

Direct Blood Flow to the Medial Meniscus: A Cadaveric Study Introducing the Medial Meniscal Artery

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INTRODUCTION:

The first in-depth description of the meniscal microvasculature was described by Arnoczky et al. in 1982. They found that the genicular arteries have branches that give rise to a perimeniscal capillary plexus within the posterior capsular tissues of the knee joint. This plexus sends radially directed branches with terminal loops extending 10-30% into the outer menisci. Arnoczky et al. further demonstrated that tears closest to the periphery of the meniscus healed with a fibrovascular scar, while incisions in the avascular portion of the meniscus failed to heal unless the incision was in an area where a vascular channel was present. This study helped establish the "red-red," "red-white," and "white-white" terminology that surgeons have commonly used to assess the meniscus' healing potential after repair. Recent dissections on cadaveric knees in our biomechanics laboratory have demonstrated the presence of a small arterial vessel that branches off the popliteal artery and inserts into the medial meniscal capsule. This vessel has not been previously described in anatomical literature. The purpose of this study was to use anatomical dissection of cadaveric knees and ultrasonography of living patients to provide a detailed characterization of its precise anatomy.

METHODS:

Fifteen frozen cadaveric knees obtained from a commercial vendor were used for this study. Donor sex, age, weight, race, and laterality were recorded. Cadavers with known pre-existing peripheral artery disease were excluded. The cadaveric knees underwent sharp dissection of skin, subcutaneous tissue, fascia, and gastrocnemius-soleus muscle complex to isolate the popliteal artery 10 cm proximal and distal to the joint line. Once the popliteal artery was isolated, careful blunt dissection taken to isolate and expose the intact superior and inferior medial and lateral genicular arteries. The middle genicular artery was also isolated, and at this point, careful examination for any other vascular variants extending to the medial knee were confirmed and carefully isolated. If at any point during the dissection, the dissector was worried about potentially damaging vasculature or had poor visualization, the proximal popliteal artery was cannulated with a 14-gauge angiocatheter and 120 mL of Higgins Black Magic India Ink was injected into the catheterized popliteal artery. Once all vessels were isolated, the distance from the branch points where the medial-sided vasculature branched from the popliteal artery to the joint line were measured. The same procedure was completed using the direct insertion of the semimembranosus on the medial tibial condyle. The angle at which the medial meniscal artery (MMA) travels compared to the popliteal artery was measured as well as the distance the artery traveled from the popliteal artery to the insertion of the joint capsule. The vessel diameter was measured using digital calipers.

RESULTS:

The presence and characteristics of the MMA were investigated in 15 fresh frozen cadaveric knees. Nine male and six female cadaveric knees were utilized. The mean donor age of death was 57.8 years (Range: 35-70, SD = 9.7). The average donor weight was 81.6 kg (Range: 42.6-131, SD = 22.6). Seven right knees and eight left knees were dissected. The MMA branching directly from the popliteal artery was identified in 12 of the 15 cadaveric dissections, while in the remaining 3, the MMA was present and shared a common trunk with the inferior medial genicular artery. The initial branch point of the MMA was on average 14.9 mm (Range: -11-36, SD \pm 10.8) proximal from the posterior tibial plateau and 22.8 mm (Range: 6.6-39, SD \pm 9.1) proximal to the direct insertion of the semitendinosus tendon. The average orientation angle that the MMA branched from the popliteal artery was 30° (Range: 5°-50°, SD \pm 14.4). The average length of the MMA from the popliteal artery until its insertion into the perimeniscal capsule was 33.2 mm (Range: 14.5-58, SD \pm 16.8). The average diameter of the MMA vessel itself was 1 mm (Range 0.3 -1.48, SD \pm 0.47).

DISCUSSION AND CONCLUSION:

This is the first study to comprehensively characterize a persistent artery that branches from the popliteal artery and extends directly to the posteromedial meniscal capsule. This artery has been termed the medial meniscal artery. This structure can be consistently seen on gross anatomic dissection. Given that this anatomical variation could imply a direct source of blood with growth factors necessary for meniscal healing, the role of this vasculature could be very relevant to clinical practice. Further research is needed to determine the artery's role in meniscus preservation, healing, and repair.

