Intra-articular Fluid Distension for Initial Portal Placement During Hip Arthroscopy: The "Femoral Head Drop" Technique

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Abstract: Iatrogenic injury is a known complication of initial portal placement during hip arthroscopy. The rate of labral puncture or damage to the articular surfaces with arthroscopic instruments is variable and may be associated with operator inexperience or complex anatomy. In addition, the amount of traction applied to achieve joint distraction may unnecessarily place patients at risk of neurapraxia. The purpose of this article is to describe the "femoral head drop" technique as a method to increase safe access to the central compartment and minimize the amount of traction needed to do so, especially in patients with challenging bony anatomy. This technique uses the application of intra-articular saline solution to cause inferior migration of the femoral head. Intra-articular fluid distension, or the femoral head drop technique, is simple, safe, and reproducible, making it appropriate for hip arthroscopists at any level of experience.

Initial portal placement can be considered one of the most important steps in hip arthroscopy. Proper portal placement avoids injuring key neurovascular elements and permits the surgeon to triangulate intra-articular damage requiring treatment.[1,2] Limited operator experience, complex 3-dimensional anatomy, and anatomic constraints due to variable hip morphology all potentiate the technical challenges of portal placement into the central compartment and may increase the risk of complications.[3,4] Therefore initial portal placement should be approached cautiously using meticulous technique.

Initial portal placement is performed without direct visualization of the joint and carries the greatest risk of iatrogenic chondrolabral injury, the most common complication of hip arthroscopy.[5] Dynamic manipulation of the arthroscopic needle and proprioceptive feedback under fluoroscopic guidance facilitate safe entry into the central compartment but do not eliminate the risk of damaging the labrum or adjacent chondral surfaces.

Traction is commonly applied to increase joint distraction and access to the hip joint. Though effective, the use of traction carries serious risks including nerve damage and should be applied sparingly.[6] Intra-articular fluid distension is an established method to increase joint distraction and minimize traction requirements, thereby reducing the risk of iatrogenic chondrolabral injury and nerve damage, respectively.[7,8] The purpose of this technical note is to describe the use of intra-articular fluid distension as a safe method for obtaining increased access to the central compartment of the hip joint.

Technique

Take the patient to the operating room, and place him or her supine on a Smith & Nephew Hip Positioning table (Smith & Nephew, London, England) (Video 1, Fig 1, Table 1). Administer general anesthesia through a general endotracheal tube intubation followed by a motor blockade. Move the patient with care against a silicone gel–padded perineal post. Pad both feet and ankles, and secure them into distraction boots. Next, prepare and drape the patient using sterile technique. Confirm the absence of a muscular twitch. Move the operative leg into the neutral position (0° of flexion/5° to 10° of abduction) with the patella pointing directly upward. At this point, establishment of the anterolateral portal can begin.

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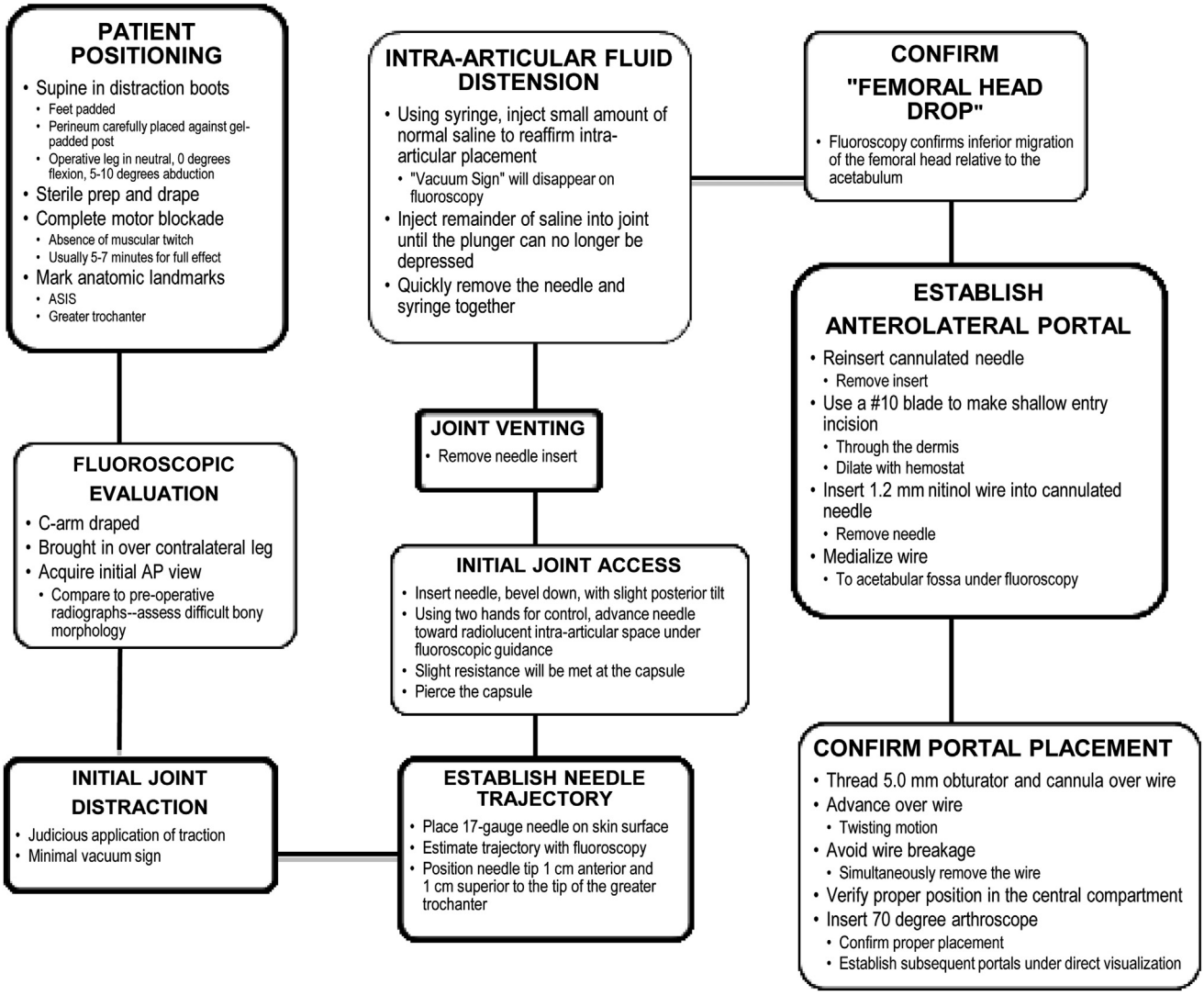

Fig 1. Flowchart for performing intra-articular fluid distension. (AP, anteroposterior; ASIS, anterior superior iliac spine.)

Judiciously apply incremental traction until enough distraction has occurred to create an intra-articular radiolucency—a "vacuum sign" (Fig 2A). Next, place a 17-gauge arthroscopy needle (cannulated needle) on the skin of the patient to approximate the trajectory into the joint. Insert the needle 1 cm anterior and 1 cm superior to the tip of the greater trochanter. Hold the needle with a slight posterior tilt, and advance past the capsule into the joint using proprioceptive feedback and intermittent fluoroscopic guidance. Once the joint space has been entered, remove the needle insert (Fig 2B). This will promote venting of the joint to alleviate any negative pressure that will resist joint distraction. Leave the needle in place.

Prepare a syringe with 40 mL of normal saline solution; epinephrine is not added because of chondrotoxic effects.[9] Attach the syringe to the cannulated needle, and inject a small amount of fluid. Use fluoroscopy to confirm intracapsular placement; the previously identified radiolucency, or vacuum sign, will disappear. Confirmation avoids excess accumulation of extracapsular fluid. Inject saline solution until firm resistance is encountered; typically, 30 mL is sufficient. Repeat flouroscopy will show inferior migration of the femoral head away from the acetabulum (Fig 2C). When sufficient distension has been achieved or saline solution can no longer be injected because of resistance, quickly remove the needle with the syringe still attached. Extracapsular soft-tissue collapse along with the needle tract will trap the saline solution within the joint. Removal of the needle also prevents threading a previously punctured labrum with wider-bore instruments during later steps, which can cause significant damage to the labrum and adjacent chondral surfaces.

When adequate joint distraction (>9 mm) has been achieved, reinsert the cannulated needle, bevel down, into the clear space. Remove the needle insert, and use a No. 10 blade to create a shallow (1-mm-deep) incision

Table 1. Equipment and Indications for Intra-Articular Fluid Distension

Procedural Aspect	Description
Equipment	Supine hip positioning table
	Fluoroscopy equipment
	17-gauge cannulated needle
	Syringe + 40 mL of normal saline solution
	70° video arthroscope
	No. 10 blade
	Hemostat
	1.2-mm nitinol wire
	Hip cannula + obturator set (4.5, 5.0, or 5.5 mm in diameter)
Indications	Minimal joint distraction (<9 mm) despite complete muscular relaxation and appropriate axial traction
	Coxa profunda
	Coxa vara
	Cranial retroversion
	Large, overhanging os acetabuli

that breaches the dermis. Use a hemostat to dilate this entry site. Advance a 1.2-mm nitinol wire through the cannulated needle and into the clear space. Confirm appropriate positioning in the central compartment with fluoroscopy. Proprioceptive feedback should also indicate that the wire has been medialized within the acetabular fossa. Remove the cannulated needle, leaving the nitinol guidewire in place.

Next, thread the 5.0-mm cannula and obturator over the nitinol wire. Cautiously advance the cannula and obturator, using a twisting motion, through the soft tissue and down to the capsule. Exercise great care during this step to not over-medialize and loop the wire around the femoral head. To avoid breaking the wire, gradually pull back on the wire as the cannula and obturator are advanced over it. Resistance will be met when breaching the capsule, just before entry into the central compartment. Any unusual resistance may indicate the presence of a dermal tag. In this scenario, remove the obturator and cannula, leave the wire in place, re-dilate the portal entry site around the wire with a hemostat, and rethread the cannula and obturator over the wire. Once the capsule has been breached by the 5.0-mm cannula and obturator, remove the nitinol wire. Retrograde flow of the previously injected fluid may be observed. Use flouroscopy to preliminarily confirm intracapsular placement. Finally, insert a 70° video arthroscope through the anterolateral portal for definitive confirmation of proper portal placement. Then, with direct visualization established, diagnostic arthroscopy and additional portal placement can commence.

Discussion

Intra-articular fluid distension is a simple method to increase the safety of initial portal placement during hip arthroscopy. The space available for safe entry into the hip joint is largely dependent on 2 factors: (1) the identifiable clear space between the articular surfaces of the femoral head and lateral sourcil of the acetabulum and (2) the estimated proportion of that space that is not occupied by the acetabular labrum. Unfortunately, the labrum cannot be visualized with routine fluoroscopy and is variable in width.[10] However, the identifiable clear space is a parameter that can be manipulated by altering the forces that dictate joint distraction, traction, and distension. Joint distraction by traction is the result of tension placed across the joint through an axial load. Here, the femoral head is "pulled away" from the acetabulum with the immediate result based on soft-tissue compliance. In contrast, joint distension occurs by venting and subsequent injection of saline solution; this acts to relieve negative intracapsular pressure resisting distraction and produces positive intra-articular pressure that "pushes" the femoral head away from the acetabulum, respectively.[8]

The application of traction is effective but increases the risk of both transient and permanent nerve damage

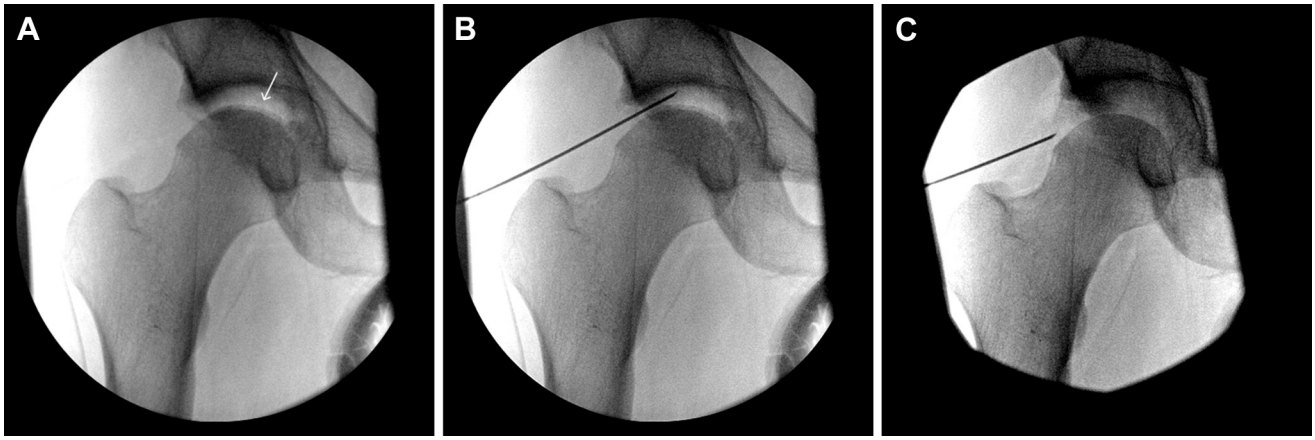

Fig 2. (A) Radiolucent vacuum sign (arrow) after minimal traction and before distension. (B) After venting. (C) After distension.

Table 2. Pearls and Pitfalls of Femoral Head Drop Technique

Pearls	Pitfalls
Confirm complete muscular relaxation.	Reduced efficacy in overweight and muscular patients
Apply the smallest amount of traction needed to obtain the vacuum sign.	Over-application of traction
Venting the joint before saline solution injection reduces the forces that resist distraction.	Mimicking of firm resistance by extracapsular saline solution injection
The vacuum sign will disappear after intra-articular saline solution injection.	Over-medialization of nitinol wire leading to breakage
Inject saline solution until the greatest inferior migration of the femoral head, relative to the lateral sourcil of the acetabulum, has been achieved or firm resistance is met.	Skiving of articular cartilage during introduction of obturator, cannula, or arthroscope

during hip arthroscopy. Therefore, when possible, increasing the amount of applied traction should be avoided. Intra-articular fluid distension increases joint distraction when combined with appropriate intra-operative traction.[8] Cadaveric studies have shown this technique to have the greatest effect on joint distraction at modest levels of traction.[7] Anecdotally, the success of this technique regarding increasing joint distraction is dependent on the amount of periarticular soft tissue and degree of muscular relaxation, with optimal results seen in patients of normal body mass under complete muscular paralysis. In highly muscular or overweight patients, we allow sufficient time for the neuromuscular blockade to take effect, typically 5 to 7 minutes, before attempting this technique.

Ultrasound is another method to indirectly visualize hip joint anatomy during portal placement.[11] Proponents of ultrasound-guided hip arthroscopy have stated that it reduces radiation exposure to the patient, operating room staff, and surgeon while minimizing the risk of iatrogenic chondrolabral injury during portal placement.[12] However, effective ultrasound-guided portal placement requires dedicated ultrasound training and adjunct fluoroscopy until the operator is proficient. The disadvantages of ultrasound include extra equipment, difficulty appreciating the joint structures in the presence of an effusion or soft-tissue envelope of 10 cm or greater, and a nonzero rate of iatrogenic chondrolabral damage.[12] Lastly, in most cases, the use of ultrasound for portal placement does not eliminate the use of fluoroscopy during hip arthroscopy, especially for femoroacetabular impingement. In these cases, bony resection is performed under fluoroscopic guidance to assess the adequacy of acetabular rim recession or femoral neck osteoplasty (or both).

The main advantage of the "femoral head drop" technique is creating greater joint space to safely establish the anterolateral portal. This technique is well suited for patients with challenging bony anatomy, including mixed-type femoroacetabular impingement, cranial retroversion, large os acetabuli, coxa profunda, and coxa vara, that limits the utility of conventional techniques used to access the hip joint. In these situations, intra-articular fluid distension may overcome anatomic constraints to joint distraction (Table 2). The disadvantages of the femoral head drop technique are those inherent to procedures that implement indirect visualization. The risks of portal placement under fluoroscopy include increased radiation exposure to the patient and operating room staff, soft-tissue damage including neurovascular injury, iatrogenic labral puncture, and damage to the chondral surfaces. Lastly, the effect of intra-articular fluid distension on joint distraction can be variable.[7,8] When intra-articular fluid distension does not adequately increase joint distraction, we recommend using a smaller 4.5-mm cannula to enter the central compartment. Once access is established with a smaller cannula, the anterolateral portal can be safely dilated to standard arthroscopic size under direct visualization.

In conclusion, intra-articular fluid distension is one of many existent techniques that can be used to minimize iatrogenic injury to the chondral surfaces and labrum during initial portal establishment.[11-14] The appeal of this technique is that it is simple, safe, and reproducible and reduces the amount of traction that is needed to achieve adequate joint distraction for initial anterolateral portal placement during hip arthroscopy.

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