The Relationship of Schöttle's Point to the Medial Distal Femoral Physis: A Digitally Reconstructed Radiograph and 3-Dimensional Computed Tomography Study

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INTRODUCTION:

There is significant controversy regarding ideal medial patellofemoral ligament reconstruction (MPFLR) tunnel position in the pediatric setting. The position of the radiographic MPFLR femoral tunnel start point (Schöttle's point) relative to the medial distal femoral physis is not well defined. The complex curvature of the distal femoral physis, and its projection on the lateral view radiograph has led to controversy regarding the risk of physeal injury and subsequent growth disturbance. Prior studies provide conflicting data regarding position of the MPFL origin relative to the distal femoral physis. The purpose of this study was to determine the proximity of Schöttle's point to the medial distal femoral physis and the medial epicondyle using a digitally reconstructed radiographs (DRR) and three-dimensional (3D) computed tomography (CT) models.

METHODS:

The institutional picture archiving and communication system (PACS) was queried for CT imaging studies of pediatric knees with open physes. CT data were imported to a 3D Slicer Image Computing Platform and transformed to create true lateral digitally reconstructed radiographs (DRR) (Figure 1) and 3-dimensional (3D) renderings of the distal femur (Figure 3). Schöttle's point and the medial epicondyle were registered using fiducial markers and 3D distance measurements were then obtained from Schöttle's point on the medial cortex to 1) the medial epicondyle, 2) the physeal point directly superior to Schöttle's point, and 3) the shortest distance to the medial physis on the cortical surface. A 6-millimeter circle was used to simulate reaming diameter and physeal intersections were tabulated.

RESULTS:

Forty-nine pediatric knee CT scans with open physes were included in the data. Average patient age was 13.0 ± 2.3 years (range: 6-17 years). Apparent position of Schöttle's point on the lateral view DRR was proximal to the physis in 22 of 49 (44.9%) of cases and at the physis in 22 of 49 (44.9%) of cases. Apparent position of Schöttle's point was distal to the physis in 5 of 49 (10.2%) of cases. True mean minimum distance from the medial physis to Schöttle's point was 9.9 mm ± 3.0mm (range: 3.4-16.1 mm) as measured on 3D reconstructions and confirmed on CT scans and 3D models (Figure 3). On 3D reconstructions, in 49 of 49 cases (100%), Schöttle's point was distal to the physis. Schöttle's point was localized at a mean distance of 7.5mm ± 3.14mm posterior to the medial epicondyle and 6.1mm ± 2.9mm superior to the medial epicondyle. Using a 6mm reaming diameter, 3 (6%) femurs in our study would have violation of the medial distal femoral physis. Moving the start point 3mm distally would result in 0 of 49 (0%) having physeal injury.

DISCUSSION AND CONCLUSION:

The present study, using CT scan data from 49 pediatric knees, demonstrates that in all cases, 49 of 49 knees (100%), Schöttle's Point localized distal to the medial knee physis. This study links an established, reliable surgical technique to physeal anatomy, providing intraoperative confidence and technique guidance to the pediatric sports surgeon. As such, Schöttle's Point, with some small adjustment based on reamer size, may be used as the radiographic start point for pediatric MPFLR.

Historically, characterizing the position of the origin of the MPFL on the medial condyle relative to the medial distal femoral physis has been challenging. Prior cadaveric studies have suggested the MPFL originates proximal to the physis in younger patients (<7 years). However, more recent cadaveric studies have challenged this idea, finding the bony landmarks of the MPFL origin to be distal to the physis. Although these studies have sparked significant discussion regarding the pediatric MPFL origin, they did not provide a comprehensive understanding of the physeal anatomy in three dimensions and did not demonstrate its relationship to Schöttle's point. Using a comprehensive, 3 dimensional, surgically relevant approach, the present study demonstrates that Schöttle's point is consistently distal to the medial distal femoral physis.

Prior studies have also suggested anterior and distal drill trajectories that may minimize physeal injury. Although useful, these studies do not assess drilling path relative to the commonly used radiographically identified starting point known as Schöttle's point. The present study complements this prior work by addressing the radiographic start point upon which the drill trajectory is based intraoperatively. Further, the present investigation offers a larger sample size than any previously published pediatric MPFL anatomic study and uses a highly accurate and repeatable methodology.

In conclusion, the radiographically defined surgical start point for MPFL tunnel placement (Schöttle's point), is consistently distal to the medial distal femoral physis. Mean minimum distance from Schöttle's point to the physis on the medial cortex is 9.9mm. Using Schöttle's point for the start of tunnel drilling leads to physis violation in 6% of cases, when using a 6mm reamer. Distalization of the start point by 3mm leads to avoidance of physeal injury in all cases.

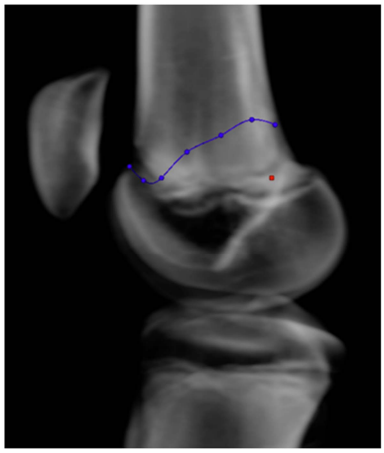

Figure 1: Lateral view DRR demonstrating Schöttle's point (red), and the medial distal femoral physis (blue)

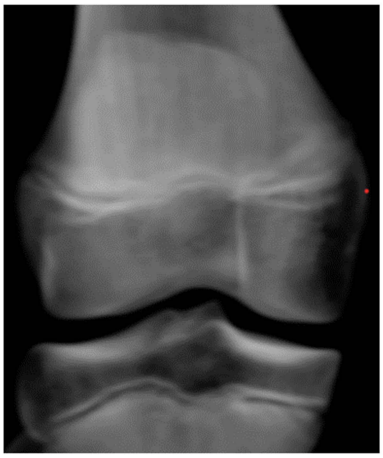

Figure 2: Anteroposterior view DRR demonstrating Schöttle's point on the medial epiphyseal cortex

Figure 3: 3-Dimensional reconstruction of the knee demonstrating Schöttle's point (red) distal to the medial distal femoral epiphysis (blue)