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Case Report

Morphometric Features of Tibial Attachment of Posterior Cruciate Ligament on Thiel Embalmed Cadavers

Alobaidy M[1,2,3*], Wilkinson T[1] and Bidaut L[2]

[1]*Centre for Anatomy and Human Identification (CAHID), School of Science and Engineering, University of Dundee, Dundee, DD1 5EH, UK*

[2]*School of Medicine, University of Dundee, Dundee, DD1 5EH, UK*

[3]*Department of Anatomy, Faculty of Applied Medical Science, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia*

[*]**Corresponding author**: Mohammad Alobaidy, Centre for Anatomy and Human Identification (CAHID), University of Dundee, Dundee DD1 5EH, UK, Tel: +44 1382 388825; E-mail: m.alobaidy@dundee.ac.uk

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Abstract

Background: The posterior cruciate ligament (PCL) is variable in terms of its origin, course and termination. The tibial insertion of the posterior cruciate ligament is variable and may have implications for accurate tunnel placement during reconstruction surgery.

Methods: This study investigates this attachment in the Thiel embalmed cadaver of a 71-year-old female European Caucasian. The inferior attachment of the ligament was then examined histologically.

Results: The attachment was macroscopically and microscopically examined, and found to terminate by forming a fan shape and blending with the periosteum. Histological examination confirmed that fibers extended up to 25 mm inferior to the ligament's usual insertion point.

Conclusions: These fibers are anatomically important, as they may be an additional supporting factor, assist with stabilization of the knee joint, and further inform surgical approaches to PCL reconstruction surgery.

Keywords: Posterior cruciate ligament; Posterior cruciate ligament tibial attachment; Thiel embalmed

Introduction

The posterior cruciate ligament (PCL) is the main stabilizer of the knee joint, helping to prevent posterior tibial translation [1,2]. In classical anatomy textbooks, it is said to arise from the posterior tibial intercondylar area, passing supero-anteriorly to insert into the lateral aspect of the medial femoral condyle [3,4]. Other studies [5] describe the attachments as reversed, with the PCL arising from the femur, and inserting into the tibia between the posterior horns of the menisci. The functional center and area of the tibial attachment is thus considered controversial [6], with the ligament consisting of two bundles – an anterolateral (ALB) and posteromedial bundle (PMB) – and the ALB larger than the PMB [1,5].

Hatsushika et al. [7] described the PCL tibial footprint as having two patterns: parabolic and transverse. In the parabolic footprint pattern, the ALB is rhomboid and the PMB lunate shaped, whereas in the transverse type, the ALB occupies the anterior half and the PMB the posterior half of the footprint. Similar to the parabolic pattern, Anderson et al [2] portrayed the attachment of the PMB as wrapping around the ALB like two arms.

Although studies and classical anatomy textbooks [8,9] typically describe the PCL as being attached to the tibial PCL facet, Amis et al. [1] and Malone et al. [9] found the fibers of the PMB extending more distally – 7-15 mm inferior to the PCL facet – and blending with the tibial periosteum and knee joint capsule.

Understanding PCL tibial attachment sites is of primary functional relevance in PCL reconstruction, and essential for accurate tunnel placement [10,11].

Case Report

A 71-year-old female European Caucasian Thiel embalmed cadaver knee was harvested and dissected. There were no scars and no indication of injury to the knee ligaments. The PCL and meniscofemoral ligaments were identified, dissected, measured, and photographed. Passive stretching of the knee ligaments helped define their attachments.

The PCL fibers on the tibial attachment were found to extend over the posterior rim of the shelf, forming a fan shape (Figure 1A). Some fibers blended with the tibial periosteum or the knee capsule (Figure 1B). The longest fibers passed through the depression between medial and lateral tibial plateaus and extended approximately 25mm inferior to the posterior rim. These fibers were part of the PMB; the ALB bundle fibers were attached only to the anterior half of the posterior intercondylar area.

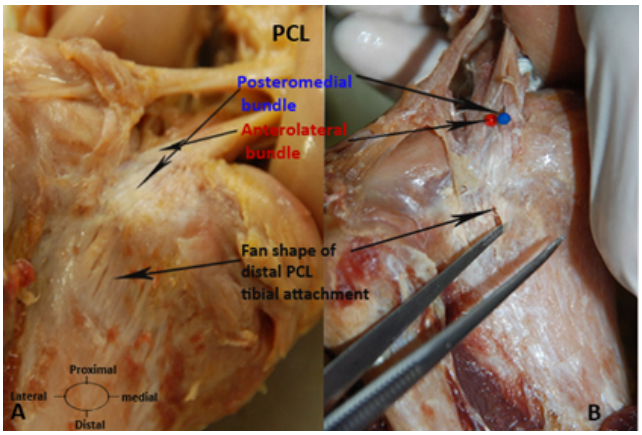

Figure 1: Dissection of posterior cruciate ligament (PCL) A: The PCL fibers are seen to blend with the tibial periosteum. B: The PCL fibers can be seen to extend over the posterior rim of the shelf, forming a fan shape.

A histological study was carried out to confirm that the extended fibers were part of the PCL. A 3x3x25 mm^3 sample was taken from the posterior upper aspect of the right proximal tibia and the distal half of

the PCL (Figure 2A). The sample was stained with Hematoxylin and Eosin to visualize the collagen fibers of the PCL. Figure 2B illustrates the histology of the specimen at 10x magnification. The tibial attachment of the PCL was magnified to 40x (Figure 2C); the continuous fibers of the PCL can clearly be seen extending below the PCL facet.

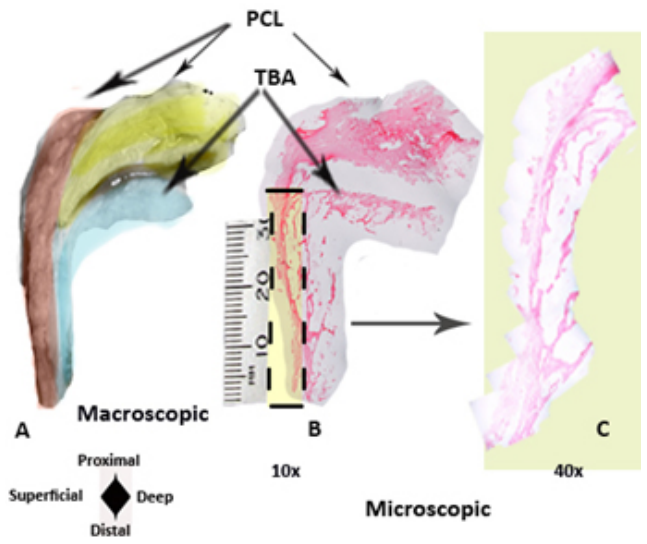

Figure 2: Histological preparation of posterior cruciate ligament (PCL) A: Macroscopic specimen of the distal half of the posterior cruciate ligament (PCL). Yellow – anterolateral bundle; brown – posteromedial bundle; blue – tibial bony attachment (TBA). B: Microscopic view at 10x magnification, highlighting the tibial attachment of the PCL. C: Microscopic view at 40x magnification, showing the attachment of the PCL fibers inferior to the facet.

Discussion and Conclusion

Previous studies have measured the distance that the fibers of the PCL tibial attachment extend inferior to the PCL facet. Reports vary: Amis et al. [1] and Malone et al. [9] found that PMB fibers extended up to 15 mm on to the posterior tibial surface, while Takahashi et al. [12], Van Dommelen et al. [13] and Cosgarea et al. [5] found that they extended by distances of 4.6 ± 3.6 mm, 10 mm, and 10-15 mm respectively.

The PMB fibers in our subject extend appreciably further, as much as 25 mm inferior to the PCL facet, which to our knowledge has not been previously reported and is markedly beyond the usually adopted range. In addition to a valid and yet undocumented anatomical variant, such a finding might also be credited to the Thiel embalming technique, which leaves tissue in a near natural form. When further confirmed and characterized through a larger cohort (ongoing work at our institution), these fiber-ligamentous extensions to the posterior surface of the tibia will likely prove to be anatomically important and directly relevant to planning accurate tunnel placements in PCL reconstruction surgery.

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