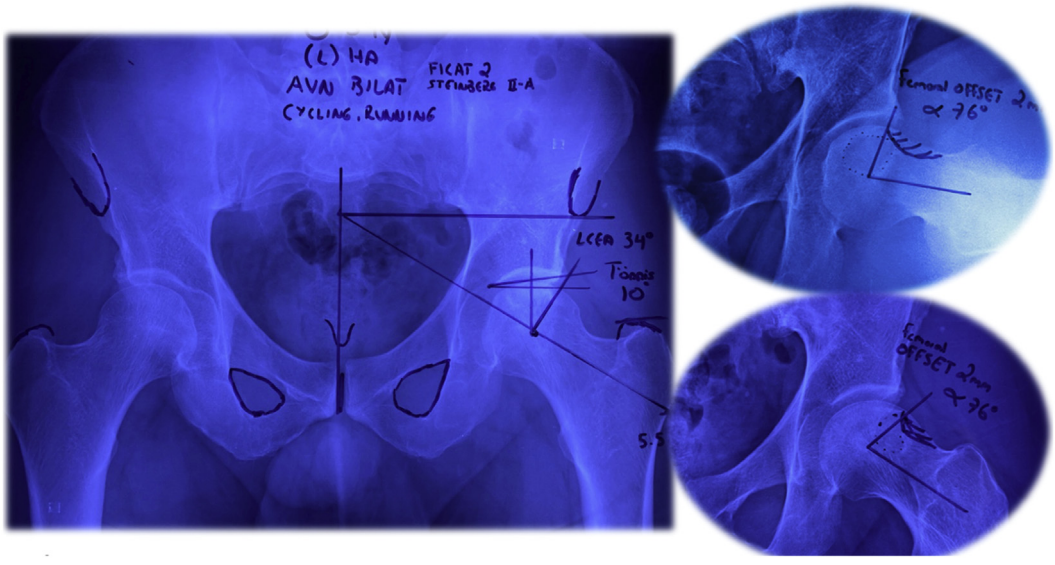

Fig 1. X-ray film (anteroposterior of the pelvis, 45° Dunn view and frog view) of a male patient with bilateral FICAT I stage avascular necrosis of the femoral head. Observe the subchondral intact bone in the frog view.

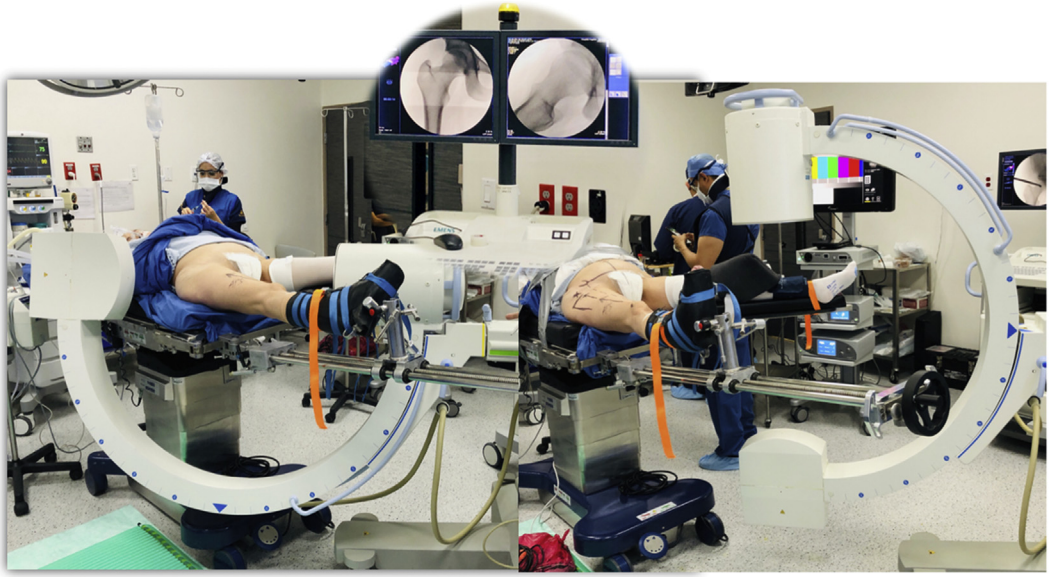

Fig 2. The surgical position in the operating room. Lateral view of the right hip (left) and anteroposterior view of the right hip (right). Observe the fluoroscopic images in the top pictures in an exact position for pin placement and retrograde core decompression.

midanterior portal is located 1.5 cm above and between the anterolateral and peritrochanteric space portals, which we call the trochanteric triangle portal, and a posterior portal (PP) is introduced to the femoral head aiming guide (Parcus Medical, Sarasota, FL). The anterior hip bursa is resected with a shaver and cauterized with a radiofrequency wand (RF) if there is bleeding. Anterior longitudinal capsulotomy is performed posteriorly to access the head neck junction and to perform femoro-osteochondroplasty of the cam morphology without hip traction. Hip distraction can be made under arthroscopic vision to enter the central compartment (CC), exchange to a 70° scope with switching sticks in a Seldinger technique is performed when entering the CC to observe the femoral head cartilage, labrum, chondrolabral junction, ligamentum teres, and acetabular fossa. If a labral tear exists, it is tackled in a standard fashion with 1.8- or 2.8-mm anchors (Parcus Medical) (Fig 3). With fluoroscopic assistance and guidance, we confirm the location of the necrotic lesion, followed by an exhaustive examination and palpation with a ballotment test, which is

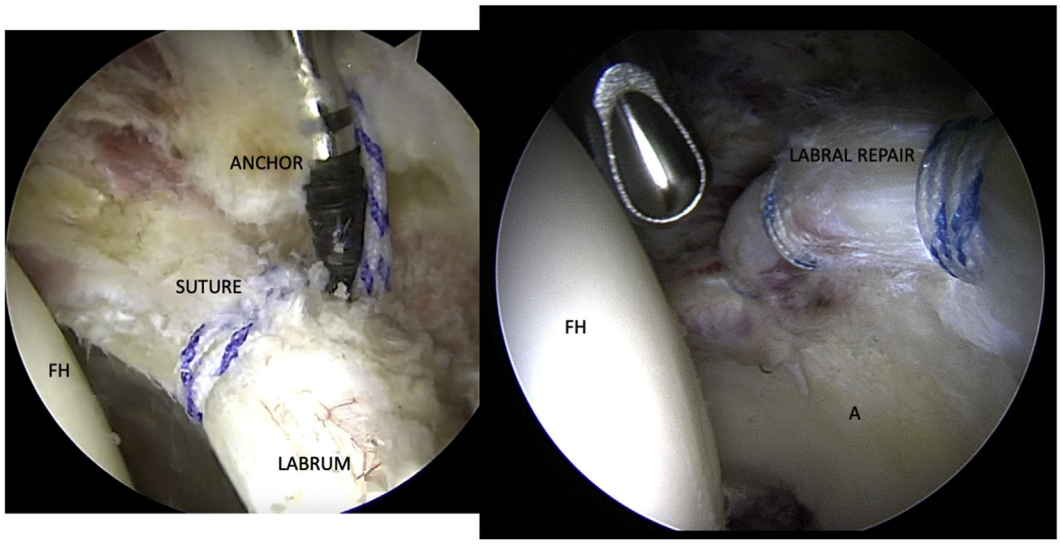

Fig 3. Hip arthroscopy is performed before the femoral head decompression to evaluate the entire hip joint and to treat intraarticular cartilage lesions. Observe here the pristine femoral head without collapse and acetabular cartilage without damage, and observe the chondrolabral junction disruption (right) that was repaired with 3 anchors in a patient with AVN Ficat I stage.

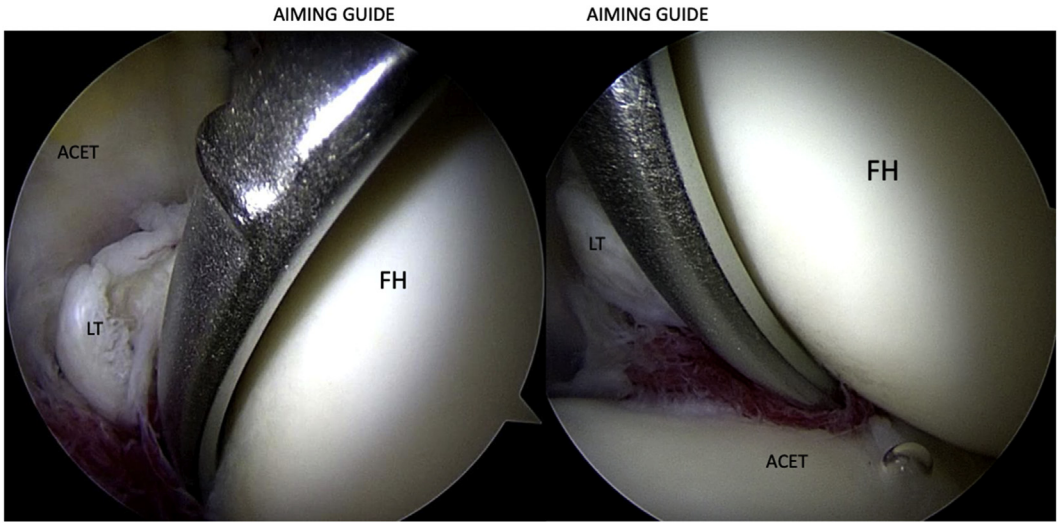

Fig 4. The specific femoral head aiming guide is introduced through the posterolateral portal at the desired position (anterosuperior portion of the femoral head).

performed with an arthroscopic hook palpator or a blunt obturator. Here the specific femoral head aiming guide (Parcus Medical) is placed in the site of necrosis on the femoral head; it is very important to introduce the aiming guide through the posterior portal along the posterior line of the femoral cortex with maximal internal rotation of the hip to place the guide pin in the center of the femur and toward the necrotic lesion to have perfect placement of the aiming guide as observed in the fluoroscope image. After proper placement of the femoral head aiming guide, a guide pin is passed toward the femoral head at the site of the necrosis with fluoroscopic guidance. (Figs 4-6). Posteriorly a 5 mm reamer is passed through the guide pin; it is important to perform a longitudinal incision at the trochanteric crest, and blunt dissection is carried down to the tensor fascia lata to expose the lateral cortex of the femur where the reamer will break this cortex aimed toward the femoral head. We continue with retrograde femoral head decompression with

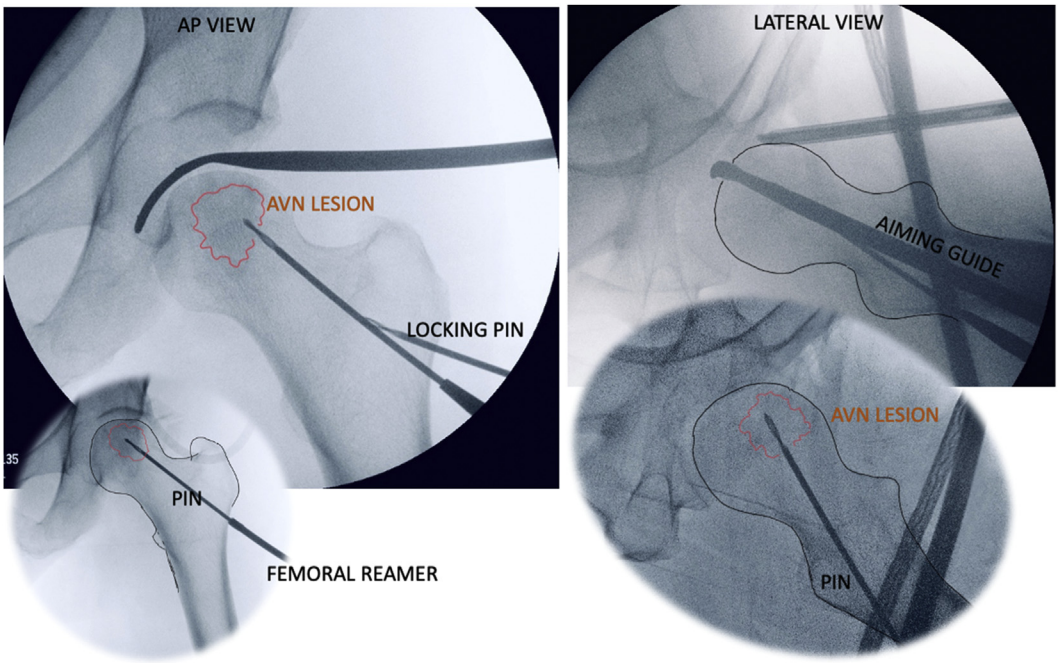

Fig 5. Intraoperative fluoroscopic images in the anteroposterior (AP) and lateral plane. The specific femoral head aiming guide (superior pictures) is placed in the necrotic lesion site, and the guide pin (inferior pictures) is passed at the exact site. These steps are corroborated with fluoroscopy planes in an AP view (left picture) and lateral view (right figure).

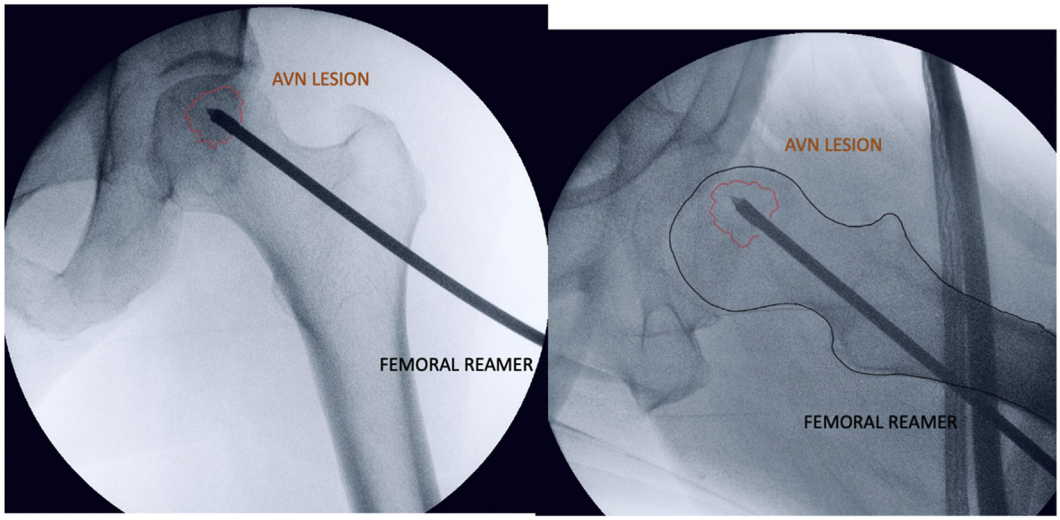

Fig 6. After aiming guide retrieval, a 4 mm cannulated reamer is passed through the guide pin, breaking the lateral cortex of the femur and posteriorly creating the decompressed femoral tract and tunnel toward the anterosuperior portion of the femoral head. This is double checked in both fluoroscopic planes (anteroposterior and lateral). Posterior advancement of the size reamers (from 4 mm to 12 mm), is performed depending on the necrotic lesion on the femoral head.

low-profile headed reamers from 5 mm to 10 or 12 mm depending on the size of the lesion. Careful attention is required when reaming closely to the subchondral bone of the femoral head. Posteriorly a specialized loop curette (Parcus Medical) is introduced to the core tract, and removal of remaining sclerotic bone is performed, where we change to a 30° scope to observe the core and make a thorough lavage with the arthroscopic sheath. Next, cancellous bone allograft in chips is mixed with bone demineralized matrix, and blood is obtained from the decompressed tract; this mixture is impacted and pushed in a retrograde fashion with specialized XL blunt bone tamps and impactors until the core tract is filled (Figs 7-9). Final AP and lateral fluoroscopic views are obtained to observe the result (Tables 1 and 2; Video 1).

Discussion

HA has shown the advantages in treating avascular necrosis of the femoral head concomitantly with core decompression and treating intra-articular pathology as demonstrated by several authors. The senior

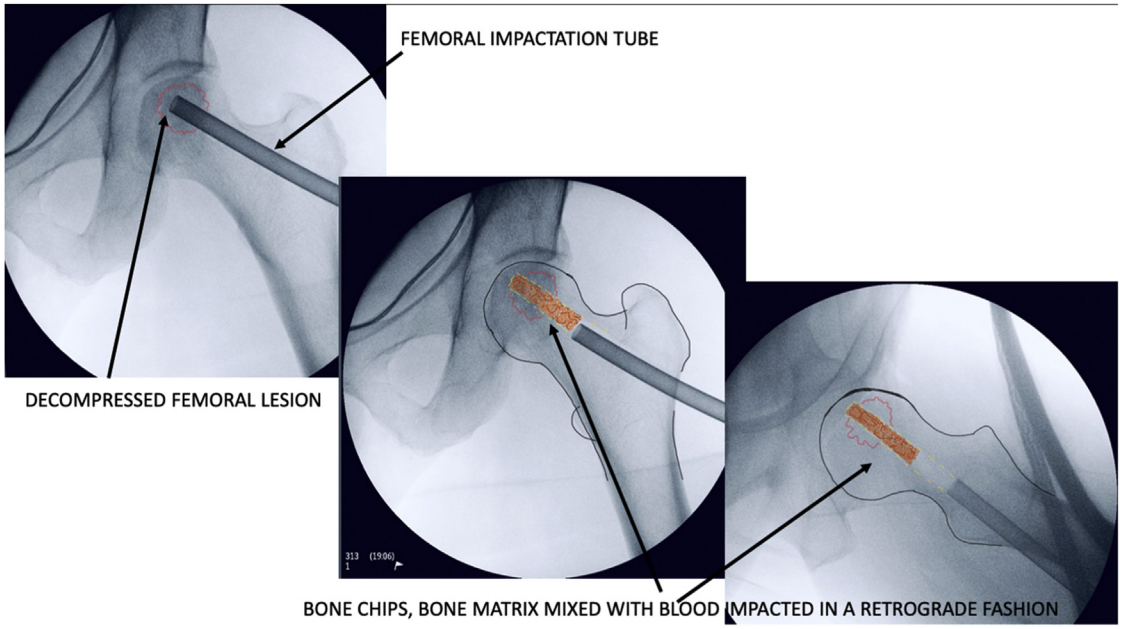

Fig 7. After reaming to the desired size in the femoral head, interchange of the reamer and guide pin is made for a 10 mm specific cannulated femoral impactation tube (left). Through this tube, bone chips and bone demineralized matrix mixed with blood will be impacted retrogradely toward the necrotic site (middle and right).

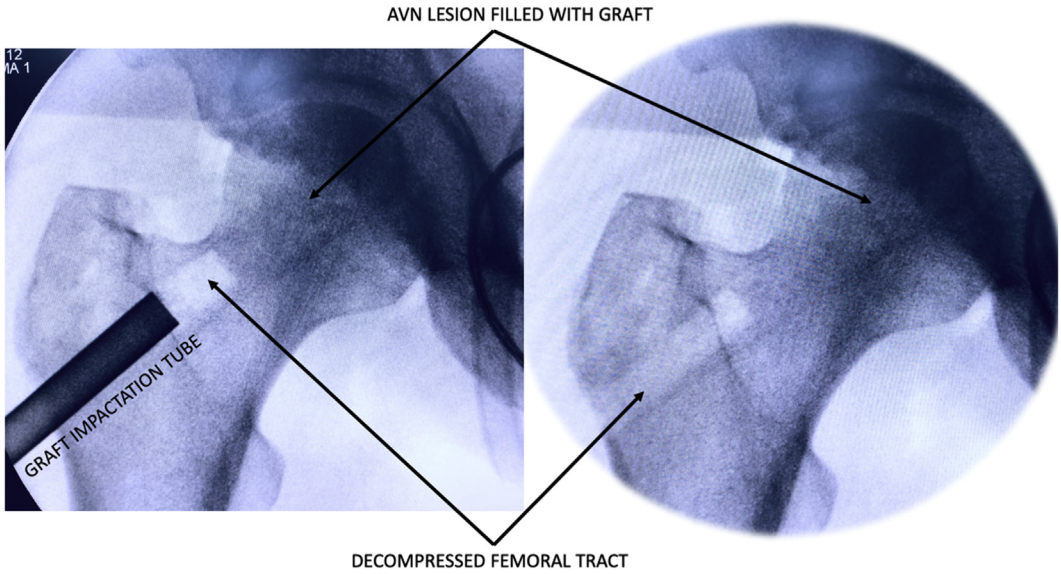

Fig 8. Right hip with avascular necrosis of the femoral head, filled retrogradely with bone graft (bone chips, bone demineralized matrix, and blood) in the femoral head. Observe color change in the tunnel when bone graft is impacted.

authors (A.P.S., J.M., J.O.D., F.M.) have dedicated years in trying to develop a reliable system in HA with a specific aiming guide for the treatment of core decompression for avascular necrosis of the femoral head and for ligamentum teres reconstruction. Gupta et al.[18] mention that the efficacy of such techniques has not been fully elucidated because of lack of a prospective comparative data. Core decompression is a very demanding surgical and technical procedure that requires a high volume of surgeries. The aid of arthroscopic vision during the decompression of the FH has the advantage over the traditional technique in directly observing the femoral head cartilage and the necrotic site, it also stages the disease and treats concomitant intraarticular hip pathology (FAIS, labral tears, LT tears). Moya-Angeler et al.[5] mentions that medical management and surgical intervention have been demonstrated to provide symptomatic relief, early intervention before collapse has been shown to be critical to successful outcomes in joint-preserving procedures. Future research should be directed at delineating whether 1 treatment strategy can delay the progression of ONFH of the hip, thereby preventing collapse and the need for a THA. Papavasiliou et al.[17] in their management of ONFH say that arthroscopic surgery of the hip is a well-established technique; the indications of its use have been set since the initial publications on HA and ONFH more than a decade ago, when hip arthroscopy was still evolving. These indications are clear and universal, which might

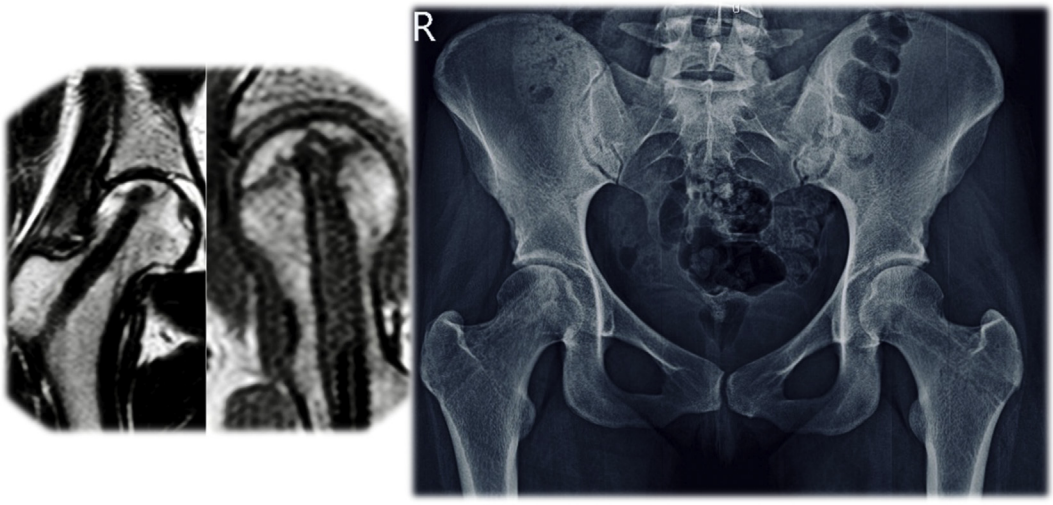

Fig 9. X ray film and magnetic resonance image of a patient who underwent right hip arthroscopy, core decompression, and bone graft retrogradely impacted at 6 months after surgery. The left hip was treated with a ligamentum teres reconstruction.

Table 1. Pearls and Pitfalls

Pearls
Position the patient properly in the modified supine position and with his nonoperative hip abducted, externally rotated and flexed to permit the passage of the image intensifier and obtain a proper lateral X-ray film.
Obtain perfect X-ray films in the AP plane and lateral plane.
The lateral X-ray film must show the center of the neck of the femur where you will pass the guide pin, the retrograde reamers, and the impacted bone mixture.
First start with diagnostic arthroscopy to evaluate the hip joint cartilage, labrum, and ligamentum teres and to evaluate the AVN lesion.
Decompress FAIS morphologies if this is the case (pincer, cam, or mixt).
Tackle the labrum with a repair or a reconstruction, depending on the case.
Assess the LT and tackle it with a debridement or a shrinkage.
Assess the femoral head and its necrosis by a ballotment test.
Remove all the floating pieces of cartilage in the hip joint, if this is the case.
Proceed to create a posterolateral portal to introduce the specific aiming guide toward the femoral head.
Ask the assistant to maximally internally rotate the hip and observe fluoroscopically the entire femoral head neck junction with both of his cortices.
Properly place the specific aiming guide in the femoral neck at the AVN lesion and necrosis, and this placement is corroborated in an AP and lateral plane of the hip.
The blunt cannulated obturator is placed at the lateral cortex of the femur, and the skin is incised with an 11-blade scalpel toward the iliotibial band where the obturator is pushed toward the bone cortex of the femur.
The guide pin is passed through the cannulated obturator toward the AVN necrotic lesion; if this is placed in the desired spot, you can remove the whole decompression system to advance the reamers.
A 5 mm reamer is used to break the lateral cortex of the femur and advanced to the AVN lesion; always corroborate your position in both X-ray planes.
Posteriorly you can upgrade the reamers to decompress the lesion from 5 mm to 12 mm, depending on the size of the necrotic lesion.
After finishing the retrograde decompression, the guide pin can be removed, and you can introduce the arthroscopic sheath and observe the entire femoral head decompressed tract; here you can also make a thorough lavage to the necrotic bone.
If you desire here, you can introduce open curettes and remove more necrotic bone.
In the back table, your surgical assistant will prepare the bone mixture (cancellous bone chips, bone matrix, bone putty, platelet-rich plasma, or blood from the surgical wound); this is surgeons' preference.
With the specific blunt cannulated impactors, the bone mixture is retrogradely impacted with the aid of fluoroscopy until you fill the entire femoral head defect.
Finally at the femoral tract you can place a bone plug, or an interference bone screw or leave the tract open; this is surgeons' preference.
Pitfalls
Introduction of the specific aiming guide through a portal that is not the posterolateral portal.
Insufficient internal rotation of the hip; this is important to observe both femoral neck cortices and will avoid a femoral neck fracture while passing the reamers to the AVN lesion.
Incorrect passage of the guide pin toward the AVN necrotic lesion; this is to safely remove the whole decompression system and confidently advance the retrograde reamers.
Not placing and passing first the smallest reamer (5 mm) to break the lateral cortex of the femur; this avoids a fracture to the lateral cortex of the femur.

AP, anteroposterior; AVN, avascular necrosis; FAIS, femoroacetabular impingement syndrome; LT ligamentum teres.

explain why the pioneer authors who published their experience and set these indications never published again on the matter. Overall, when hip-preservation surgery is decided on for a lesion that is at pre-collapse in the presence of mechanical symptoms, hip arthroscopy has a clear and important role.[5,17] Serong et al.[20] show in their collective study of patients with proven ONFH that intraarticular co-pathologies were prevalent in more than 95% of patients. These pathologies were revealed by hip arthroscopy performed as a supplementary procedure to core decompression in patients with cam-like morphologies of the head-neck junction, labral anomalies, and chondral defects being the most often detected conditions. Issa et al.,[19] Lieberman et al.,[21] and Mont et al.[22] encourage performing THA in symptomatic ONFH with the presence of femoral head subchondral fracture, collapse, and acetabular involvement. THA appears to be a reliable and reproducible treatment and is the only treatment that has been proven to reduce pain, restore mobility, and increase quality of life for the management of the end stages of the osteonecrosis.[20-22]

Table 2. Advantages and Disadvantages

Advantages
Treat concomitantly intra-articular lesions (labral tears, cartilage tears, ligamentum teres tears, etc.)
Less radiation to the entire hip team while trying to place the guide pin.
Easy placement of the specific femoral head aiming guide.
The same femoral aiming guide can be used for ligamentum teres reconstruction of the hip.
Disadvantages
Entrance to the hip by arthroscopy is mandatory to place the specific femoral head aiming guide.
Advanced training in hip arthroscopy is needed because maneuverability in the hip is very important.
Proper knowledge and experience to work in the central compartment of the hip, because the distraction time can take more minutes while repairing intraarticular pathology.

Conclusion

Hip arthroscopy and core decompression of the femoral head can be used effectively and concomitantly to treat ONFH/AVN with excellent results, HA allows for excellent visualization of the hip joint cartilage, allowing treatment of FAIS, labral tears and to stage the necrosis. Our technique in HA demonstrates that retrograde core decompression with allograft and bone matrix is an excellent choice of treatment in the early stages of AVN/ONFH. The specific femoral head aiming guide is very reliable, due to the fact that it offers exact pin placement at the necrotic site, less operative time, and, most importantly, less radiation to the patient and the surgical hip team.

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