

Original Research Article

Influence of prosthetic joint line position on outcome after total knee replacement

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ABSTRACT

Background: The current study had been designed so as to assess whether joint line elevation and change in patellar tendon length influences knee flexion after primary cruciate retaining TKR.

Methods: This prospective study involved patients with advanced degenerative joint disease involving one or both knees who presented to the outpatient department of a tertiary care hospital. Exclusion criteria were any prior knee surgery. Surgery was performed under tourniquet with standard medial para-patellar arthrotomy to expose all our knees. In the study radiological assessment was done by true lateral X-ray view of knee in 30 degree of flexion. We choose Caton-Deschamps indices (CI) for diagnosis of post TKR patella infera and joint line elevation. CI<0.6 was defined as patella infera (normal range of CI 0.60-1.45). After all data collection comparison was done between joint line elevation versus without joint line elevation patients (with/without patellar tendon shortening) range of movement.

Results: Total of 100 patients (72 females and 28 males) with 176 knees (bilateral=76, unilateral=24) who fulfilled the above said criteria involved in study. The mean age of the patients at the time of surgery was 64.4 years with range of 54 years to 80 years. The average follow up of 24 months, with minimum follow up of 18 months. Average range of motion (ROM) in NO Joint line elevation/patella tendon shortening patient measured 107.2°, and joint line elevation with patellar tendon shortening (prior patella infera) and joint line elevation without patella tendon shortening (prior patella infera) patient average ROM was measured 86.7 and 87.8 degree respectively.

Conclusions: In our study patellar tendon shortening and joint line elevation reduces ROM knee. Mechanical factors also explain the association between joint line elevation and patellar tendon length with range of motion. Reduction in length of extensor apparatus reduces the range of flexion.

Keywords: Patella tendon length, Patella infera, Total knee replacement, Total knee arthroplasty, Pseudo-patella infera, Jointline elevation

INTRODUCTION

Range of motion is an important measure of outcome of total knee arthroplasty (TKA), and is an important part of most knee scoring systems. Many factors affect the flexion range achieved after total knee arthroplasty such as preoperative deformity, rheumatoid or osteoarthritis,

range of motion, surgical technique, prosthetic design and rehabilitation. In surgical techniques several factor have been found to be important. These include the tightness of the retained posterior cruciate ligament, the elevation of the joint line (pseudo patella infera), increased patellar thickness, and a trapezoidal flexion gap. Joint line elevation causes relative patellar tendon shortening,

which is one of cause of patella infera. Reduction of patellar tendon length (normally 5 cm) leads to patella infera. So patella infera is described as reduction of distance between the patella and tibia. Patella infera can be divided into congenital, acquired or combination of both. Congenital is present at early age. Acquired patella infera as a result of true patella tendon shortening or pseudopatellar tendon shortening (pseudo patella infera). True patella inferais caused by scarring and arthrofibrosis due to RTA and surgical trauma during high tibial osteotomy, ACL reconstruction.¹⁻⁶

Pseudo-patella infera (Prosthetic joint line elevation) described as reduction of distance between patella and tibia without shortening of the patella tendon, commonly occurs following TKR. About 25 to 30% of TKRs may develop patella infera.⁷

The current study was designed so as to assess whether jointline elevation and change in patellar tendon length influences knee flexion after primary cruciate retaining TKR.

METHODS

This prospective study involved patients with advanced degenerative joint disease involving one or both knees who presented to the outpatient department of a tertiary care hospital at Indore, M.P. from January 2014 to June 2014. Exclusion criteria were any prior knee surgery. Surgery was performed under tourniquet with standard medial para-patellar arthrotomy to expose all our knees. The tibia was subluxated anteriorly and the infra-patellar fat pad was saved and patella tendon not exposed in any case. The patella was not routinely everted but retracted laterally for exposure for femoral preparation. Extension and flexion gap was balanced in extension and flexion by soft tissue release. The tourniquet was inflated during full surgical process. In all patients posterior cruciate retaining Nexgen CR knees were used. We did not perform patellar resurfacing in any of our patients, only patellar cheilectomy was done.



Figure 1: Insall-Salvati index ratio (ISR): The ratio of the length of inferior patellar tendon (LP) to the longest (diagonal) length of patella (P).



Figure 2: Blackburn-peel index (BPI): The distance from the border of the patellar articular surface to tibio-femoral joint line (1) divided by length of patellar articular surface (2).

In the study radiological assessment was done by true lateral X-ray view of knee in 30 degree of flexion and ensures that there was no variation in magnification. Radiographs were obtained 100 cm from the film and positioned and centered perpendicular to the knee joint. We choose Caton-Deschamps indices (CI) (Figure 3) for diagnosis of post TKR patella infera and joint line elevation. $CI < 0.6$ was defined as patella infera (normal range of CI 0.60-1.45). After all data collection comparison was done between joint line elevation versus without joint line elevation patients (with/without patellar tendon shortening) range of movement.



Figure 3: Caton-Deschamps index (CI): distance from inferior border of patella articular surface to tibial plateaeu (1) divided by length of articular surface of patella (2).

RESULTS

Total of 100 patients (72 females and 28 males) with 176 knees (bilateral=76, unilateral=24) who fulfilled the above said criteria involved in study (Table 1). The mean age of the patients at the time of surgery was 64.4 years

with range of 54 years to 80 years. The average follow up of 24 months, with minimum follow up of 18 months.

Out of 176 knees included into our study, 130 knees (73.86%) showed no joint line elevation and no patellar tendon shortening; 2 (1.14%) knees showed joint line elevation with patellar tendon shortening (pre TKR patella infera); 9 (5.11%) knees showed joint line elevation with no patellar tendon shortening (pre TKR patella infera); 35 (19.88%) knees had joint line elevation

without patella tendon shortening (pre TKR normal). Average range of motion (ROM) in NO Joint line elevation/patella tendon shortening patient measured 107.2 degree, and joint line elevation with patellar tendon shortening (prior Patella infera) and joint line elevation without patella tendon shortening (prior Patella infera) patient average ROM was measured 86.7 and 87.8 degree respectively. And joint line elevation without patella tendon shortening (prior normal knee) patient ROM was measured 88.9 degree (Table 2).

Table 1: Demographic and clinical characteristics of study participants [n=100].

Characteristics	N (%) or mean±SD
Male	28 [28]
Female	72 [72]
M/F ratio	0.38:1
Age (years)	64.4±11.5
BMI measured, (kg/m ²)	28.28±5.98
Bilateral knee joint involvement	76 [76]
Unilateral knee joint involvement	24 [24]

Table 2: Incidence and pre-op and post-op range of motion in different groups of patients [n=176].

	Incidence % (n)	Pre-op ROM (mean in degrees)	Post-op ROM (mean in degrees)
Incidence of no joint line elevation with no patellar tendon shortening (pre TKR normal)	73.86 (130)	99.8	107.2
Incidence of joint line elevation with patellar tendon shortening (pre TKR patella infera patient)	1.14 (2)	96.2	86.5
Incidence of joint line elevation with no patellar tendon shortening (pre TKR patella infera present)	5.11 (9)	96.6	87.8
Incidence of joint line elevation without patellar tendon shortening (pre TKR normal)	19.88 (35)	100.6	88.9

DISCUSSION

Patellar location is important for TKR outcome. It affects patella-femoral function. Any abnormality in patellar positioning cause anterior knee pain and decreased ROM of TKR knee. Unnoticed prosthetic joint line elevation can lead to decreased range of motion (ROM), decreased lever arm, extensor lag, impingement of the patella against the tibial polyethylene or tibial plate, anterior knee pain, increased energy expenditure, and rupture of the patellar or quadriceps tendons.^{2,3,8-16}

Patellar height is one of the important parameter in assessing patellar stability.¹⁷ Its importance has been reflected through attempts by renowned scientists to measure the patellar height by such an index which is simple, accurate, practical and also reproducible. As a result, several radiological indices have been used to measure the height of the patella of which "IS Index" is the most popularly used method so far, as it fulfills all the above criteria.¹⁸ Insall and Salvati (Figure 1) introduced this index from lateral view X-ray film of knee joint taken at 30° angle of flexion.¹⁷ "IS index" is the ratio of

LT and LP where LT indicates length of distal part of tendon of quadriceps femoris (i.e., ligamentum patellae) extending from distal pole of patella to tibial tuberosity and LP means diagonal length of Patella.¹⁹

Thornton-Bott et al study done on 506 patients underwent 526 Kinemax TKAs, performed by 7 surgeons in 5 centres between 1999 and 2002 with minimal follow-up of 12 months.¹⁶ Results are TKR creates pseudo-patella infera in 26.7% cases, Pseudo patellar infera incidence increases with extent of soft tissue release, incidence of pseudo patellar infera increased with increase in insert thickness. They divided patients in 3 groups minimal, moderate and extensive releases. 47% of extensive release group patient had pseudo-patella infera as compared to 21% to 22% of minimal and moderate release group patient had pseudo-patella infera. Pseudo-patella infera patient further divided into small inserts (approx. 8 mm), moderate inserts (approx. 10 to 12 mm) and large inserts (approx. 15 to 22 mm). They found 25% of patient with small to moderate inserts developed pseudo-patella infera as compared to 45% to 46% of

patients with large inserts, but no detrimental outcomes found in Pseudo-patella infera patients.¹⁶

Schwab et al retrospectively studied the results of reconstruction with use of a rotating-hinge endoprosthesis for distal femoral tumor in 43 patients.¹⁹ Follow up done for clinically and radiographically for a minimum of 48 months or until death; patella baja occurred in 9 of their patients. Patella baja is relatively common complication of distal femoral replacement, which has negative impact on knee ROM. Normal jointline is necessary to maintain proper function of patella-femoral biomechanics.^{19,20}

Kazemi et al study done in 2010, on 60 patients (with prior patella baja patient exclusion) shows 43 had no joint line elevation or patellar tendon shortening.²¹ Divided patients into 3 groups- Group A had no patella baja or pseudo-patella baja, Group B had pseudo-patella baja and Group C had patella baja and pseudo-patella baja patients. 15 patients demonstrated joint line elevation, and both patella baja and pseudo-patella baja were present in 2 patients. KSS was lower in patients who had joint line elevation and patients having both patella baja and pseudo-patella baja as compared to those who had no joint line elevation and patella tendon shortening patients but this difference is not significant. And Range of motion is more in no patella infera and pseudo-patella infera patient group as compared to others. Group A (N=43) average range of motion were 96 and 98.7 degrees pre op and postop respectively. Group B (N=15) average range of motion were 102 and 90.66 degree pre op and post op respectively. Group C (N=2) average range of motion were 104 and 92.5 degree pre-op and post-op respectively.²¹

In this study we choose Caton-Deschamps indices for diagnosis of post TKR patella infera. $ISR < 0.8$, $BPI < 0.54$, $CI < 0.6$ was defined as patella infera (normal range $ISR 0.83 - 1.39$, $BPI 0.60 - 1.23$, $CI 0.60 - 1.45$). Insall-Salvati ratio is not appropriate as prosthetic joint line elevation cannot be assessed and Caton-Deschamps (as compared to Blackburne-peel indice) was the one that showed greatest concordance in the study by Seil et al.¹⁹

In our study patellar tendon shortening and joint line elevation reduces ROM knee. Mechanical factors also explain the association between joint line elevation and patellar tendon length with range of motion. Reduction in length of extensor apparatus reduces the range of flexion. When there is short patellar tendon, it contacts the femur at a smaller angle of flexion as compared to normal patellar length. We offer several explanations for our results, patella infera can be a result of higher femoral cut, tibial undercut where tibial prosthesis plus insert are thicker than resected tibia and excessive soft tissue release mainly lateral retinaculum release results in thicker tibial insert. Change in prosthetic joint line without patellar tendon length shortening causes decrease in ROM of knee, impingement of patella on tibial height and wear of polyethylene.^{2,10}

Causes for patellar tendon shortening and joint line elevation are different. Incidence can be reduced with proper attention and planning of each deformity. Joint line elevation incidence can be reduced by proper preoperative planning that includes radiographic evaluation, clinical evaluation, Implant design choice, operative technique, adequate soft tissue release and bony cuts, Intraoperative precaution for patella tracking and position, surgery timing (before severe deformity develop).²²

Future studies will require larger cohorts and a more robust method of measuring the joint line such as CT or MRI. Although stiffness is a common problem after total knee replacement (TKR), it is a difficult and multifactorial complication for the patient and physician. A stiff TKR can be defined as a flexion less than 90° and/or a flexion contracture more than 10°, while a severe stiffness is defined as less than 70° of ROM. Identifying the cause(s) of a postoperative stiff TKR is generally challenging but essential, as it largely determines the method of treatment and prognosis. While preoperative limited ROM is the most important risk factor for postoperative stiffness, surgical errors remain the most frequent cause.^{23,24}

CONCLUSION

Patellar location is important for TKR outcome. It affects patella-femoral function. Clearly there are many factors affecting the outcome of TKR, of which change in the joint line is just one. In our study patellar tendon shortening and joint line elevation reduces ROM knee. Out of 176 knees included into our study, 130 knees (73.86%) showed no joint line elevation and no patellar tendon shortening; 2 (1.14%) knees showed joint line elevation with patellar tendon shortening (pre TKR patella infera); 9 (5.11%) knees showed joint line elevation with no patellar tendon shortening (pre TKR patella infera); 35 (19.88%) knees had joint line elevation without patella tendon shortening (pre TKR normal). Although the current study showed that restoring the joint line had a positive impact on the post-operative ROM and kneeling ability, the numbers involved were small and a larger prospective study is needed. Kneeling ability can be affected by many factors. Further studies are necessary to investigate this complex function of the knee joint.

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