LENGTH CHANGES OF THE MEDIAL PATELLOFEMORAL LIGAMENT DURING IN VIVO KNEE MOTION: A DYNAMIC EVALUATION

Miriam R. Boot (1), Sebastiaan A.W. van de Groes(2), Hans Dunning(1), Esther Tanck(1) and Dennis Janssen (1)

1 Orthopaedic Research Laboratory, Radboud University Medical Center, Nijmegen, The Netherlands

2 Department of Orthopaedics, Radboud University Medical Center, Nijmegen, The Netherlands

Introduction

Medial patellofemoral ligament (MPFL) reconstruction is the primary surgical intervention for patients with recurrent patellofemoral instability.[1] Yet, the treatment is associated with high complication rates including pain, recurrent instability and restricted range of knee motion. [2] Two common causes are graft overloading and laxity, which are associated with surgical malpositioning. Clinical outcomes can be improved by a better understanding of MPFL elongation patterns and the effect of variations in graft placement. Therefore, this study aimed to assess length changes of the MPFL along the superomedial patellar edge throughout the range of knee motion.

Methods

A high resolution static and medium resolution dynamic CT scan of both knees were obtained in 115 knees of 63 healthy subjects (Figure 1). Static CT scans were obtained in full extension. Dynamic CT scans were obtained during an active flexion-extension-flexion movement in 11 seconds (full extension to 90° flexion).

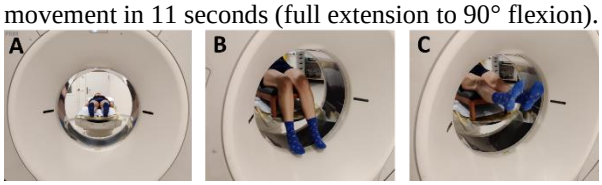

Figure 1: Overview of the scan protocol. A) All subjects first underwent a static CT scan in supine position. B & C) Then, a dynamic CT scan was made during an active flexion-extension-flexion movement in 11 seconds. Adapted from [3].

Static and dynamic CT data were superimposed using image registration and transformations were interpolated to get 3D knee joint models per angle of flexion. Using the knee models, the MPFL length was measured from Schöttle's point on the femur to three insertion points on the superomedial border of the patella (proximal, central, and distal; Figure 2). These locations corresponded with common attachment sites of the MPFL in anatomic studies. [4,5] The shortest wrapping path around the femoral condyle was selected as the MPFL length. Subsequently, MPFL length changes were assessed per flexion angle and expressed as percentual length changes relative to the length in full extension.

Results

The mean MPFL length in full extension was 58.4, 55.7 and 53.8 mm for the proximal, central and distal patellar insertion. During knee flexion, the median percentual MPFL length changes varied between -6 to 4 % relative to full extension (Figure 3). In the first 10° of flexion, the median MPFL length decreased by 2-3%. Beyond 10° of flexion, the elongation pattern depended on the patellar attachment site. The MPFL length of the central fibre restored to the length in full extension at 50° of flexion and subsequently decreased again to -2.7% (IQR, -6.2 to 1.1%) at 90° of flexion. The proximal fibre length decreased to -6.0% (-9.4 to -2.6%) and the distal fibre length increased to 1.9% (-1.5 to 7.7%) at 90° of flexion.

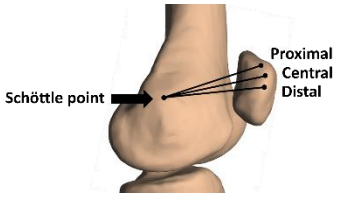

Figure 2: 3D bone surface model of the knee in full extension showing the 3 MPFL fibers.

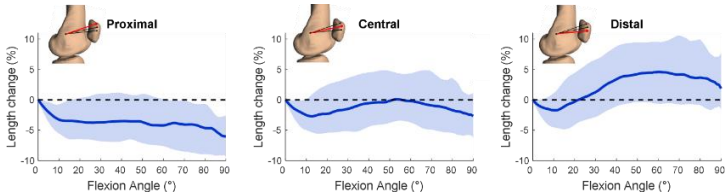

Figure 3: Percentual MPFL length changes relative to full extension from 0 to 90° knee flexion for the proximal, central and distal patellar attachment. Lines and shadings represent medians ± IQR.

Discussion

The length changes of the MPFL depend on the patellar attachment site. The central MPFL bundle of the MPFL exhibited the most isometric behavior during knee flexion, whereas the MPFL slackened proximally and elongated distally. This suggests that reconstructing the MPFL at the central patellar insertion would result in the lowest complication rates when adhering to an isometric reconstruction. Surgeons should particularly avoid a too distal patellar insertion, as that may increase the risk for complications due to overloading.

References

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