The Location of Femoral and Tibial Tunnels in Anatomic Double-Bundle Anterior Cruciate Ligament Reconstruction Analyzed by Three-Dimensional Computed Tomography Models

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Background: Characterization of the insertion site anatomy in anterior cruciate ligament reconstruction has recently received increased attention in the literature, coinciding with a growing interest in anatomic reconstruction. The purpose of this study was to visualize and quantify the position of anatomic anteromedial and posterolateral bone tunnels in anterior cruciate ligament reconstruction with use of novel methods applied to three-dimensional computed tomographic reconstruction images.

Methods: Careful arthroscopic dissection and anatomic double-bundle anterior cruciate ligament tunnel drilling were performed with use of topographical landmarks in eight cadaver knees. Computed tomography scans were performed on each knee, and three-dimensional models were created and aligned into an anatomic coordinate system. Tibial tunnel aperture centers were measured in the anterior-to-posterior and medial-to-lateral directions on the tibial plateau. The femoral tunnel aperture centers were measured in anatomic posterior-to-anterior and proximal-to-distal directions and with the quadrant method (relative to the femoral notch).

Results: The centers of the tunnel apertures for the anteromedial and posterolateral tunnels were located at a mean (and standard deviation) of $25\% \pm 2.8\%$ and $46.4\% \pm 3.7\%$, respectively, of the anterior-to-posterior tibial plateau depth and at a mean of $50.5\% \pm 4.2\%$ and $52.4\% \pm 2.5\%$ of the medial-to-lateral tibial plateau width. On the medial wall of the lateral femoral condyle in the anatomic posterior-to-anterior direction, the anteromedial and posterolateral tunnels were located at $23.1\% \pm 6.1\%$ and $15.3\% \pm 4.8\%$, respectively. The proximal-to-distal locations were at $28.2\% \pm 5.4\%$ and $58.1 \pm 7.1\%$, respectively. With the quadrant method, anteromedial and posterolateral tunnels were measured at $21.7\% \pm 2.5\%$ and $35.1\% \pm 3.5\%$, respectively, from the proximal condylar surface (parallel to the Blumensaat line), and at $33.2\% \pm 5.6\%$ and $55.3\% \pm 5.3\%$ from the notch roof (perpendicular to the Blumensaat line). Intraobserver and interobserver reliability was high, with small standard errors of measurement.

Conclusions: This cadaver study provides reference data against which tunnel position in anterior cruciate ligament reconstruction can be compared in future clinical trials.

Clinical Relevance: This study may help surgeons to evaluate tunnel position and facilitate anatomic tunnel placement in anterior cruciate ligament reconstruction.

Recent studies have contributed substantially to our understanding of anterior cruciate ligament anatomy and have revealed that common techniques for anterior cruciate ligament reconstruction may fail to replicate native ligament origins or insertions. This has led to a growing interest in anatomic single-bundle and double-bundle anterior cruciate ligament reconstruction.

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