Anatomical Relationship of the Popliteal Artery to Tibial Landmarks at Resection Levels Relevant to Total Knee Arthroplasty: A Cadaveric Study

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INTRODUCTION: Popliteal artery injury is a rare but serious complication of total knee arthroplasty (TKA), with an incidence of approximately 0.05%. Performing the tibial cut with the knee flexed and using a posterior retractor can reduce this risk, but not eliminate it entirely. Thus, precise anatomical knowledge of the popliteal artery's proximity to the tibial osteotomy plane is crucial. However, detailed cadaveric studies accurately simulating the surgical tibial cut in three-dimensional orientation are scarce. This study aims to clarify the anatomical relationship of the popliteal artery relative to the tibial osteotomy in TKA and determine sex-based anatomical variations.

METHODS:

This study analyzed 102 knees (48 male, 54 female) from 51 formalin-fixed cadavers. Specimens were placed in a prone position, and a midline incision in the popliteal fossa exposed the popliteal artery and posterior cruciate ligament (PCL). To replicate surgical conditions, a Kirschner wire was inserted from the PCL tibial attachment to the medial patellar tendon border on the tibial tuberosity, establishing the Akagi line as the anteroposterior (AP) axis. A perpendicular line formed the mediolateral (ML) axis, with the PCL attachment as the origin. Measurements of the popliteal artery's position relative to the posterior tibial cortex were taken in AP and ML directions. Additionally, the shortest direct distance from the posterior tibial cortex to the artery was recorded at three distinct levels: the lateral articular surface, 10 mm distal to the articular surface, and 15 mm distal to the articular surface.

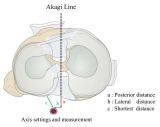
RESULTS:

At the lateral articular surface level, the popliteal artery was located 10.8 ± 3.0 mm posterior and 2.7 ± 2.6 mm lateral from the PCL. At 10 mm distal to the articular surface, these distances were reduced to 6.7 ± 1.5 mm posteriorly and 2.6 ± 2.0 mm laterally. At 15 mm distal, the artery was even closer, at 5.7 ± 1.3 mm posteriorly and 2.5 ± 2.0 mm laterally. The shortest distance from the posterior tibial cortex to the artery decreased progressively: 10.1 ± 2.3 mm at the lateral articular surface, 6.1 ± 1.4 mm at 10 mm distal, and 4.9 ± 1.1 mm at 15 mm distal. Male knees showed significantly greater posterior and shortest distances at the lateral articular surface level and posterior distance at the 10 mm distal level compared to females ($p < 0.05$), but no significant sex differences were observed for the other measurements, and the sex difference tended to decrease as the measurements moved distally. No sex difference was observed in the medial or lateral direction.

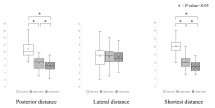
DISCUSSION AND CONCLUSION:

Our cadaveric analysis demonstrates that a typical 10 mm tibial osteotomy from the lateral articular surface in TKA leaves approximately 6 mm of shortest distance from the posterior tibial cortex to the popliteal artery. When extending the osteotomy 15 mm distal to the lateral articular surface, this shortest distance decreases further to about 5 mm, highlighting significantly reduced clearance with more distal cuts. These findings align with previously reported clearances of 2.7–6.6 mm at comparable levels. Although slight sex differences were present proximally, these differences largely disappeared at more distal levels, reflecting that the artery consistently runs close to the tibial cortex. Surgeons must remain vigilant to prevent popliteal artery injuries, especially when performing extended distal osteotomies, irrespective of patient sex.

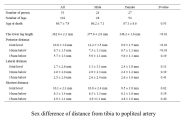
Running of popliteal artery of cadaveric view and enhanced CT view



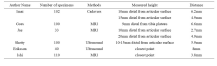
Axis settings and measurement



Distance from tibia to popliteal artery



Sex difference of distance from tibia to popliteal artery



Comparison with previous reports