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ORIGINAL STUDY

The contribution of the medial retinaculum as a restraining factor to the patella dislocation

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The objective of this study was to evaluate the contribution of the medial retinaculum to the stability of the patella, for several angles of knee flexion.

For six cadaveric knees, the patella and patella retinaculum were exposed, and the force required to dislocate the patella laterally by 5 mm was measured, in 0, 45 and 90 degrees of knee flexion, preserving and dissecting the medial retinaculum. Wilcoxon singed rank test (SPSS, version 23, Chicago, USA) was used for data analysis. A p value of < 0.05 was considered as statistically significant.

The force required to displace the patella laterally is smaller with the medial retinaculum dissected than intact, in 0, 45 and 90 degrees (p = 0.028, p = 0.046, p = 0.027 respectively). The lateral displacement force is greater as the flexion angle increases, with medial retinaculum intact or dissected (p = 0.028).

Thus, an intact medial retinaculum provides more stability against lateral displacement forces to the patella, especially in lower flexion angles. Consequently, surgical methods reinforcing the medial retinaculum combined or not with lateral retinaculum release, are of great importance in the plan of the orthopedic surgeons. The engagement of the bones during flexion of the knee contributes significantly to the stability of the patella.

Keywords : Patellar instability ; patellar retinaculum ; medial retinaculum ; patella lateral displacement ; lateral displacement force.

INTRODUCTION

Patellar instability is a common entity, especially in adolescent females. Factors contributing to patella stability for the knee joint are the quadriceps muscle (Q-angle) *(5)*, engagement of the patella with the trochlear groove (engagement of bones), especially after 30 degrees of knee flexion *(4)*, patello-femoral ligament, contributing up to 60% to the stability of the patella to the joint *(3)*, patello-tibial ligament and the soft tissues surrounding the patella, especially the retinaculum (medial and lateral). As far as the retinaculum is concerned, several studies showed the contribution of lateral retinaculum tightness *(2,10)* and medial retinaculum

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laxity *(1,7,8,9,11, 13,14)* to patellar lateral dislocation, suggesting methods for lateral retinaculum relaxation and medial retinaculum reinforcement (plasty, plication, imbrication), as well as tibial tubercle medialisation (Fulkerson type osteotomy) in order to treat recurrent dislocation of the patella in several patients. Fulkerson and Hungerford *(6)* in 1959 reported 137 surgical techniques for patello-femoral stability disorders.

Other factors contributing to patella dislocation are differences in patella height (patella alta-baja), greater Q-angle, difference in trochlear depth and tibial tubercle-trochlear groove distance greater than 20 mm.

Farahmand et al 2004, Senavongse et al 2003, conducted biomechanical studies on cadaveric knees in vitro *(4,5,12)*, measuring the patella lateral displacement force, in several flexion angles of knee flexion, between 0-90 degrees, applying loads to the quadriceps muscle, showing that lateral patellar displacement required a constant displacing force up to 60° knee flexion and then a significant increase at 90° (Farahmand et al 1998). Moreover, lateral patellar displacement occurred at the lowest restraining force when the knee was flexed 20° (Senavongse et al 2003). Specifically, Farahmand F. et al 2004 conducted a study for the contribution of quadriceps muscle along with medial retinaculum to the patella stability against lateral displacing force, showing that the quadriceps muscle had a significant effect across the whole range of knee flexion, but the contribution of the medial retinaculum was restricted to extended knee postures *(5)*.

The aim of the present study was to quantify the lateral displacement force for the patella, in several flexion angles of the knee, in two specific cases: cadaveric knees with the medial retinaculum intact and knees with the medial retinaculum dissected. We attempted to contribute to the medical literature by proposing methods for medial retinaculum reinforcement for the treatment of lateral patellar dislocation.

MATERIALS AND METHODS

Six frozen cadaveric knees were used in this study. The patella was exposed after surgical incision across the two poles of the patella, extended 5 cm proximally and distally. The medial retinaculum was located and marked. The center of the patella was marked using a colored stitch, while another ethibond stitch was attached to the lateral-middle side of the patella, with the other end of it attached to an electronic dynamometer.

Four ethibond stitches were clothed around the four parts of quadriceps muscle fibers and attached to the mass of the muscle by knots. The other ends of the stitches were attached to 2.5 kg weights (24.51 N), hanging out and below the study table.

The specimen's femoral diaphysis was fixed to the study table by means of a mechanical clamp, preventing any movement and rotation, with the patellar lateral side facing upwards. The stitch attached to the lateral side of the patella and the dynamometer was rolled over a metallic rod above and parallel to the femoral diaphysis, letting the dynamometer hang above the knee. The 2.5 kg weight attached to the quadriceps muscle hanged out and below the study table, applying the 24.51 N force to the four parts of the quadriceps muscle, partially simulating the stabilizing force of the quadriceps muscle to the patella. A ruler was placed next to the marked center of the patella for the measurement of the lateral displacement of the patellar center (Figure 1).

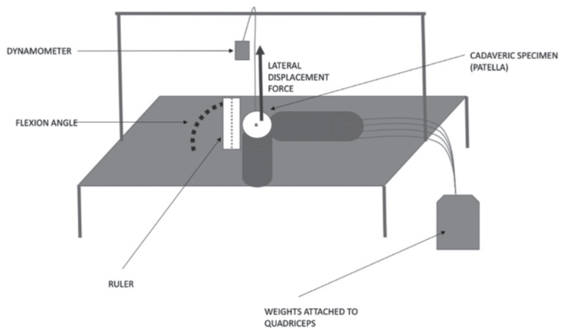


Fig. 1. — Experimental table setup

With the knee extended, a lateral displacement force was applied to the lateral side of the patella, via the ethibond stitch attached to the patella and dynamometer, and a measurement was obtained when the patellar center dislocated laterally by 5 mm (lateral displacement force). Two more measurements were conducted with the knee flexed up to 45 and 90 degrees. The above measurements were performed again following dissection of the medial retinaculum.

Due to paired data and small sample size we used the non-parametric Wilcoxon singed rank test (SPSS, version 23, Chicago, USA for OsX). The Kolmogorov-Smirnov test of normality was also used to ensure whether the data were normally distributed. A p value of < 0.05 was considered as statistically significant. The confidence interval was 95%.

RESULTS

The statistical analysis of the data (Table I, Table II), revealed that the lateral displacement force for the patella was lower after the dissection of the medial retinaculum in every flexion angle of the knee. Specifically, in extension, 45 degrees and 90 degrees of flexion the p values were 0.028, 0.046 and 0.027 respectively. This finding shows that the medial retinaculum plays a role as a restraining factor for the lateral displacement of the patella.

In both cases the lateral displacement force was greater with increased flexion angles of the knee, with medial retinaculum intact or dissected (p = 0.028). This indicates that as the patella starts to engage with the bony structures of the femur during flexion of the knee, the role of medial retinaculum as restraining factor is not of that importance as in extension or lower flexion angles of the knee.

DİSCUSSİON

The stability of the patella for the knee joint depends on many factors, such as the interaction of soft tissues (quadriceps muscle, patello-femoral and patello-tibial ligaments, patella retinaculum) and bone (trochlear groove depth, engagement of the patella and groove during flexion, height of the patella-alta, baja).

In the present anatomical-biomechanical study, we quantified the lateral displacement force for the patella, causing subluxation of it up to 5mm in several flexion angles with or without preservation of the medial retinaculum.

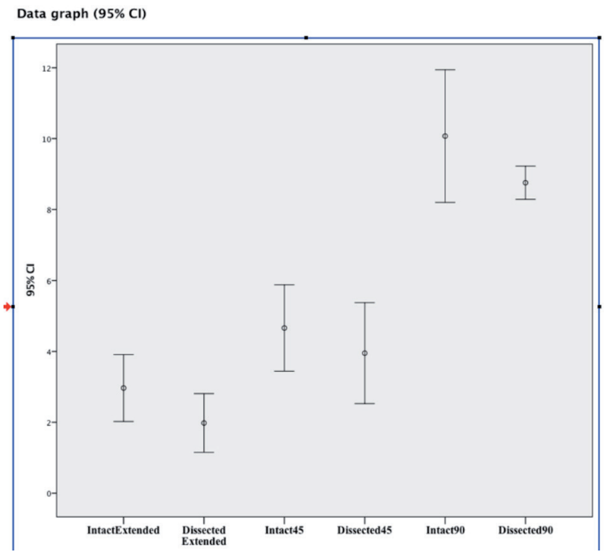
It is known that the patella is restrained into the trochlear groove during flexion, especially by the soft tissues' tension applied to it by the quadriceps muscle and surrounding ligaments and retinaculum, preventing the lateral subluxation of it, in a normal working knee. The measurements and analysis in our study agreed with this pattern, showing the importance of the medial retinaculum as a restraining factor.

The force applied by quadriceps muscle could not reach the original force applied by this muscle

Table I. — Measurement results

	INTACT-EXTENSION	INTACT-45 FLEXION	INTACT-90 FLEXION	DISSECTED-EXTENSION	DISSECTED-45 FLEXION	DISSECTED-90 FLEXION
Knee No 1	4.13 N	6.99 N	13.18 N	3.04 N	6.36 N	8.92 N
Knee No 2	3.55 N	4.43 N	9.27 N	2.62 N	3.55 N	9.02 N
Knee No 3	3.13 N	3.99 N	10.80 N	1.87 N	3.39 N	8.88 N
Knee No 4	1.67 N	4.41 N	7.93 N	1.01 N	2.78 N	7.89 N
Knee No 5	2.18 N	3.90 N	9.42 N	1.20 N	2.94 N	8.71 N
Knee No 6	3.14 N	4.24 N	9.83 N	2.14 N	4.68 N	9.12 N

Table II. — Comparison between knees:
1. Intact retinacullum - Knee extended to Dissected retinacullum - Knee extended, P value = 0,028
2. Intact retinacullum - Knee 45 degrees flexion to Dissected retinacullum - Knee 45 degrees flexion, P value = 0,046
3. Intact retinacullum - Knee 90 degrees flexion to Dissected retinacullum - Knee 90 degrees flexion, P value = 0,027



in vivo, due to experimental limitations, such as tearing of the muscle fibers and the fact that forces applied by quadriceps muscle change in standing position of the human body, in several states (athletic activities, walking). Two additional limitations were the use of cadaveric specimens rather than living ones and the lack of application of forces to the patella by other surrounding tissues, which are present in vivo.

Despite the above mentioned limitations, the results of this study were in concordance with the current literature *(4,5,12)*, showing that the medial retinaculum plays an important role to the stability of the patella for the knee joint, especially in extension. This shows the importance of many methods that reinforce the medial retinaculum (plasty, plication, imbrication), combined or not with methods of relaxation of lateral retinaculum, as well as the medialisation of tibial tubercle, the change of the height of the patella (for patella alta) and the change of the depth of the groove (trochleoplasty). The present study provides further quantified results regarding the restraining role of the medial soft tissues of the patella, such as medial retinaculum.

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