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Proximity of Lateral Critical Structures in All-Epiphyseal Outside-In Femoral Tunnel Drilling for Paediatric Anterior Cruciate Ligament Reconstruction

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Summary:
This study evaluates the lateral knee structures in proximity to the femoral tunnel in outside-in all-epiphyseal ACL reconstruction. The Lateral Collateral Ligament and Popliteus Tendon were at risk with knee flexion whereas the Cartilage and the Peroneal Nerve were safe regardless of flexion angle. Outside-in all-epiphyseal femoral drilling is most safely performed in full knee extension.

Abstract:
BACKGROUND
The incidence of Anterior Cruciate Ligament(ACL) tears in the pediatric population is on the rise due to increasing participation and intensity of competitive sports at an early age. Neglected ACL tears lead to meniscal tears, chondral damage and poor outcomes therefore early anatomic ACL reconstruction has been advocated. However, ACL reconstruction in the skeletally immature athlete poses a challenge due to the presence of a physis and all-epiphyseal techniques have been developed. These techniques lead to a horizontal femoral tunnel that exits more distally than in standard adult ACL reconstructions, which may put the lateral collateral ligament(LCL), Popliteus(PT), Articular Cartilage(AC), and Peroneal Nerve(PN) at risk. To our knowledge, this is the first study evaluating the proximity of the lateral structures to the femoral tunnel in an outside-in all-epiphyseal ACL reconstruction.

METHODS
Twelve all-epiphyseal ACL reconstructions were performed in human cadaveric knees using arthroscopy and outside-in drilling for anatomic femoral tunnel placement. Fluoroscopy was used to confirm tunnel position and reconstructions were performed with quadruple hamstring grafts and endobutton fixation on the femoral side. Following reconstruction, the lateral side of the knee was dissected and the LCL, PT, distal and posterior AC, and the PN were identified. The distances of these structures from the femoral tunnel were then measured using a digital caliper at 0°, 30°, 60°, 90°, and 120° of knee flexion. Any damage to these structures caused by the femoral drilling was also noted.

RESULTS
Clear violation of the LCL was noted in 3 specimens and of the PT in 1 specimen. As the knee was progressively flexed, the femoral tunnel approached and passed underneath the LCL with an average distance of 6.1mm at 0°, 5.8mm at 30°, 3.6mm at 60°, 2.3mm at 90°, and 0.8mm at 120°. The PT similarly approached the femoral tunnel with progressive knee flexion with an average distance of 7.5mm at 0°, 7.1mm at 30°, 5.7mm at 60°, 3.9mm at 90°, and 2.0mm at 120°. The PN was remote from the femoral tunnel at all flexion angles with a mean distance from 45.4 to 61.7mm. The articular cartilage was respected in all specimens.

CONCLUSIONS

The LCL and PT are at risk during femoral drilling for all-epiphyseal anatomic ACL reconstruction using outside-in drilling. This risk was maximized at 120° and minimized in full extension. These findings suggest that the optimal position for femoral drilling in outside-in all-epiphyseal ACL reconstruction is full or near-full extension of the knee. This is important because it the opposite of the high knee flexion angles(>120°) recommended for standard ACL reconstructions using an anteromedial portal to protect the posterior wall and the PN. Neither of these were at risk in our study regardless of flexion angle. All-epiphyseal femoral drilling using an outside-in technique is best performed at full or near-full knee extension to minimize the risk to the LCL and PT.