BS Structured Summary

Article: A Novel Anteromedial Knee Ligament — The Anterior Oblique Ligament and the ‘Medial Cross’

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Structured Summary: A Novel Anteromedial Knee Ligament — The Anterior Oblique Ligament and the 'Medial Cross'

Original Article: A Novel Ligamentous Complex in the Anteromedial Region of the Knee: A Cadaveric Study

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Journal: OJSM – Orthopaedic Journal of Sports Medicine

Year: Vol. 12, Issue 4 — April 2024

DOI: 10.1177/23259671241241091

INTRODUCTION / BACKGROUND

The medial structures of the knee are primary restraints to valgus and rotational stress, making them central to the global assessment of the ligament-injured knee and to treatment choice. The superficial medial collateral ligament (sMCL) is the most commonly injured knee ligament, yet the medial side has historically received less anatomic attention than the lateral side — partly because the MCL has a substantial capacity to heal after injury. That balance is shifting: in the presence of unaddressed MCL laxity, the failure rate of ACL grafts has been reported to rise roughly 13-fold after primary ACL reconstruction (ACLR) and 17-fold after revision, which raises an obvious question — if extra-articular reinforcement is increasingly added laterally, why not also reconsider the medial side?

The classic anatomic map of the medial knee comes from Warren and Marshall (1979), who divided the medial side into three layers (crural/sartorial fascia; sMCL; capsule and deep MCL), later refined by Robinson et al (2006). In 2007, LaPrade et al argued that a quantitative, attachment-based description — rather than a simple layer division — is what surgical reconstruction actually requires; in their account, the anteromedial quadrant appeared almost empty, containing little more than the anterior fibres of the sMCL. Only a few structures have since been described there (the deep MCL and the patellar retinaculum).

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Building on the authors' own 2021 and 2022 cadaveric work, this study set out to perform a thorough layer-by-layer dissection of the anteromedial knee and to characterise — qualitatively, quantitatively and histologically — a ligament the group terms the anterior oblique ligament (AOL), together with its relationship to a four-structure complex they call the ‘medial cross’, proposed as a stabiliser of the medial pivot.

OBJECTIVE

To perform a layer-by-layer dissection of the anteromedial side of the knee and provide a qualitative, quantitative and histological description of the anterior oblique ligament (AOL), and to define its relationship with the ‘medial cross’ — the ligament complex (sMCL, AOL and posterior oblique ligament) proposed to stabilise the medial pivot.

METHODS

After ethics approval, 35 fresh-frozen knees donated between April 2020 and November 2022 following transfemoral amputations performed exclusively for vascular reasons (no trauma) were dissected. Exclusion criteria were signs of trauma, previous surgery, macroscopic osteoarthritis or poor preservation. All dissections and measurements were performed by a single knee-surgery senior consultant (P.B.J.), with co-authors assisting on different specimens; histology was read by a single independent pathologist. Measurements used a 0.01-mm digital caliper (Mitutoyo) and are reported as mean ± SD.

Specimens were thawed for 24 hours and dissected 2–21 days after amputation (mean 11.65 ± 5.39). Through a medial hockey-stick incision with the knee at 45° of flexion, the subcutaneous tissue was dissected from the anterior region to the popliteal fossa and the medial epicondyle identified. The medial fascia was opened longitudinally, and palpable thickness transitions at the joint line were marked, identifying the anterior edge of the AOL and the posterior edge of the posterior oblique ligament (POL). The distal sMCL attachment was identified distal to the semitendinosus and gracilis insertions — these four landmarks defining the ‘medial cross’.

The POL was dissected over the semimembranosus; the sMCL was released from the tibia (distal to proximal), exposing a bursa and a bony tubercle; the deep MCL borders were marked. The AOL then became evident as a structure anterior and superficial to the deep MCL, running obliquely from the medial epicondyle to the tibia and readily separable from the joint capsule. AOL length, femoral-origin width, tibial-insertion width and the distance from its tibial insertion to the anterior edge of the sMCL were measured. Twenty-three knees were block-cut (preserving bony origin and insertion) and processed for histology (10% formalin, graded ethanol, paraffin, 4-µm longitudinal sections, haematoxylin and eosin).

MAIN RESULTS

The donors (13 female, 22 male) had a mean age of 69.3 ± 10.1 years (mean weight 77.6 kg, height 1.7 m). The AOL was identified as a superficial, extracapsular structure on the anteromedial side in 100% of specimens, and was reliably distinguishable from the sMCL, deep MCL, articular capsule and medial patellofemoral ligament.

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The femoral attachment lay at the anterior portion of the medial epicondyle; in 28 of 35 knees the AOL origin could be individualised from the sMCL origin (more superficial and anterior), while in 7 the two proximal attachments could not be separated. The tibial attachment — thicker than the femoral origin and located immediately distal to the tibial plateau — gave the ligament a fan shape and was clearly separated from the anterior edge of the sMCL by loose connective tissue.

Quantitatively, the AOL had a mean length of 31.47 ± 5.06 mm, a mean femoral-origin thickness of 6.51 ± 1.03 mm and a mean tibial-insertion thickness of 12.99 ± 1.67 mm (confirming the fan shape); the distance between the centre of its tibial insertion and the anterior edge of the sMCL was 10.29 ± 1.51 mm. Within the medial cross, the AOL represents the anterior arm.

Histology showed a slender but well-defined ligament: densely organised collagen fibrils, thicker and more compact than the anteromedial capsule, with parallel, gently undulating fibres and sparse cellularity — a dense connective-tissue pattern typical of ligament, consistent across all specimens.

AUTHORS' CONCLUSION

Across 35 dissections, the study consistently demonstrated the AOL as a discrete ligament of the medial knee: arising from the anterior border of the medial epicondyle, inserting more broadly just below the articular surface (fan-shaped), extracapsular and not directly related to the medial meniscus, and forming the anterior arm of the 'medial cross'. The authors argue that revisiting the medial compartment may, as happened with the lateral side, refine the understanding of joint instability and improve the results of central-pivot reconstructions. Study design: descriptive laboratory (cadaveric) study.

💬 BS DISCUSSION

This is our own anatomy line of work — the third cadaveric chapter, after the 2021 and 2022 descriptions — and it consolidates the anterior oblique ligament (AOL) as a consistent, histologically confirmed structure of the anteromedial knee, present in 100% of 35 dissections. For BS, the value lies less in 'discovering a ligament' and more in reframing how we look at the medial side: the anteromedial quadrant that LaPrade's classic map left almost empty is, on careful layer-by-layer dissection, occupied by a reproducible fan-shaped ligament with a clear femoral origin, an oblique course and a broad tibial insertion.

The organising idea worth teaching is the 'medial cross' — sMCL, AOL (anterior arm) and POL (posterior arm) framing the medial pivot. It gives trainees a simple mental model: the medial side is not just 'the MCL', but a cross of restraints, and the AOL is the anterior limb sitting precisely in the quadrant that, by our tibial-quadrant theory, controls valgus and external rotation.

The clinical thread is the one we keep returning to at the Summit: unaddressed medial laxity multiplies ACL graft failure (≈13× primary, ≈17× revision). The lateral side already taught us this lesson — the anterolateral ligament was 'revisited' in 2013 and extra-articular reinforcement changed ACLR outcomes. The AOL is our argument that the medial side deserves the same scrutiny. In the specific phenotype — ACL injury with subtle anteromedial rotatory instability, a

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valgus/external-rotation mechanism, without high-grade pivot shift — a medial extra-articular reinforcement in the AOL topography is a rational adjunct, and one we already perform with a described technique.

I want to be careful here, because this is our own hypothesis and the paper is explicit about its limits. The strongest external support is biomechanical and indirect: Miyaji et al and Behrendt et al both show that reinforcing the anteromedial compartment, in the AOL topography, improves control of anteromedial rotatory instability. But this study itself has no biomechanics, no sample-size calculation and elderly specimens — it is anatomy, not proof of function. The honest framing for BS: we have a reproducible structure and a coherent theory, not yet a functional mandate.

For our Labs, this is a teachable, standardisable dissection — the hockey-stick access, the fascia opening, the four-pin 'medial cross' and the plane between the AOL and the capsule are all reproducible steps worth filming for the surgical-anatomy module. For the Summit, the open question is functional: does AOL reinforcement change outcomes in the right ACL phenotype, and can we design the biomechanical and clinical studies that this anatomy now invites? That is the next chapter — and the limitations section of this paper is essentially its research agenda.

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