The Reproducibility and Repeatability of Valgus Stress Radiographs to Assess Medial Knee Ligament Injuries

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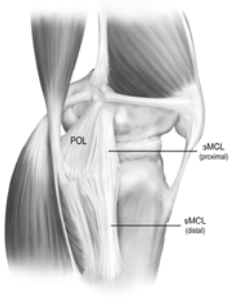
Introduction

The medial collateral ligament and medial knee stabilizers are the most commonly injured structures of the knee [12, 2, 3, 10]. Early diagnosis is crucial for identification of the injury grade and treatment planning for isolated medial collateral ligament injuries and combined medial structure injuries [4, 14, 1, 11, 5, 8]. The physical examination for grading a superficial medial collateral ligament injury and presence of other knee injuries relies on the clinician's expertise to determine the presence of an endpoint during the application of valgus stress at 30 degrees of knee flexion [13].

However, this allows for potential subjective error in diagnosis and grading of the injury especially in the presence of combined injuries [2, 12]. By performing valgus stress radiographs, a comparison can be made with the unaffected contralateral knee and used to judge the degree of instability, as indicated by the amount of gapping, and more accurately grade the injury [7, 9]. Therefore, the method of valgus stress radiographs for determining instability can be used not only to diagnose medial knee injuries, but also to manage an injury and utilized as an indicator for the return of stability throughout treatment.

The **purpose** of this study was to measure medial compartment opening secondary to applied valgus loads following medial structure sectioning and to develop radiographic guidelines to quantify the amount of medial compartment gapping seen with these injuries.

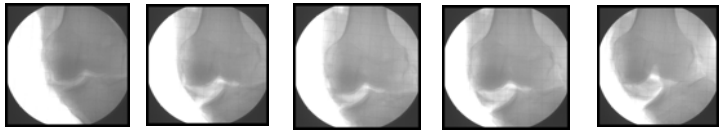


Materials & Methods

Fourteen fresh-frozen lower extremities were used. Two valgus loads, a 10-Nm moment and a clinician-applied valgus stress, were applied to the intact knees and after sequential sectioning of the superficial medial collateral ligament proximally and distally, meniscotibial portion of the deep medial collateral ligament, meniscofemoral portion of the deep medial collateral ligament, posterior oblique ligament, anterior and posterior cruciate ligaments. Each cut state was measured at 0° of flexion and 20° flexion. The parameters for measurement were the shortest distance between the most distal subchondral bone surface of the medial femoral condyle and the corresponding perpendicular surface of the medial tibial plateau. Two observers were used to determine intraobserver repeatability and interobserver reproducibility.

Results

The knee images were stored and accessed through our institution's picture archiving and communication system (PACS). Using the PACS measuring tool, the closest perpendicular distance between the central aspect of the medial femoral condyle and the corresponding medial tibial plateau was utilized for measurement. "Gapping" was defined as the shortest distance between the subchondral bone surface of the most distal aspect of the medial femoral condyle and the corresponding medial tibial plateau without taking into account the thickness of the articular cartilage. The placement of the 1 cm x 1 cm grid in the image was used to measure the perpendicular line and allowed for calibration of the images to account for magnification differences between radiographs.



Intact | Proximal Superficial Medial Collateral Ligament | Distal Superficial Medial Collateral Ligament | Posteromedial Corner Ligaments | Posterior Cruciate Ligament

Protocol A

Proximal Superficial Medial Collateral Ligament
From the intact state, sectioning the proximal sMCL caused an increase of 1.5 mm at the 10-Nm moment for 0° and an increase of 2.8 mm at 20° of knee flexion.

Proximal Superficial Medial Collateral Ligament and the Meniscofemoral portion of the Deep Medial Collateral Ligament
Combined sectioning of the meniscofemoral portion of the deep medial collateral ligament with the proximal superficial medial collateral ligament resulted in increased gapping of 2.4 mm at 0° and 4.4 mm at 20° of knee flexion over the intact state when a 10-Nm force was applied. Compared with the sectioning of the proximal superficial medial collateral ligament alone, this was an increase of 0.5 mm in medial compartment gapping at 0° and 1.6 mm at 20° of knee flexion.

Proximal Superficial Medial Collateral Ligament, the Meniscofemoral Ligament, and Posterior Oblique Ligament (Complete Medial Meniscofemoral based Lesion)
Further sectioning of the posterior oblique ligament resulted in increased gapping of 4.5 mm over the intact state when a 10-Nm force was applied at 0° and 6.8 mm at 20°of knee flexion. Compared with the sectioning of the superficial medial collateral ligament and meniscofemoral ligament, this was an increase of 2.1 mm in medial compartment gapping at 0° and 2.4 mm at 20° of knee flexion

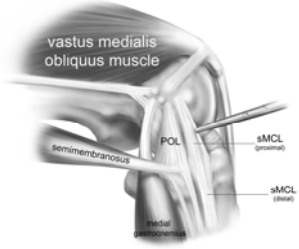
Proximal Superficial Medial Collateral Ligament, the Meniscofemoral Ligament, Posterior Oblique Ligament, and Distal Superficial Medial Collateral Ligament
By adding the sectioning of the distal superficial medial collateral ligament to the sectioned posterior oblique ligament, meniscofemoral ligament, and the proximal superficial medial collateral ligament, the resulted increase in gapping was 5.6 mm at 0° of flexion and 7.45 mm at 20° flexion over the intact state when a 10-Nm force was applied. When compared with the sectioning of the proximal superficial medial collateral ligament, meniscofemoral ligament, and posterior oblique ligament this is an increase of 1.1 mm in medial compartment gapping at 0° of flexion and 0.7 mm at 20° of knee flexion.

Proximal Superficial Medial Collateral Ligament, the Meniscofemoral Ligament, Posterior Oblique Ligament, Distal Superficial Medial Collateral Ligament, and the Meniscotibial portion of the Deep Medial Collateral Ligament (Complete Medial Structure Injury)
Combining the sectioning of the meniscotibial portion of the deep medial collateral ligament with the distal superficial medial collateral ligament, posterior oblique ligament, meniscofemoral ligament, and the proximal superficial medial collateral ligament resulted in increased gapping of 5.8 mm at 0° and 8.7 mm for 20° of knee flexion compared to the intact state when a 10-Nm force was applied. Compared with the sectioning of the proximal superficial medial collateral ligament, meniscofemoral ligament, posterior oblique ligament, and distal superficial medial collateral ligament at 0° and 20° of knee flexion, there was an increase of 0.2 mm and 1.3 mm in medial compartment gapping, respectively.

Medial Knee Structures and the Anterior Cruciate Ligament
When the ACL was sectioned in conjunction with the medial knee structures, the increased gapping was 7.1 mm at 0° over the intact state and 11.8 mm at 20° flexion over the intact state for an applied 10-Nm force.

Conclusions

Based upon our findings, the standard medial gapping distance observed for these combined superficial medial collateral and cruciate ligament injuries on valgus radiographs can be utilized to evaluate an injury and provide the clinician more information regarding the extent of a medial knee injury.



Clinical Significance

Valgus stress radiographs appear to give an objective and reproducible measure of medial compartment gapping which should prove useful for definitive diagnosis, management, and postoperative follow-up of patients with medial collateral ligament injuries.

References

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