



Arthroscopic Core Decompression for Avascular Necrosis of the Femoral Head Using Multiple Small-Diameter Tunnels

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Abstract: Avascular necrosis of the femoral head (AVNFH) is a debilitating disease that requires early intervention to prevent subchondral collapse and irreversible damage leading to premature hip replacement. Patients presenting with AVNFH can have concomitant intra-articular pathology, including femoroacetabular impingement (FAI), that contributes to their hip pain and dysfunction. It is important to restore the native hip anatomy in addition to providing revascularization of necrotic areas to reduce pain, improve function, and maximize efforts to preserve the joint. The purpose of this Technical Note is to describe our preferred arthroscopic approach to core decompression through the femoral neck in combination with femoral osteoplasty to address AVNFH and FAI in a single-staged and minimally invasive procedure.

Avascular necrosis of the femoral head (AVNFH) is a significant cause of hip pain and disability in young and middle-aged adults. The femoral head is particularly susceptible to avascular necrosis because of

its delicate blood supply, which can be disrupted from trauma, extravascular compression, or intravascular occlusion.¹ When irreversible destruction exists, it often necessitates a total hip replacement, which can be a devastating outcome for young, active patients without pre-existing arthritis.

Because of the high rate of progression to destructive hip disease, surgical treatment is typically warranted for early-stage AVNFH. Hip-preserving surgical procedures for AVNFH include vascularized and nonvascularized bone grafting, rotational osteotomy, core decompression, and biologic adjuncts.² Core decompression, often used in combination with bone grafting or biologic adjuncts, has been shown to prevent progression of AVNFH if performed before radiologic evidence of subchondral collapse.³

Patients found to have AVNFH with concomitant intra-articular hip disorders, such as femoroacetabular impingement (FAI) and labral tears, create an additional challenge to treatment planning and surgical approach because both pathologies can contribute to hip dysfunction and pain and lead to further damage if not addressed.⁴ Most authors who have used hip arthroscopy to treat AVNFH have used it in conjunction with the traditional percutaneous core decompression technique of retrograde drilling through the lateral subtrochanteric region.^{5,6} In this Technical Note, we describe the senior author's preferred technique for treating AVNFH using numerous small diameter drill holes of 1.5mm to

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Table 1. Pearls and Pitfalls

Pearls
Harvest BMAC from the posterior superior iliac spine before the hip arthroscopy.
Traction may be applied to access the AVN if needed.
Fluoroscopy may be used to verify the trajectory of the drill.
A 1.5 mm JuggerKnot drill is used with the drill guide.
Drilling can be performed through either portal.
Turn off the fluid and assess for bleeding after drilling.
Pitfalls
Avoid bending the drill bit to prevent it from breaking in the joint.
Ensure correct drill trajectory and avoid drilling too deep into the joint.
Drilling less than 5 to 10 drill holes may not completely decompress the area of AVN.
BMAC, bone marrow aspirate concentrate; AVN, avascular necrosis.

decompress the necrotic lesion in a retrograde fashion through the femoral neck, with arthroscopic treatment of concomitant FAI and the use of bone marrow aspirate concentrate (BMAC) as a biologic adjunct to improve the healing response. This procedure is minimally invasive, because it can be performed entirely through the working arthroscopic portals.

Surgical Technique

A video overview of this procedure with narration can be found in [Video 1](#). Pearls and pitfalls associated with the procedure are noted in [Table 1](#). Before standard hip arthroscopy, BMAC harvest in line with institutional protocol is performed using the ipsilateral posterior superior iliac spine, with the contralateral side

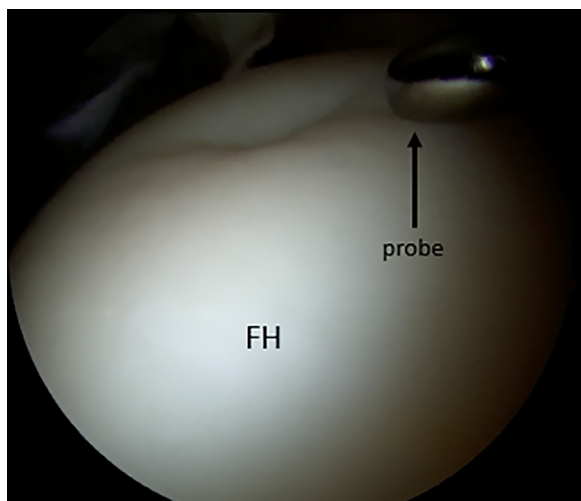


Fig 1. Arthroscopic view of a right hip with the patient supine on a traction table and the hip distracted. The arthroscope is in the anterolateral portal and the probe is placed in the mid-anterior portal. The probe (3 mm tip) can be used to palpate along the articular surface of the femoral head (FH) to help identify the area of avascular necrosis.

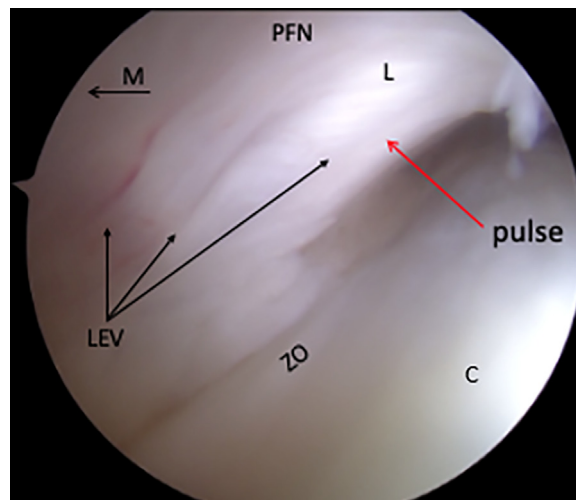


Fig 2. Arthroscopic view of the lateral epiphyseal vessels (LEV) of a right hip with the patient supine viewed from the anterolateral portal. Blood flow is confirmed by observing LEV pulse or use of an arthroscopic Doppler ultrasound probe. PFN, proximal femoral neck; M, medial; L, lateral; LEV, lateral epiphyseal vessels; ZO, zona orbicularis; C, capsule.

being used if more aspirate is needed. The aspirate is sent for processing while the patient is positioned supine.

After standard hip arthroscopy setup and patient positioning, we establish anterolateral and midanterior portals with an interportal capsulotomy used for all indicated arthroscopic procedures, as well as the core decompression. Our standard arthroscopy setup, portal placement, and capsulotomy have been described previously.⁷

A diagnostic arthroscopy is performed and any necessary central compartment work is completed. If indicated for the treatment of cam impingement, an osteoplasty of the femoral neck is performed. The focus is then changed to the area of avascular necrosis (AVN) of the femoral head for the core decompression. The femoral head can be distracted with traction, and the area of AVN is verified to be viable tissue with a 3 mm long hip probe (Smith & Nephew, Andover, MA) placed in the central defect ([Fig 1](#)). Bleeding may be verified on the periphery of the defect. Additionally, the lateral epiphyseal blood vessels can be visualized to be intact and blood flow can be appreciated by pulse visualization ([Fig 2](#)) or with a Doppler ultrasound probe. The core decompression is then performed with a 1.5 mm JuggerKnot drill (Biomet Orthopedics, Warsaw, IN) in a retrograde fashion to decompress the area from the femoral neck to the site of the lesion within the femoral head ([Fig 3](#)). Fluoroscopy can be used to confirm the trajectory and depth of the drill into the area of AVNFH. Multiple passes are made with the drill, and bleeding is noted with the passes after arthroscopic fluid is turned off ([Fig 4](#)). The number of passes is variable with the

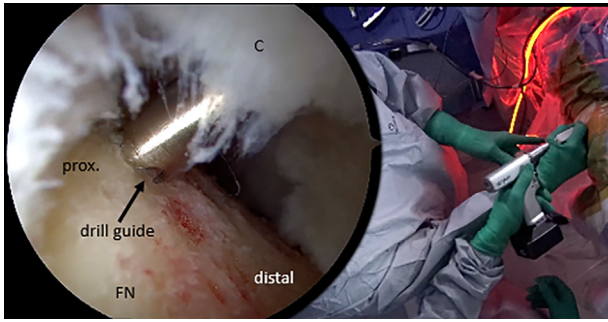


Fig 3. The core decompression is performed through the anterolateral and midanterior portals as necessary, using a drill guide and a 1.5 mm JuggerKnot drill. The number of passes is variable with the aim of stimulating blood flow throughout the entire area of necrosis. Five to 10 passes usually achieve adequate decompression. Fluoroscopy may be used to confirm the trajectory and depth of the drill into the area of avascular necrosis. This image is of a right hip with the patient supine with the arthroscope in the anterolateral portal and the drill in the midanterior portal. C, capsule; FN, femoral head; Prox, proximal.

objective of stimulating bleeding throughout the defect, typically this is between 5 and 10. The shaver is used to create a suction effect to illustrate that blood is coming through the drill holes (Fig 5). A key aspect of this technique is the creation of a relatively large number of small-diameter tunnels rather than 1 large-diameter tunnel, with the primary aim of stimulating blood flow more diffusely throughout the area of necrosis and avoiding the creation of an unnecessarily large cortical defect (Fig 6). The BMAC collected earlier is then injected into these drill holes. Last, capsular closure is performed to preserve stability of the hip joint.

Our postoperative protocol includes placement of a postoperative hip brace and antirotational boots. Directly after surgery to protect the operative site and the capsular closure, and to reduce pain. The patient is limited to less than 20 pounds of flat-footed weight-bearing for 6 weeks. This period is followed by 1 week of progression to full weightbearing. To reduce the formation of adhesions, we prescribe continuous passive motion for at least 6 weeks, 6 to 8 hours per day, with passive range of motion exercises and stationary biking without restriction initiated within the first few days after surgery. Hip external rotation and extension are limited for 2 to 3 weeks.

Discussion

This Technical Note highlights our preferred treatment of AVNFH and concomitant FAI with arthroscopic femoral osteoplasty followed by core decompression with multiple small-diameter retrograde drill holes through the femoral neck and BMAC injection. Serong et al.⁸ arthroscopically assessed a cohort of 27 hips with pre-collapsed AVNFH and found concomitant

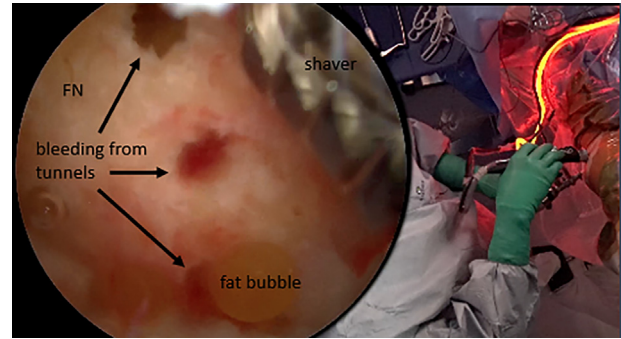


Fig 4. With the arthroscopic fluid flow turned off, bleeding can be visualized from the cored tunnels, indicating an adequate blood flow and depth of decompression, which can also be signified by fat bubbles escaping from the marrow space. This image is of a right hip with the patient supine with the arthroscope in the anterolateral portal and the shaver in the midanterior portal. FN, femoral neck.

pathologic intraarticular findings in >95% of evaluated hips, including cam deformity (82%), labral defects (85%), and chondral defects (74%). Combined management of AVN and other intra-articular pathologies in a single-staged procedure provides revascularization to the necrotic areas and restoration of the native hip anatomy and function in a less-invasive manner while reducing the risk of early-onset osteoarthritis leading to premature total hip arthroplasty.

Traditionally, core decompression of the femoral head has been performed percutaneously in a retrograde fashion through the lateral subtrochanteric femur. Hip arthroscopy has gained traction as a method for improving visualization during core decompression for AVNFH. The improved visualization allows for a more accurate diagnostic assessment and reduced risk of penetration through the chondral layer during drilling.^{5,6} The adaptation of performing the core decompression arthroscopically eliminates the open surgery component, which has the benefit of lower

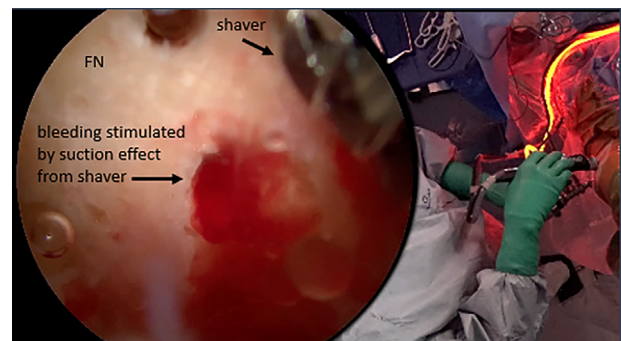


Fig 5. Using a shaver, a suction effect is created to confirm generous blood flow from within the cored area. This image is of a right hip with the patient supine with the arthroscope in the anterolateral portal and the shaver in the midanterior portal. FN, femoral neck.

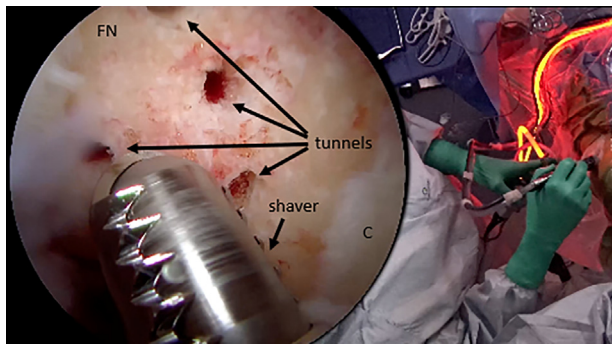


Fig 6. Five to 10 small-diameter tunnels are made with the primary aim of stimulating blood flow more diffusely throughout the area of necrosis. This image is of a right hip with the patient supine with the arthroscope in the anterolateral portal and the shaver in the midanterior portal. FN, femoral neck; C, capsule.

complication rate, reduced postoperative pain, and faster recovery time. Furthermore, use of multiple small-diameter drill holes allows for more diffuse stimulation of blood flow throughout the necrotic area and avoids the creation of a large cortical defect with the single drill hole.

Similar techniques for arthroscopic core decompression of precollapsed AVNFH have been published with creation of large, 3 mm drill holes through the femoral neck. Furthermore, Guadilla et al.⁹ described the use of a cortical window at the femoral head-neck junction, referred to as the “light bulb” approach, to achieve full debridement of moderate to severe cystic and sclerotic changes. We prefer to use a 1.5 mm drill for core decompression to create smaller defects in the cortical surface and allow for more precise tunneling to the necrotic areas. There is a paucity of outcomes data for arthroscopic core decompression. Li et al.¹⁰ demonstrated superior postoperative outcome scores in patients treated for pre-collapsed AVHN with multiple small-diameter drilling decompression combined with hip arthroscopy compared to drilling decompression alone at average follow-up of 4.8 years. However, additional larger cohort studies with comparison to percutaneous core decompression are necessary to further determine the efficacy and safety of this procedure.

In conclusion, our preferred technique for arthroscopic core decompression with BMAC injection is indicated for patients presenting with precollapsed AVNFH and concomitant intra-articular pathology. Benefits of this technique include treatment of AVNFH and other intra-articular pathology in a single-staged procedure that is less invasive and eliminates the risk associated with open surgery.

References

1. Zalavras CG, Lieberman JR. Osteonecrosis of the femoral head: evaluation and treatment. *J Am Acad Orthop Surg* 2014;22:455-464.
2. Atilla B, Bakırcıoğlu S, Shope AJ, Parvızı J. Joint-preserving procedures for osteonecrosis of the femoral head. *EFORT Open Rev* 2019;4:647-658.
3. Hua KC, Yang XG, Feng JT, et al. The efficacy and safety of core decompression for the treatment of femoral head necrosis: A systematic review and meta-analysis. *J Orthop Surg Res* 2019;14:306.
4. Beck DM, Park BK, Youm T, Wolfson TS. Arthroscopic treatment of labral tears and concurrent avascular necrosis of the femoral head in young adults. *Arthrosc Tech* 2013;2(4):e367-e371.
5. Theopold J, Armonies S, Pieroh P, Hepp P, Roth A. Nontraumatic avascular necrosis of the femoral head: Arthroscopic and navigation-supported core decompression. *Oper Orthop Traumatol* 2020;32:107-115.
6. Nazal MR, Parsa A, Martin SD. Mid-term outcomes of arthroscopic-assisted Core decompression of Precollapse osteonecrosis of femoral head—Minimum of 5 year follow-up. *BMC Musculoskel Disord* 2019;20:448.
7. Philippon MJ, Faucet SC, Briggs KK. Arthroscopic hip labral repair. *Arthrosc Tech* 2013;2(2):e73-e76.
8. Serong S, Haubold J, Theysohn J, Landgraeber S. Arthroscopic assessment of concomitant intraarticular pathologies in patients with osteonecrosis of the femoral head. *J Hip Preserv Surg* 2020;7:458-465.
9. Guadilla J, Fiz N, Andia I, Sánchez M. Arthroscopic management and platelet-rich plasma therapy for avascular necrosis of the hip. *Knee Surg Sports Traumatol Arthrosc* 2012;20:393-398.
10. Li J, Li ZL, Zhang H, Su XZ, Wang KT, Yang YM. Long-term outcome of multiple small-diameter drilling decompression combined with hip arthroscopy versus drilling alone for early avascular necrosis of the femoral head. *Chin Med J (Engl)* 2017;130:1435-1440.