Variability of measurement of patellofemoral indices with knee flexion and quadriceps contraction - A MRI-based anatomical study.

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Purpose

The objective of this study was to measure the variability of patellofemoral indices on MR images with knee in full extension and 25 degree flexion with and without quadriceps contraction.

Methods and Materials

15 patients undergoing MRI scan of the knee for non-patellar pathology were identified from a pool of referrals made to the departments of trauma and orthopaedics and radiology. Inclusion criteria of the study were isolated pathology of the knee which is non-patellar related, age group of 15-40 years and a body mass index of less than 30. Exclusion criteria included patella related pathology, presence of connective tissue disorder and previous surgery or injury to the knee. Only 10 patients fitted the inclusion criteria.

Axial and sagittal sequences were done in full extension with relaxed quadriceps, full extension with contracted quadriceps, 25 degree flexion of knee with relaxed quadriceps and 25 degree flexion of knee with contracted quadriceps.

Bisect offset, patella tilt angle and sulcus angle were measured on the axial scans. Insall-Salvati ratio and Caton-Deschamps Index were measured on the sagittal images of the magnetic resonance scans.

Bisect offset angle is the percentage of patellar width lateral to a line drawn perpendicular to the posterior condylar line AB and passing through the deepest point of the trochlea groove. (Figure 1)

Patellar tilt was defined as the angle formed by lines joining the maximum width of the patella (AB) and the posterior femoral condyles (BC). (figure 2)

The Insall-Salvati ratio is the ratio of the patella tendon length (A) to the length of the patella (B). (figure 3)

The Caton-Deschamps index is the ratio between the distance of the lower edge of the patellar joint surface to the upper edge of the tibial plateau (A) and the length of the patellar articular surface (B). (figure 4)
Subjects were defined to have excessive bisect offset if their bisect offset at full extension during the weight-bearing task was >65%. Subjects were defined as having excessive patellar tilt if their patellar tilt at extension during the weight-bearing task was >15 degrees.

Images for this section:

Fig. 1: Measurement of Bisect offset (figure 1) and Patella tilt (figure 2)
**Fig. 2:** Measurement of Insall-Salvati Index (figure 3) and Caton-Deschamps Index (figure 4)
The results of the Patella tilt, Bisect offset, Insall-Salvati Index and Caton-Deschamps Index with various positions of the knee and state of the quadriceps are tabulated below:

| Position of knee + state of quads | Patella tilt | Bisect Ofset |
|-----------------------------------|-------------|--------------|
| Normal values                     | < 15 °      | <65%         |
| Knee ext + relax quads            | 15 (8-27.7) | 62% (54%-85%)|
| Knee ext + contracted quads       | 20.3 (6.2-47.7) | 70% (51%-96%) |
| Knee 25° flex + relax quads       | 9.5 (3.2-21.8) | 56% (50%-69%) |
| Knee 25° flex + contracted quads  | 10.6 (3.4-26.4) | 58% (49%-73%) |

| Position of knee + state of quads | Insall-Salvati Index | Caton-Deschamps Index |
|-----------------------------------|----------------------|-----------------------|
| Normal values                     | 0.8-1.2              | 0.6-1.3               |
| Knee ext + relax quads            | 1.14 (0.96-1.22)     | 1.27 (1.05-1.40)      |
| Knee ext + contracted quads       | 1.20 (0.96-1.45)     | 1.33 (0.99-1.43)      |
| Knee 25° flex + relax quads       | 1.18 (0.97-1.34)     | 1.22 (0.83-1.40)      |
| Knee 25° flex + contracted quads  | 1.16 (0.91-1.44)     | 1.18 (0.86-1.39)      |

Two patients had abnormal patellofemoral indices however, they were included in the study as they fitted the inclusion criteria and were asymptomatic at the time of scanning for any patellofemoral pathology.

Patella tilt was of normal values in knee kept in 25 degrees flexion with or without contraction of the quadriceps and in extended knee with relaxed quadriceps. In extension of the knee with quadriceps contraction, patella tilt increased by 5.3 degrees.

Bisect offset was within normal limits (less than 65%) in knees with full extension but relaxed quadriceps and knees in 25 degrees flexion with or without quadriceps
contraction. However, the bisect offset increased to 70% with contraction of the quadriceps in full extension of the knee.

Insall-Salvati Index was normal in knees with full extension as well as 25 degrees of flexion with or without contraction of quadriceps.

Caton-Deschamps Index increased in knee with full extension and quadriceps contraction compared to normal values in full extension of the knee and relaxed quadriceps with 25 degrees of flexion of knee with or without contraction of quadriceps.

**Conclusion**

We conclude, from our study, that additional information regarding patellar tilt is obtained in patients with patellofemoral instability when MRI is done with knee in full extension, knee in full extension with contraction of the quadriceps and knee in 25 degrees of flexion with or without contraction of the quadriceps.

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