The Posteromedial Knee Arthroscopy Portal: A Cadaveric Study Defining a Safety Zone for Portal Placement

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Purpose: To define a neurovascular safety zone for proper placement of at least 2 posteromedial (PM) portals and to describe a safe intra-articular entrance point based on the location of the PM capsular folds. **Methods:** Arthroscopy was performed on 10 fresh-frozen cadaveric knees. With the knee flexed 90°, PM portals were created under direct visualization with a 70° arthroscope. The anatomic soft spot between the PM edges of the femoral condyle and the proximal tibia was palpated, and 18-gauge spinal needles were inserted into the joint followed by 5.0-mm cannulas. The PM capsular folds were used to guide portal locations. Four portals (A, B, C, and D) were created in each of the first 3 knees. Portal position was described in relation to the soft spot: through the soft spot (A), 1 cm superior (B), 1 cm posterior (C), and 1 cm inferior (D). Dissection was performed along the path of the cannulas. **Results:** In the first 3 knees, the most inferior portal (D) always overlapped the course of the saphenous nerve, and the posterior portal (C) always pierced the gastrocnemius musculotendinous junction. Therefore these portals were eliminated from further study for safety reasons, and in the final 7 knees, we studied only the remaining 2 portal placements (A and B). Portals A and B were found to be the safest, with at least 1.5 cm of clearance between the portals and the saphenous nerve in all specimens. **Conclusions:** At least 2 PM portals can be safely placed in the knee. The soft spot is an appropriate landmark to ensure safe portal entry. The PM capsular folds can help guide intra-articular placement so that damage to surrounding structures can be avoided. **Clinical Relevance:** We believe that 2 portals would be beneficial when performing complex arthroscopic procedures involving the PM compartment of the knee.

The posteromedial arthroscopy portal at the knee is known to pose a particular risk to the saphenous nerve and accompanying vein. Several studies have cited injuries to these structures as a result of portal placement.[1-3] Damage to the nerve can lead to temporary or permanent loss of sensation. It can also cause saphenous neuritis, which can be a source of morbidity and can be difficult to treat.[4]

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The posteromedial portal is being used more frequently as knee surgeons perform increasingly complex meniscal and articular cartilage repair procedures with minimally invasive arthroscopic techniques. First described by Burman[5] in 1931, its use has evolved from a means of improving diagnostic utility to an important portal for instrumentation. Today, it is used for a number of procedures, including anterior and posterior cruciate ligament reconstructions,[6,7] meniscal transplantation,[8] repair of posterior root medial meniscus tears,[9] removal of loose bodies,[10] and synovectomy.[11] There are also reports in the literature of forming 2 posteromedial portals.[3,12] We believe that a second posteromedial portal would be beneficial during some of the previously mentioned procedures by allowing instrumentation and direct visualization simultaneously from the posteromedial compartment. This would also eliminate the need to alternate the

arthroscope between the notch and posteromedial portal to obtain proper visualization.

Other studies have described the saphenous nerve anatomy at the level of the knee joint,[13,14] but only 1 study examined the location of the nerve with respect to an arthroscopically formed posteromedial portal.[2] Ogilvie-Harris et al.[2] reported that the portal could be safely formed by keeping the knee flexed to 90° and allowing the neurovascular structures to be located posteriorly. No studies have used cadavers to examine the safety of placing more than 1 portal posteromedially. In addition, there are no descriptions of portal placement based on the anatomy of the posteromedial capsular folds.

The purpose of this study was to define the neurovascular safety zone based on medial knee anatomy for proper placement of 2 or more posteromedial portals. Furthermore, our goal was to describe a safe intra-articular entrance point based on the location of the posteromedial capsular folds. We hypothesized that at least 2 portals could safely be formed and that, by using the capsular folds to guide intra-articular placement, the portal location would be more reproducible and associated with less morbidity to surrounding structures.

METHODS

Arthroscopy was performed on 10 fresh-frozen cadaveric knees. Inflow was controlled with gravity by use of four 3-L bags of irrigation fluid hung at 2.5 m above specimen height. All arthroscopies and dissections were performed with the knee in 90° of flexion. Standard anterolateral and anteromedial portals were created with a 30° 4.0-mm arthroscope (ConMed, Largo, FL). A 5-mm bur (ConMed) was inserted through the anteromedial portal and used to perform a limited inferior notchplasty at the lateral aspect of the medial femoral condyle (MFC) until the posterior horn of the medial meniscus was clearly visualized. The inferior notchplasty was performed to follow the steps in the meniscus transplant technique performed by the senior author. A 30° arthroscope was then advanced until the posteromedial compartment of the knee could be clearly observed. Leaving the arthroscopy sheath in position, a 70° arthroscope was then introduced into the knee for a panoramic view.

Posteromedial portals were created by palpating the soft spot located between the femoral condyle and proximal tibia that was formed by the medial head of the gastrocnemius, the tendon of the semimembranosus, and the medial collateral ligament at the posterior aspect of the joint line. Eighteen-gauge spinal needles were then inserted under direct vision of the arthroscope. The capsular folds and the curvature of the posterior aspect of the MFC were used as internal anatomic landmarks for consistent portal positioning (Fig 1). Blunt dissection was performed along the tracts of the needles. Five-millimeter cannulas were introduced to create the portals.

Four posteromedial portals were created in each of the first 3 knees (Fig 2). First, the location for portal A was determined by palpating the medial soft spot described previously. Portals B, C, and D were then marked 1 cm superior, posterior, and inferior, respectively, in reference to portal A (where the directions relate to the tibial axis with the knee in 90° of flexion). Once the locations of portal entry through the skin were determined, the intra-articular landmarks mentioned previously were used to guide portal placement into the joint (Fig 1). Portals A and C were placed at the midpoint, or equator, of the arthroscopically visible portion of the MFC. Portal A was located just posterior to the condyle, and portal C was placed just posterior to the gastrocnemius capsular fold. Both were above the horizontal capsular fold, corresponding to the semimembranosus tendon. The third portal (B) entered the joint 1 cm superior to portal A and just inferior to the adductor tendon capsular fold. Portal D was placed 1 cm inferior to portal A. Dissection was performed along the paths of the cannulas. Measurements were performed in the initial specimens with a metric ruler (Devon, Mansfield, MA) to identify the

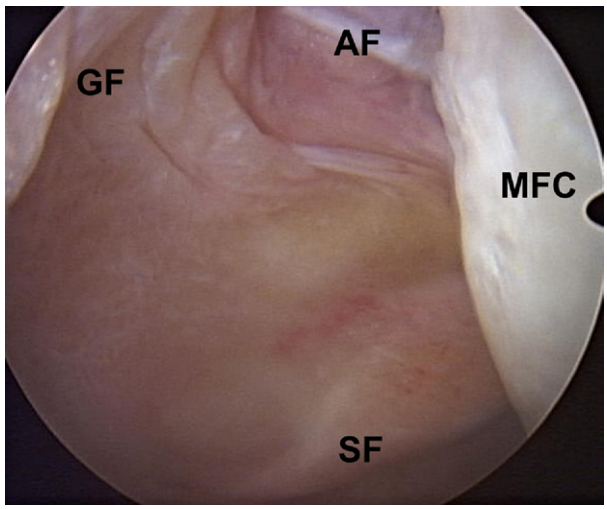

FIGURE 1. Intra-articular view of posteromedial compartment with 70° arthroscope. (GF, gastrocnemius fold; AF, adductor fold; SF, semimembranosus fold.)

FIGURE 2. Medial view of left knee showing the 4 portal locations. Portal A is located over the medial soft spot. Portals B, C, and D are located 1 cm superior, posterior, and inferior, respectively.

shortest distance between the portals and the surrounding structures. Portals were eliminated from the safe zone based on morbidity related to portal placement.

RESULTS

Because the first 3 placements of portal C violated the gastrocnemius musculotendinous structure and the first 3 placements of portal D overlapped the course of the saphenous nerve (Fig 3), they were eliminated from safe zone consideration. Portal D was located 1 cm inferior to the horizontal capsular fold, corresponding to the semimembranosus tendon, found at the equator of the MFC. Portal C was located posterior to the gastrocnemius fold, approximately 1 cm from the saphenous nerve; however, the gastrocnemius musculotendinous structure was violated in all 3 initial specimens (Fig 4). The 7 final specimens were evaluated with only portals A and B (Fig 5). Portal B violated the gastrocnemius muscle in 1 knee because it was not properly placed anterior to the gastrocnemius fold. In another specimen it was placed too superiorly and the adductor tendon was penetrated. Portal A was determined to have the least morbidity, with at least 1.5 cm between the portal and the course of the saphenous nerve in all specimens. The intra-articular placement of this portal was superior to the semimembranosus capsular fold found at the equator of the MFC. Portal B was found to be safe if placed 1 cm above portal A, anterior to the gastrocnemius fold and inferior to the adductor tendon. The safety zone was bound by the capsular folds and located just posterior to the MFC (Fig 6).

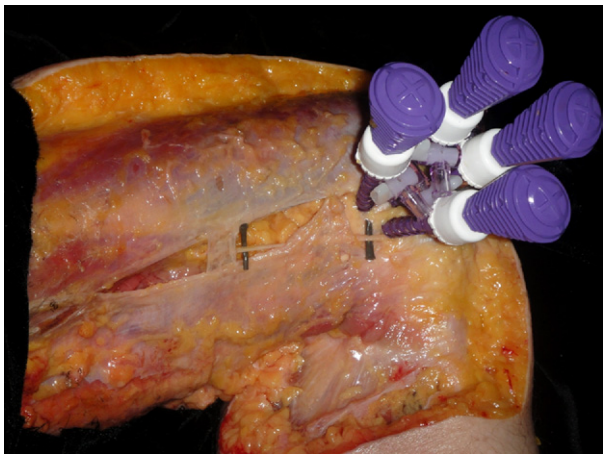

FIGURE 3. Dissected specimen with all 4 portals in place showing portal D (inferior) in contact with saphenous nerve (highlighted with markers).

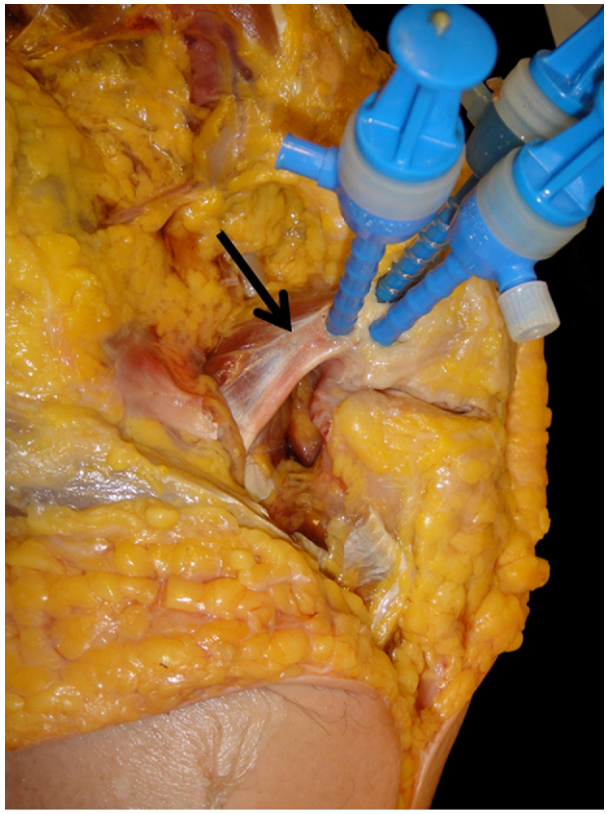

FIGURE 4. Medial view of left knee with dissection showing portal C (left) penetrating gastrocnemius tendon (arrow) as it inserts on posterior femur.

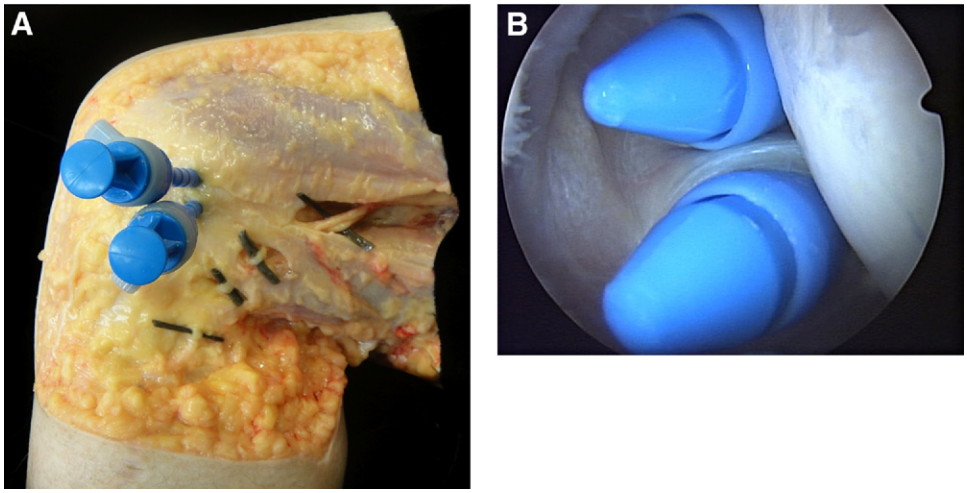

FIGURE 5. Right knee showing the 2 recommended portals. (A) Dissected specimen showing both cannulas safely avoiding saphenous nerve. (B) Arthroscopic view of 2 portals in same knee.

DISCUSSION

The primary purpose of this study was to define a neurovascular safety zone for proper placement of 2 or more posteromedial portals. Second, our goal was to describe a safe and reproducible intra-articular entrance point based on the location of the capsular folds. We found that at least 2 posteromedial portals can be safely placed by use of both intra- and extra-articular anatomic landmarks.

The anatomy of the saphenous nerve and, in particular, its sartorial branch has been well described in the literature. Both Dunaway et al.[13] and Arthornthurasook and Gaew-Im[14] showed from cadaveric dissection that the sartorial branch of the saphenous nerve remains posterior to the sartorius muscle throughout its course. Therefore it follows that posteromedial dissection performed anterior to the sartorius muscle should not endanger the sartorial branch of the saphenous nerve. However, Kramer et al.[15] noted that neither of these studies was conducted under simulated arthroscopic conditions, and therefore they have limited application to clinical arthroscopy. The design of this study was meant to replicate a normal operative environment as closely as possible while still using a cadaveric model.

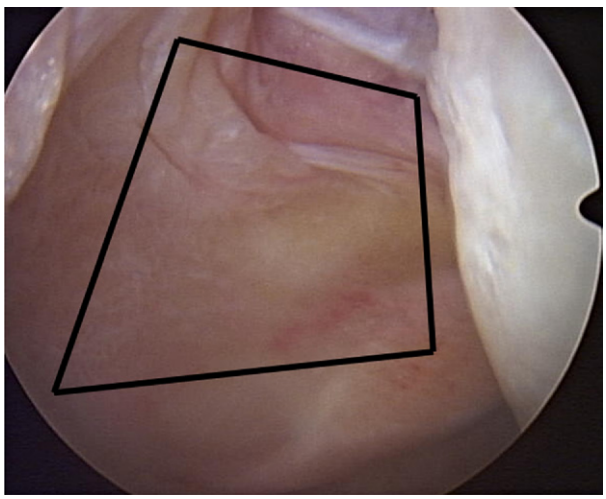

FIGURE 6. Arthroscopic view with black lines defining boundaries of safety zone.

Only 3 previous studies have reported on neurovascular complications directly related to posteromedial portal formation. In clinical studies Gold et al.[3] reported 1 saphenous nerve injury among 78 portals placed, whereas Ogilvie-Harris et al.[2] reported 3 saphenous nerve injuries and 2 saphenous vein injuries among 179 cases. In a recent cadaveric study, Pace and Wahl[16] reported an adequate posteromedial portal safe zone in relation to the saphenous vein; however, its relation to the saphenous nerve and its adjacent branches was not reported. Each of these reports stressed the importance of maintaining knee flexion and the use of proper technique for portal formation.[2,3,16]

Multiple techniques have been described to enhance the safety of posteromedial portal formation. Schreiber[17] reported on the use of transillumination. He placed a 70° arthroscope through the intercondylar notch to perform transillumination of the saphenous nerve and vein. The portal was then formed 1 cm proximal to the joint line, posterior to the nerve. Whipple and Bassett[18] also recommended a posteromedial puncture 1 cm proximal to the joint line. The portal was placed

immediately posterior to the longitudinal portion of the medial collateral ligament.

In the early description of the portal of Johnson,[19] the knee joint was entered with a cannula and sharp trocar just posterior to the tibial collateral ligament, superior to the meniscus, and posterior to the MFC. Gold et al.[3] described a very different technique in which a curved, "inside-out" guide rod passed through the intracondylar notch and posteromedial joint capsule. The portal was then formed at the site where the tip was palpated. They believed this was a safer approach in terms of preventing saphenous nerve injury. Moreover, they criticized previous techniques as being too close to the joint line, which results in limited visualization and little room for instrumentation or for a second accessory portal.

Ogilvie-Harris et al.[2] described a technique similar to ours with insertion of a spinal needle under arthroscopic visualization at the soft spot. This was followed by dissection around the portals to evaluate the proximity of the saphenous nerve and other neurovascular structures. They found that with the knee in 90° of flexion, there was 1 cm of clearance between the portal and the saphenous nerve. During our dissection, we also showed that 90° of knee flexion allowed adequate space for safe portal placement; however, we noted at least 1.5 cm between the 2 recommended portals (A and B) and the saphenous nerve.

To our knowledge, no previous study has described use of the posteromedial capsular folds to guide portal placement. These folds are easily identified under arthroscopic visualization. They are a very useful and reproducible adjunct to avoid injury to important medial knee structures. Avoiding injury to the gastrocnemius insertion, for instance, could easily be achieved by placing the portal slightly anterior and inferior to that fold. Another important intra-articular landmark is the equator of the MFC. As long as portals were placed at or superior to this level, the saphenous structures were not at risk.

There are some limitations to this study. First, the number of specimens was limited to 10 because of cadaver availability at our institution. The inclusion of more knees in the study would better account for anatomic variability. It should be noted, however, that the capsular folds as well as the anatomy at dissection was consistent among all cadaveric specimens. Another limitation is the use of gravity for fluid flow into the joint. If pumps or other methods are used, this could introduce some variability in pericapsular anatomy. One final limitation is the inability of cadaveric specimens in a laboratory setting to accurately simulate live patients in the operating room. Our soft-tissue dissection laboratory makes use of a light embalming process to better preserve more natural soft-tissue characteristics than standard embalming procedures.[20] Great efforts were made to create a realistic operating room environment, but certain inherent differences will always be present in anatomic studies, such as lack of blood flow to a cadaveric limb.

CONCLUSIONS

At least 2 posteromedial portals can be safely placed in the knee. The soft spot is an appropriate landmark to ensure safe portal entry. The posteromedial capsular folds can help to guide intra-articular placement to avoid damaging adjacent structures.

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