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Comparison of two extensile approaches to the knee: a cadaveric study evaluating quadriceps snip and extensile medial parapatellar approach

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A B S T R A C T

Purpose: This study aimed to evaluate the mobility and excursion of the patella achieved by two different techniques for increasing exposure to the knee joint: the quadriceps snip and the extensile medial parapatellar approach.

Method: Six matched intact fresh frozen cadaveric knees were used in this study. A standard medial parapatellar approach was undertaken and the patella excursion with a constant force of 5 kg was measured based on two fixed points at 0, 45 and 90 °s of knee flexion. The left knee in the matched pair was made extensile with a quadriceps snip and the right with an extensile medial parapatellar approach. The distance and change in distance as a percentage were then recorded at 0, 45 and 90 °s of knee flexion.

Results: Both techniques increased the mobility of the patella and its excursion. Quadriceps snip was found to give an average increase in excursion of 7 mm (12% increase in excursion), while the extensile medial parapatellar approach increased the patella distance from a fixed point by 10 mm (15% increase in excursion). Maximum displacement of the patella was consistently found to occur at 5 kg. The angle of knee flexion at which the maximum excursion was achieved was variable.

Conclusion: The quadriceps snip and extensile medial parapatellar approach both provide increased mobility of the patella in the cadaveric knee. When exploring the options to increase exposure to the knee, the operating surgeon may wish to employ either the extensile medial parapatellar approach or the quadriceps snip. There may be clinical advantage in developing the plane between vastus medialis and rectus femoris, as opposed to cutting across the quadriceps tendon.

1. Introduction

Many exposures have been developed to preserve the integrity of the extensor mechanism when approaching the knee joint.[1–4] This is particularly important in arthroplasty, revision arthroplasty, trauma and tumour procedures where increased exposure is required, typically following the standard medial parapatellar approach. Increasing patella excursion while maintaining the function of the extensor mechanism is a critical step when extensile exposure is required.

Gaining further exposure and increasing the mobility of the patella can be achieved by proximal releases,[1,4] tenolysis[2] and distal tibial tuberosity osteotomies.[5,6] A balance is frequently sought between increased exposure, technical difficulty and potential complications. The quadriceps snip is often employed to gain exposure via increased patella excursion and mobility. The extensile medial parapatellar approach, using the unique landmark of the fat stripe demarcating the interval between vastus medialis and rectus femoris, has allowed surgeons at our unit to achieve sufficient exposure to the knee and increased patella mobility.

The purpose of this study was to compare and discuss the effect of the quadriceps snip technique and the extensile medial parapatellar approach for mobilising the patella, thereby increasing exposure to the knee. We used matched cadaveric models with a standard medial parapatellar approach as the control. It was hypothesised that both techniques would increase patella mobility and that one may be superior.

2. Method

Specimen Preparation: Six intact human fresh frozen cadaveric knees were used in this study. The specimens were checked by inspection, palpation and physical examination, including a Lachman test and varus/valgus stress test to detect any obvious bony deformity, previous fracture or ligamentous laxity. All specimens included in the study had no signs of previous operation and were clinically stable throughout a full range of movement. For all cadaveric specimens, a

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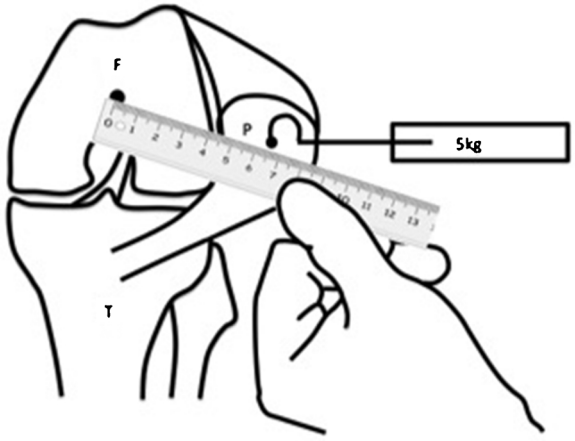

Fig. 1. F = Femur, T = Tibia, P = Patella, 5 kg traction and measure the transposition.

Fig. 2. Femoral pin placement.

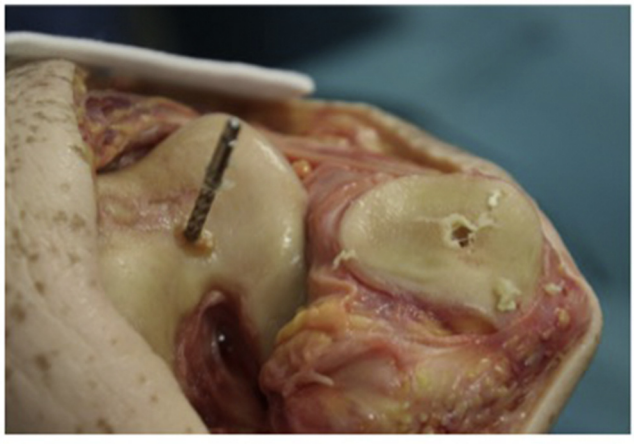

Fig. 3. Central patella drill hole to attach scale and act as a second fixed point.

standard medial parapatellar approach was undertaken as described by Hoppenfeld (3). The patella was everted in extension and then flexed to the 90 ° position. At this point two fixed points were selected for comparison of mobility (Fig. 1). The apex of the femoral notch was identified and a pin placed 10 mm proximal along Whiteside's line

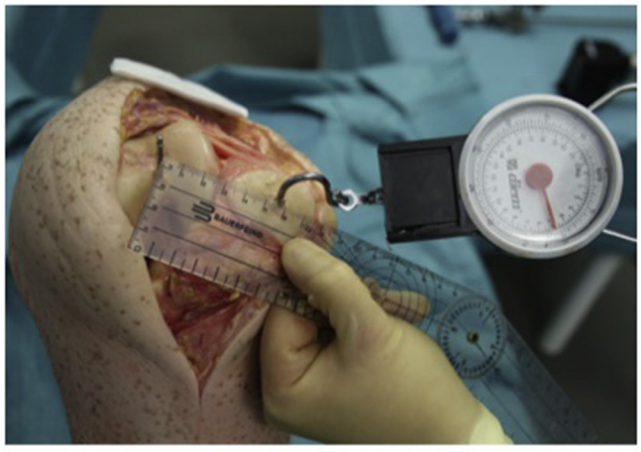

Fig. 4. 5 kg traction and measurement of distance.

(Fig. 2). A drill hole for the scale was placed in the centre of the patella (Fig. 3). These two points acted as fixed references for measuring the patella excursion.

Following the standard medial parapatellar approach to the knee, the distance between the two fixed points was measured in millimetres with traction applied at 0, 45 and 90 °s of knee flexion (Fig. 4). Constant lateral force of 5 kg was used as this was determined to be the minimum force required to achieve reasonable excursion (Fig. 6).

The left knee underwent a quadriceps snip (QS) as described by Garvin et al.[9] and the right knee underwent the extensile medial parapatellar (EMP) approach. These two techniques are illustrated on the lithographs by J. Walsh, entitled Plate xxxii (Fig. 5). Traction was added with the use of a spring scale with the loading hook in the centre of the patella. The distance between the two fixed points was then re-measured and recorded. The distance as a percentage difference compared to the standard medial parapatellar approach was calculated at 0, 45 and 90 °s of knee flexion. The amount of force applied to the patella was determined by using sequentially increasing force until a point at which no significant increase in the excursion distance was observed.

Statistical Analysis: Statistical analysis was performed using the Statistical Package for Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA). Non-parametric tests were used to assess continuous variables for significant differences between groups. A Mann Whitney U test was used to compare linear variables between groups. A p-value of < 0.05 was defined as statistically significanct A power calculation was performed. Using a Mann Whitney test, an effect size of 1.3, a power of 80% and an alpha of 0.005 it was determined that nine comparative measures would be required between the groups.

3. Results

In order to determine the appropriate amount of traction to be placed on the patella, increasing force was applied to the first cadaveric knee in the study and plotted against the measured excursion of the patella (Table 1, Fig. 6). Once 5 kg of force was applied, there was no significant increase in the excursion distance observed ($p = 0.80$) and the 5 kg force was then used as the standard for all further assessments.

The cadaver specimens were composed of two males and one female aged 73, 80 and 91 respectively. The measured patella excursion for the standard MPA and the QS or EMP approaches are recorded in Table 2.

The median excursion of the patella in the QS group after the standard MPA was 64 mm (inter quartile range (IQR) 62 to 66 mm), which significantly (difference 9, 95% confidence interval (CI) 7.8–11.8, $p < 0.001$ Mann Whitney) increased to 75 (IQR 72–77) after the QS was performed. The median excursion of the patella in the EMP group after the standard MPA was 65 mm (inter quartile range (IQR) 62

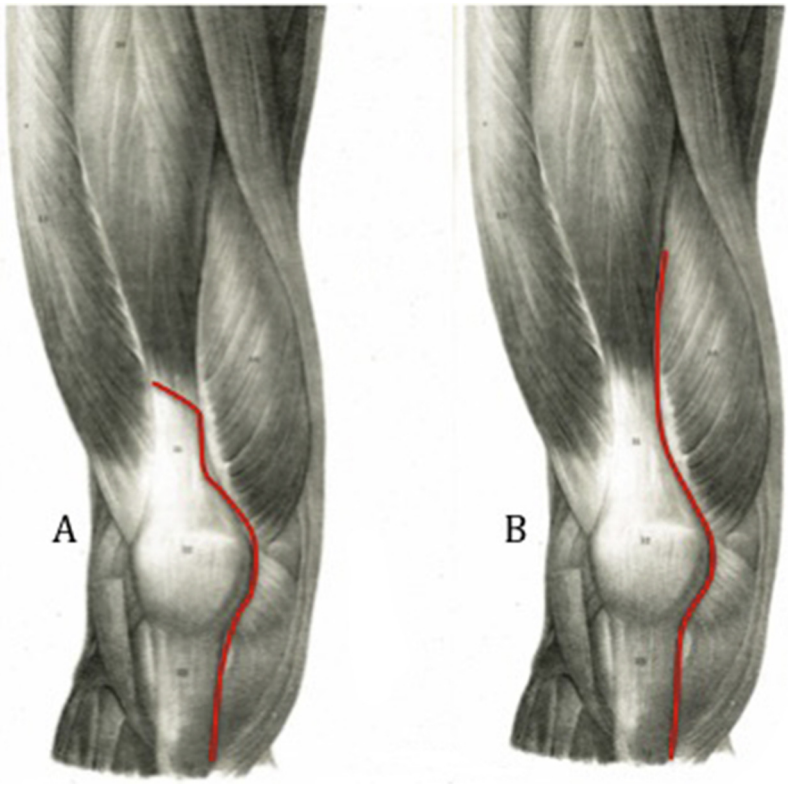

Fig. 5. Lithographs by J. Walsh, entitled Plate xxxii: A: Quadriceps snip; B: Extensile medial parapatella approach.

Table 1
Distance with increasing traction.

Traction (kg)	Distance (mm)
0	52
1	60
2	64
3	65
4	67
5	71
6	71
7	73

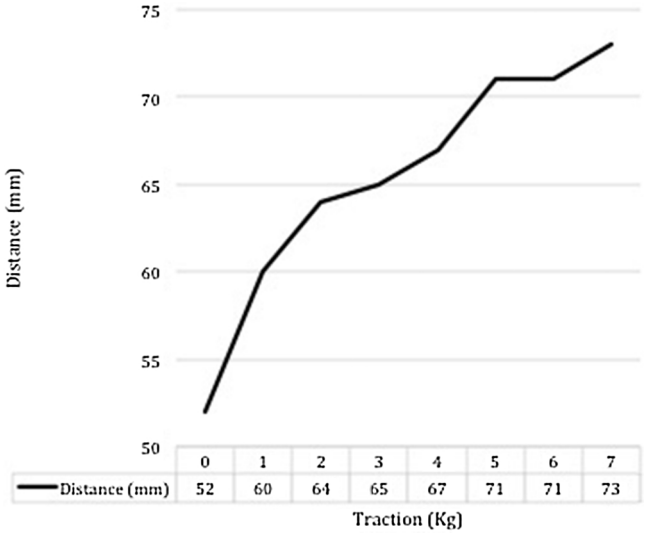

Fig. 6. Increasing force and the change in measured excursion of the patella Traction (kg)Distance (mm).

Table 2
Comparison of QS and EMP approach with MPA as control.

Flexion	MPA (mm)	QS (mm)	Change (mm)	Change (%)
Left Knee 1:				
0	70	78	8	12
45	68	74	6	9
90	71	83	12	14
Left Knee 2:				
0	62	75	13	21
45	65	76	11	17
90	64	73	9	14
Left Knee 3:				
0	65	70	5	8
45	58	63	5	9
90	62	65	3	5
Flexion	MPA mm	EMP mm	Change mm	Change %
Right Knee 1:				
0	67	75	8	12
45	64	73	9	14
90	70	80	10	14
Right Knee 2:				
0	65	73	8	12
45	65	75	10	15
90	61	70	9	15
Right Knee 3:				
0	62	78	16	26
45	64	75	11	17
90	60	67	7	12

to 69 mm), which significantly (difference 9, 95% confidence interval (CI) 5.3–10.7, $p < 0.001$ Mann Whitney) increased to 74 (IQR 72–77) after the EMP was performed. The median excursion of the patella after a standard MPA was 64 mm (inter quartile range (IQR) 62 to 66 mm) in the QS group and 65 mm (inter quartile range (IQR) 62 to 69 mm) in the EMP group, which was not significantly different (95% CI −2.9 to 4.4, $p = 0.61$ Mann Whitney). The median excursion of the patella after QS was 75 (IQR 72–77) and 74 (IQR 72–77) after the EMP was performed,

which was not significantly different (95% CI −4.2 to 6.2, p = 0.80 Mann Whitney). The average change in distance between the two-fixed points in the EMP group compared to the standard medial parapatella arthrotomy (MPA) was 10 mm (7-16 mm), which equates to an increased percentage change in distance of 15%.

The results are detailed in Table 2.

4. Discussion

Increasing patella excursion while maintaining function of the extensor mechanism is a critical step when extensile exposure of the knee is required. This study is the first to quantify excursion of the patella following either quadriceps snip or the extensile medial parapatellar approach. These results can assist surgeons when selecting proximal soft tissue extensile manoeuvres where increased exposure to the knee is required. The extensile surgical approach should aim to minimise the risk of the six most common extensor mechanism complications encountered: patellar tendon disruption, quadriceps tendon rupture, patellar crepitus and soft tissue impingement, periprosthetic patella fracture, patellofemoral instability, and osteonecrosis of the patella.[7]

Sharkey et al. described extensor mechanism tenolysis to achieve patella eversion and report adequate exposure in the majority of cases undergoing revision knee arthroplasty.[2] Coonse and Adams described the VY quadriceplasty, which provides excellent exposure.[1] Postoperative immobilisation is often required and this technique is associated with a high incidence of extensor lag.[8]

Garvin et al. introduced the quadriceps snip, a 45° angle cut in the quadriceps tendon at the proximal extent of the medial parapatella approach and in line with the fibres of vastus lateralis.[9] In their review of 16 patients, they reported no cases with extensor mechanism impairment. This is now a familiar extensile exposure technique for many surgeons when increased mobility of the patella and extensor mechanism is required. Importantly, Garvin et al. concluded that the patient's postoperative rehabilitation did not require alteration. Modification of the quadriceps snip has also been described with the orientation of the cut through the quadriceps tendon being transverse or angled 45° distally.[4]

Study limitations in this work included the use of a limited range of flexion to 90°; this was due to the fixation of the femur in the prepared specimens. The clinical relevance is that flexion beyond 90° is often attainable intra-operatively and this too may affect the patella excursion. The use of fresh frozen specimens may influence the elasticity of the structures investigated in this study; however, similar ligamentous studies have been performed using fresh frozen cadavers.

5. Conclusion

Our cadaveric study has demonstrated that both quadriceps snip and an extensile medial parapatellar approach increase the mobility and excursion of the patella. This is the first study of its kind to quantify the percentage of excursion and mobility that can be achieved when using these extensile approaches. We found no significant difference between the two techniques. We prefer the extensile medial parapatellar approach as it allows for preservation of critical tissue: the quadriceps tendon.

Conflict of interest

None.

This research represents true and honest work by the authors.

Disclaimer

None.

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