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Original Article

Effects of fat pad excision on length of the patellar tendon after total knee replacement

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ABSTRACT

Purpose: We report our results of the effect that total fat pad excision has on patellar tendon length following total knee replacement.

Method: We retrospectively reviewed radiographs of the knees of 133 patients who had Depuy LCS uncemented TKR between January 2009 to December 2009. We excluded patients who had patella resurfacing, lateral release, knee replacement for other than osteoarthritis and who had other implants used. We measured the length of the patellar tendon using the Insall-Salvati ratio. Changes in the length of the tendon were calculated both as an absolute evaluation and as a percentage of the original length.

Results: We effect of fat pad excision on patellar tendon length at 1 year and 5 years following surgery. At one year we observed no change in patellar tendon length in 81.1%, patella infera in 17.3% and patella alta in 1.6% of these 133 patients. We manage to follow up 50 of these patients at 5 years following surgery. In comparison to pre-operative length, at one year 86% showed no change, 14% had patella infera and none had patella alta. At 5 years we observed no change in 98% and patella infera in 2% of patients.

Forty nine percent of our patients with patella infera developed anterior knee pain, mean flexion in those patients was 95.625° and mean oxford score was 52.31.

Conclusions: In our patients following single implant design used patella infera developed in up to 18% at one year following surgery. Two percent of fifty patients who had five years follow up showed further shortening of patellar tendon after one year. We conclude that complete fat pad excision during total knee replacement does affect patellar tendon length.

Level of evidence IV.

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1. Introduction

Retro patellar fat pad is a mass of fibro fatty tissue located in the space between the patellar ligament and proximal tibia, it lies intra-articularly but extrasynovially. The function of retro patellar fat pad is still highly debated. It is thought to supply blood to the patella through the inferior portion of the vascular ring, which passes posterior to the patellar tendon through the fat pad. Damage to the lateral inferior genicular artery is common during fat pad excision and is thought to contribute to rendering the patella avascular.

Retro patellar fat pad excision is done in total knee replacements in order to improve access and exposure. Also some authors feel that excision of fat pad reduces incidence of anterior knee pain as the fat pad and synovial lining are sensitive to painful stimuli.

Patella infera is defined as a decrease of 10% in the length of the tendon (or as an ISR of less than 0.8). Patella infera may occur following any surgery which leads to scarification of patellar tendon which could be due to ischaemia or trauma. Theory of ischaemia is supported by Shim in his study. Shim did micro angiographic study and found numerous anastomoses between fat pad and patellar tendon.

Whether fat pad should be preserved or excised is widely debated. We retrospectively looked 133 patients radiographs and we are reporting our findings of the effect that the total fat pad excision has on length of patellar tendon.

Previous studies have given results of fat pad excision after using different implants and have also compared TKR with unicompartmental knee replacement. None of previous studies have outcome after 5 years. There are conflicting outcomes from previous studies. Some studies have shown reduction¹ but others have shown no change in patellar tendon length.²

2. Materials and methods

We retrospectively reviewed radiographs of the knees of 210 patients who had total knee replacement in our hospital between January 2009 to December 2009, 193 patients had Depuy low contact stress (LCS) uncemented total knee replacement, Seven patients were unavailable for review because of death or loss to follow-up clinical details were available for the remaining knees. **We excluded patients who had patella resurfacing, lateral release, knee replacement for other than osteoarthritis and those who had other implants used.** All our patients had patellar osteophytes removed and margins diathermised.

Out of 133 (Table 1) patients who were selected for study 56 were men and 77 were women, age range was between 42 and 90 (mean age 72.7) at the time of operation. Serial radiographs were reviewed in 133 knees at one year and 50 knees at 5 years. At 5 years follow up there were 20 men and 30 women with age range from 42 to 86 (mean age 73.1). All patients had medial Para patellar approach and fat pad was excised completely. All surgeries were performed under tourniquet and all had drain put in. Patients were operated by two senior surgeons but same technique and implants were used in all patients.

Table 1 – Details of the 133 patients.

LOPT 1 year after operation	
Total number of knees	133
Mean age at operation	72.7 (42–90)
Male	56
Female	77
Died	7
Clinical review at 5 years	50
LOPT 5 years after operation	
Clinical review at 5 years	50
Mean age at operation	73.1 (42–86)
Male	20
Female	30

All the patients were mobilised from the next day of surgery and discharged with community physiotherapy as soon as they achieve 90 degree of knee flexion and were deemed safe for discharge. Radiographic evaluations were performed pre and postoperatively, standard radiographs were taken as per protocol of radiology department by senior radiographer (AP view with film to focus distance of 100 cm from the skin and patella facing forward. Lateral radiographs were taken standing with focus to film distance of 100 cm). All patients had pre-operative and post-operative radiographs at six weeks, one year and five years.

2.1. Measurements

We measured and recorded the length of the patellar tendon on the lateral radiographs taken before and after the operation, using the Insall-Salvati ratio.³ **We also measured the diameter of femoral shaft at a point 10 cm above intercondylar fossa on each radiograph.** Measurements were done by single surgeon, paired preoperative and postoperative radiographs were evaluated simultaneously to minimise error. The same points were identified on each radiograph and measurements were made between a point on the posterior surface of patellar tendon at inferior pole of the patella to the proximal margin of tibial tuberosity.

We measured diameter of femoral shaft 10 cm above intercondylar fossa on all the films (each one separately) and did statistical analysis to ensure there was no variation in magnification between different radiographs.

In order to assess the consistency of the technique used to measure the patellar tendon, we did a repeatability study on 10 of these patients (40 X-rays). Measurements were done by same surgeon who reviewed same radiograph used the same method but at two different occasions.

Changes in the length of the tendon were calculated both as an absolute evaluation and as a percentage of the original length. Patella infera has been defined as a decrease of 10% in the length of the tendon (or as an ISR of less than 0.8)³. The same method was used as in the main study of Insall-salvati.

2.2. Statistical analysis

Statistical analysis was used to determine the effects of the fat pad excision on the length of the patellar tendon after total knee replacement, outcome after 1 year and 5 years. Linear

regression analysis of the data was performed to determine variables statistically associated with changes in the length of the patellar tendon. Statistical analysis of changes in the length of patellar tendon was made using paired T-test within groups. Statistical analysis was performed with use of R version 3.0.2 (2013-09-25) Copyright (C) 2013 The R Foundation for Statistical Computing software package. Significance was established at $p < 0.001$.

Statistical analysis was used to determine the changes in the length of the tendon and the diameter of femoral shaft before, at 1 year and 5 years after the TKR surgery-complete excision of patellar fat-in two groups (Table 1): 133 patients have been measured before the operation and 1 year after the operation (Table 2A and B), 50 patients have been measured before the operation, at 1 year after the operation and at 5 years after the operation (Table 3A).

- 1) Our statistical analysis showed no significant change in diameter of femoral shaft at any stage in our series of patients indicating that the magnification of radiograph did not change.
- 2) An estimate of accuracy of the measurements of the length of patellar tendon and of the diameter of femoral shaft was made by comparison of the length of patellar tendon and the diameter of femoral shaft on a series of ten knees re-measured on the same radiographs, using the same method, by the same operator, the percent of error being established at 0.44.

3. Results

3.1. Outcome at one year

In 133 patients the length of patellar tendon (LOPT) changed from a Preoperative mean and standard deviation 47.5 ± 5.3 points (range 36–67.6) to 1 year postoperatively mean and standard deviation 46.1 ± 5.5 points (range 32.6–63.5 points). By one year after the operation, the shortening had increased by a mean of 1.4 mm, which represents a 2.9% decrease in LOPT mean. The differences in the length of patellar tendon $t(132) = 4.1714$, $p\text{-value} = 0.00002725$ before and 1 year after the TKR surgery, complete excision of patellar fat, were significant ($p\text{-value} < 0.001$). Meanwhile, there was no statistically significant change in femoral shaft diameter ($p\text{-value} > 0.01$).

There was no change in patellar tendon length in 55.6% (74 patients), reduction in length of patellar tendon (shortening $> 5\%$) in 32.3% (43 patients) and increase in length of patellar tendon in 12.1% (16 patients) from the 133 patients group sample at 1 year after the operation.

Table 2B – The mean length (mm; SD) of the patellar tendon and diameter of femoral shaft: The proportionate change in the length of the patellar tendon at 1 Year Postoperative – 133 patients.

Patellar tendon change	Frequency (No of pts)	Percentage frequency
Shortening $> 15\%$	11	8.3%
Shortening 10–15%	12	9.0%
Shortening 5–10%	20	15.0%
No change $\pm 5\%$	74	55.6%
Lengthening 5–10%	14	10.5%
Lengthening 10–15%	1	0.8%
Lengthening $> 15\%$	1	0.8%

3.2. Outcome at one year and five years (50 patients)

We found that the variation between the Preoperative mean and the 1 year Postoperative mean of the LOPT is 3.6%, a mean decrease of 1.7 mm. At five years after TKR, the mean shortening of the patellar tendon was 2.3 mm, which represents 4.8%. Between 1 year and 5 years after the operation the patellar tendon had shortened by a mean of 0.6 mm (1.3%).

Fifty patients that had a 5 years follow-up, the length of patellar tendon (LOPT) changed from a Preoperative mean and standard deviation 47.5 ± 5.1 points (range 36–63.3) to 1 year postoperatively mean and standard deviation 45.8 ± 4.2 points (range 36.9–56.5 points) and to 5 years postoperatively mean and standard deviation 45.2 ± 4.5 points (range 33.2–58 points).

There is a strong evidence of a mean decrease in the length of patellar tendon at 1 year and 5 years postoperatively. The differences in the length of patellar tendon $t(49) = 3.8535$, $p\text{-value} = 0.0001695$ at 1 year and $t(49) = 4.1521$, $p\text{-value} = 0.00006557$ at 5 years after the TKR surgery were significant.

There was a highly significant reduction in the length of the patellar tendon after the operation at one year as well as at 5 years after the operation ($p < 0.001$).

There was no statistically significant change in femoral shaft diameter ($p\text{-value} > 0.01$).

At 1 year after the operation from the 50 patients sample (with a 5 years follow-up), 36 patients shown no change in patellar tendon length (72%), 14 patients (28%) presented a reduction in length of patellar tendon (with shortening $> 5\%$) and there were zero patients (0%) with an increase in the length. (Table 3B). The proportionate change in the length of the patellar tendon for the 50 patients sample group at 1 year after operation is shown in Fig. 1.

Table 3C shows that between 1 year and 5 years post-operative there's no change in patellar tendon length in 90%

Table 2A – The mean length (mm; SD) of the patellar tendon and diameter of femoral shaft: Preoperative and 1 Year Postoperative outcome.

133 patients	Patellar tendon length (mm; SD)	p-value	Femoral shaft diameter (mm; SD)	p-value
Preoperative	47.5 (5.3)	0.00002725	34.4 (5.7)	NS
1 year after operation	46.1 (5.5)		35.3 (5.9)	
T-test Patellar tendon	t (132) = 4.1714, p-value = 0.00002725		(p < 0.001)	

Table 3A – The mean length (mm; SD) of the patellar tendon and diameter of femoral shaft: Preoperative, 1 year and 5 years Postoperative outcome.

50 patients	Patellar tendon length (mm; SD)	p-value	Femoral shaft diameter (mm; SD)	p-value
Preoperative	47.5 (5.1)	($p < 0.001$)	36.2 (5.9)	NS
1 year Postoperative	45.8 (4.2)	0.0001695	36.4 (5.8)	
5 years Postoperative	45.2 (4.5)	0.00006557	36.0 (5.6)	
T-test -Patellar tendon-1 Yr after op	$t(49) = 3.8535$, $p\text{-value} = 0.0001695$		$(p < 0.001)$	
T-test -Patellar tendon-5 Yrs after op	$t(49) = 4.1521$, $p\text{-value} = 0.00006557$		$(p < 0.001)$	

Table 3B – The mean length (mm; SD) of the patellar tendon and diameter of femoral shaft: The proportionate change in the length of the patellar tendon at 1 Year Postoperative in 50 patients group (with a 5 years follow-up).

Patellar tendon change	Frequency (No of pts)	Percentage frequency
Shortening >15%	4	8%
Shortening 10–15%	3	6%
Shortening 5–10%	7	14%
No change $\pm 5\%$	36	72%
Lengthening 5–10%	0	0%
Lengthening 10–15%	0	0%
Lengthening >15%	0	0%

Table 3C – The mean length (mm; SD) of the patellar tendon and diameter of femoral shaft: The proportionate change in the length of the patellar tendon between 1 Year and 5 Years Postoperative – 50 patients.

Patellar tendon change	Frequency (No of pts)	Percentage frequency
Shortening >15%	0	0%
Shortening 10–15%	1	2%
Shortening 5–10%	3	6%
No change $\pm 5\%$	45	90%
Lengthening 5–10%	1	2%
Lengthening 10–15%	0	0%
Lengthening >15%	0	0%

(45 patients), reduction in length (shortening >5%) in 8% (4 patients) and increase in length in 2% (1 patient) from the 50 patients group sample. Fig. 2 shows the proportionate change in the length of the patellar tendon between 1 Year and 5 years postoperative for the 50 patients sample.

4. Discussion

Whether the retro patellar fat pad should be retained or excised is widely debated. There are conflicting results from

previous studies of an effect of fat pad excision on patellar tendon length after total knee replacement. The length of the patellar tendon has a profound effect on the mechanics of the patellofemoral joint. Patellofemoral contact force changes by 3% per millimetre of alteration in length of the tendon. (Bryan in his study has concluded that excision of intra-articular structures such as the infrapatellar fat pad creates dead space that can fill with fibrous tissue which can be source of pain and stiffness, more so important after immobilisation) (see Fig. 3).

The largest series has been reported by Meneghini et al¹² who observed decrease in patellar tendon length occurred in

Fig. 1 – The proportionate change in the length of the patellar tendon –1 Year after operation – 50 patients.

Fig. 2 – The proportionate change in the length of the patellar tendon between 1 Year and 5 years Postoperative – 50 patients.

48% of the knees at one year. Lemon et al¹ showed significant shortening of patellar tendon in fat pad excised group and no change in fat pad preservation group at three years. In a series of 94 TKRs performed for both osteoarthritis and rheumatoid

disease, Koshino et al⁹ observed progressive shortening of patellar tendon at an average of 2.6 years after total knee replacement. Tanaka N⁴ et al showed an increase in pain and shortening of patellar tendon length, limited knee range of

Fig. 3 – Length of patellar tendon (LOPT) Preoperative vs. Length of patellar tendon (LOPT) at 1 year after operation (133 patients). Scatter plot of the length of patellar tendon Preoperative vs. length of patellar tendon (LOPT) at 1 year after operation with a linear regression line. The size of the plot marker (circle) indicates the number of patients. The horizontal and vertical Histograms show the distribution of the length of patellar tendon preoperative and 1 year postoperative respectively.

movement and slight quadriceps weakening in 54 patients with RA who had fat pad resection as compared to 54 patients whose fat pad was retained (see Fig. 4).

Floren et al.⁵ found an incidence of 37% patella infera after a standard TKA as compared with 12% after a MIS-TKA in which the patella was not everted and only partial excision of the fat pad was done. This reduced incidence of patella infera after a less invasive approach, in which the patella is only displaced and not everted, was also associated with a better functional outcome, less pain, and better range of motion. Patella infera after TKA has been reported in 10%–65% of cases and has been linked to patellar eversion, radical excision of the fat pad, and lateral release.^{5,6} In a prospective randomized controlled trial of 84 patients who had either TKA or UKA,⁷ Weale et al reported 34% (14 of 41) of the TKA group developed patella infera, defined as 10% or more shortening of the patellar tendon postoperatively, compared with 5% (two of 43) in the UKA group. None of the above studies have reported an effect of fat pad excision on patellar tendon height five years following total knee replacement (see Fig. 5).

We analysed effect of fat pad excision on patellar tendon length pre operatively, at 1 year and 5 years following surgery. At one year we observed no change in patellar tendon length in 55.6% (74 patients), reduction in 32.3% (43 patients) and increase in 12.1% (16 patients) of these 133 patients. We manage to follow up 50 of these and at one year 72% (36

patients) showed no change, 28% (14 patients) had reduction in length and none of them had increase.

From one to five years we observed no change in patellar tendon length in 90%, shortening in 8% and lengthening in 2%. In our study 12.1% (16 patients) had lengthening of patellar tendon at one year, we do not have explanation for this change. Looking back at literature there are other papers^{8,9} in which lengthening has been reported but they did not have any satisfactory explanation for this. It is thought that due to preoperative pain and disability resulting from degenerative process, there was already shortening of patellar tendon which was corrected when function improved after operation (see Fig. 6).

We manage to follow up patients who had patella infera (defined as > 10% shortening) and studied functional outcome (Oxford knee score), knee range of movement and pain. Forty nine percent of our patients with patella infera developed anterior knee pain, mean flexion in those patients was 95.625 and mean oxford score was 52.31.

Whether fat pad should be excised or not is debatable but in our study group patella infera developed in 18% of patients and 49% of those who had patella infera did have anterior knee pain.

The strength of our work is the detailed analytical study at 1 year and 5 years, single implant used and similar technique used in all the patients. Whilst other studies have reported outcome of only up to 3 years following surgery, they have

Fig. 4 – Length of patellar tendon (LOPT) Preoperative vs. Length of patellar tendon (LOPT) at 1 year after operation for the 50 patients with a 5 years follow-up. Scatter plot of the length of patellar tendon Preoperative vs. length of patellar tendon (LOPT) at 1 year after operation with a linear regression line for the 50 patients with a 5 years follow-up. The size of the plot marker (circle) indicates the number of patients. The horizontal and vertical Histograms show the distribution of the length of patellar tendon preoperative and 1 year postoperative respectively.

Fig. 5 – Diameter of Femoral Shaft Preoperative vs. Diameter of Femoral Shaft Postoperative. Scatter plot of the Diameter of Femoral Shaft Preoperative vs. Diameter of Femoral Shaft Postoperative with a linear regression line. The size of the plot marker (circle) indicates the number of patients. The horizontal and vertical Histograms show the distribution of the Diameter of Femoral Shaft Preoperative vs. Diameter of Femoral Shaft Postoperative respectively. An estimate of accuracy of the measurements of the length of patellar tendon and of the diameter of femoral shaft was made by comparison of the length of patellar tendon and the diameter of femoral shaft on a series of ten knees re-measured on the same radiographs, using the same method, by the same operator, the percent of error being established at 0.44.

Fig. 6 – Length of patellar tendon (LOPT) at 1 year vs. Length of patellar tendon (LOPT) at 5 years after operation. Scatter plot of the length of patellar tendon (LOPT) at 1 year vs. length of patellar tendon (LOPT) at 5 years after operation with a linear regression line. The size of the plot marker (circle) indicates the number of patients. The horizontal and vertical Histograms show the distribution of the length of patellar tendon (LOPT) at 1 year and 5 years postoperative respectively.

published outcome after using different implants or they have compared TKR with UKR or MIS-TKA. Limitations of our study are that this is a retrospective study and Insall-Salvati ratio may be affected by changes in patellar morphology due to resection of a part of the proximal or distal pole of the patella at the time of surgery

Conflicts of interest

The authors have none to declare.

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