International Journal of Research in Orthopaedics
Kanugula SK et al. Int J Res Orthop. 2020 May;6(3):487-491
http://www.ijoro.org

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20201018

Original Research Article

Influence of posterior tibial slope on knee flexion in posterior stabilized fixed bearing primary total knee arthroplasty

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Received: 10 February 2020
Accepted: 26 February 2020

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ABSTRACT

Background: The goal of total knee arthroplasty (TKA) is to relieve pain and maintain stable range of motion (ROM) for day to day activities. Among the various factors, posterior tibial slope slope (PTS) may play an important role in achieving good postoperative knee flexion. Our study aims to know the effectiveness of PTS on the ROM of the knee in a posterior cruciate ligament (PCL)-substituting TKA.
Methods: A total of 125 unilateral PCL-substituting TKA's were included in the study. Based on postoperative PTA which was measured on lateral radiograph, patients were divided into 3 groups, Group A (PTS of ≤2) comprise of 24 patients. Group B consists of 91 patients (PTS of 3 to 7). Group C includes 10 patients (PTS of 8 or more). Functional outcome was measured by using knee society score (KSS) and Western Ontario and McMaster Universities osteoarthritis index (WOMAC) which were evaluated preoperatively and at 18months post operatively.
Results: Mean postop ROM was 92.91 ± 10.632; 107.24±10.905; 107.49±13.944 in group A, B, C respectively which was significantly related to mean postop PTS (0.74; 5.62; 9.87 in group A, B, C respectively) (P<0.05). Functional outcome was measured by KSS and WOMAC which showed no significant difference pre and postoperatively.
Conclusions: The results of our study validate the hypothesis that a positive correlation exists between the postoperative flexion and PTS in the PCL-substituting TKA, an increase in PTS can lead to a greater degree of the knee flexion for every extra degree of PTS.

Keywords: Total knee arthroplasty, Range of motion, Posterior tibial slope, PCL-substituting TKA

INTRODUCTION

The goal of total knee arthroplasty (TKA) is to relieve pain and maintain stable range of motion (ROM). TKA is a successful procedure for patients suffering from advanced arthritis. It helps to improve the ability to perform daily activities like standing, walking and climbing stairs which enhances patient satisfaction.[1-3] Factors that influence ROM after TKA include Body mass index (BMI), preoperative ROM, intraoperative soft tissue balancing, posterior femoral condylar offset (PFCO), posterior tibial slope (PTS), implant design and physiotherapy.[4-18] Among the various surgical factors PTS plays an important role in achieving good postoperative knee flexion. Patients with more PTS have the tendency to flex better than knees with little or no tibial slope.[19,20] Our study aims to know the effectiveness of PTS on knee ROM in a posterior cruciate ligament (PCL)-substituting TKA.

METHODS

This is a prospective study that was carried out in BIRRD (T) Hospital, Tirupati, Andhra Pradesh, India between March 2018 to December 2019. Patients were followed up to 18 months. A total of 140 unilateral TKA's were operated during the study period. In all the patients DePuy

PFC Sigma posterior stabilized prosthesis was implanted. Based on postoperative PTS which was measured on lateral radiograph of the knee, patients were divided into 3 groups. Group A (PTS of ≤2) comprise of 26 patients of which 2 patients were lost to follow up. Group B consists of 103 patients (PTS of 3 to 7) of which 12 patients were lost to follow up. Group C includes 11 patients (PTS of 8 or more) of which 1 patient were lost to follow up. At final follow up (18 months) a total of 125 patients were analysed.

Inclusion criteria

Patients with primary osteoarthritis. Patients age between 40 and 80 years. Minimum follow up of 18 months at the time of evaluation.

Exclusion criteria

Patients who underwent high tibial osteotomy, patients with posttraumatic and Inflammatory arthritis, revision total knee arthroplasty and patients who did not give consent for surgery were excluded.

TKA was performed by one of the four surgeons using DePuy PFC sigma posterior-stabilised fixed-bearing implants. After tourniquet inflated all knees exposed with standard medial parapatellar approach. Patella everted, partial fat pad excision done for better visualization of lateral tibial plateau. Proximal tibial cut with 3^0 or 5^0 PTS was performed perpendicular to tibial mechanical axis. Some surgeons preferred 3^0 and the other 5^0 PTS. Distal femoral cuts with 5^0 valgus and posterior femoral cut was performed in 3^0 external rotation with respective to posterior femoral condyles. Patelloplasty was done in all patients. Checked for patellar tracking, if patella maltracking occur then a lateral retinacular release is performed at least 2 cm lateral to the border of the patella. cementing of the femoral and tibial components was done. Wound closed in layers in $40\text{-}50^0$ of knee flexion over suction drain. Patient was mobilized on 1st post op day. Radiographs of both weight bearing antero-posterior and lateral views were taken. The tibial slope was recorded as an angle between the line perpendicular to the tibial longitudinal axis and the line drawn along the superior margin of the proximal tibia or tibial base plate (Figure 1).[16] Standard postoperative physiotherapy protocol was followed for every patient. Knee ROM measured in degrees by one degree increment goniometer. Functional outcome was measured by using knee society score (KSS) and Western Ontario and McMaster Universities osteoarthritis index (WOMAC) which were evaluated preoperatively and at 18 months postoperatively.[21,22]

Statistical analysis

Analysis was done using SPSS 21 software. Descriptive statistics (mean, standard deviation and proportions) were used to summarize the study variables. The 95% confidence intervals for difference of mean were used. The comparison between three groups regarding PTS, ROM and outcome of our study was done using ANOVA test was used, $p<0.05$ was considered to be statistically significant.

RESULTS

During our study period a total of 140 patients were operated. Group A (PTS of ≤2) comprise of 26 patients of which 2 patients were lost to follow up. Group B consists of 103 patients (PTS of 3 to 7) of which 12 patients were lost to follow up. Group C includes 11 patients (PTS of 8 or more) of which 1 patient were lost to follow up. At final follow up a total of 125 patients were analysed. Table 1 shows demographic data which had no significant difference among the groups ($p>0.05$).

Figure 1: Preoperative and postoperative radiographs showing posterior tibial slope.

Table 1: Demographic data.

Demographic variables	PS			F value (p value)	Significance
	Group A	Group B	Group C		
Age	62.38±7.966	61.70±8.712	65.80± .957	1.067 (p=0.347)	P>0.05
Gender (male/female)	17/7	42/49	5/5	4.636 (p=0.098)	P>0.05
BMI	26.66±1814	27.41±2.661	27.56±3.269	0.885 (0.415)	P>0.05

Table 2: WOMAC and KSS in both groups.

Mean values	PS			F value (p value)	Significance
	Group A (n=24)	Group B (n=91)	Group C (n=10)		
Pre op WOMAC	66.90±5.840	71.03±8.349	68.29±6.388	2.928 (0.057)	P>0.05
Post op WOMAC	30.58±3.944	29.60±5.168	29.87±4.153	0.321 (0.726)	P>0.05
Pre op KSS	26.90±10.64	27.38±9.577	27.00±9.953	0.015 (0.985)	P>0.05
Post op KSS	158.90±17.23	168.50± 12.353	165.24±11.55	2.199 (0.115)	P>0.05

Table 3: Posterior tibial slope (PTS) and range of motion (ROM).

Mean values	PS			F value (p value)	Significance
	Group A (n=24)	Group B (n=91)	Group C (n=10)		
Pre op PTS	9.67	8.74	9.12	2.958 (0.055)	P>0.05
Pre ROM	87.0±17.512	88.7±10.347	87.91±11.597	0.1944 (0.824)	P>0.05

Table 4: Posterior tibial slope (PTS) and range of motion (ROM).

Mean values	PS			F value (p value)	Significance
	Group A (n=24)	Group B (n=91)	Group C (n=10)		
Post op PTS	0.74	5.62	9.87	3.553 (0.032)	*P<0.05
Post ROM	92.91±10.632	107.24±10.905	107.49±13.944	16.187 (0.0001)	**P<0.001

* Significant; **Highly Significant.

Functional outcome was measured by KSS and WOMAC which had shown no significant difference pre and postoperatively (Table 2). Mean pre-operative PTS was 9.67; 8.74; 9.12 in group A, B, C respectively. Mean pre-operative ROM was 87.05±17.512; 88.75±10.347; 87.91± 11.597 in group A, B, C respectively. Both pre-operative PTS and pre-operative ROM had no statistically significant difference between the groups (p>0.05) (Table 3). Mean post-operative ROM was 92.91±10.632; 107.24±10.905; 107.49±13.944 in group A, B, C respectively which was significantly related to mean post-operative PTS (0.74; 5.62; 9.87 in group A, B, C respectively) (p<0.05).

DISCUSSION

TKA is one of the most successful surgical procedure with over 90% survival rate at 10-15 year.[23-26] ROM after TKA is essential factor for patient satisfaction. There are many factors which influence postoperative ROM among which PTS plays an important role in achieving good postoperative knee flexion.[19,20] Patients with more PTS have the tendency to flex better than knees with little or no PTS but most published clinical studies have failed to show an effect of tibial slope on maximal flexion.[27-30] Kansara et al concluded that there was no significant difference in the postoperative ROM between the knees with 0^0 and 5^0 of PTS after PCL-sacrificing TKA.[16,17] Bauer et al reported that the correlation between PTS and maximal knee flexion that was observed after PCL-retaining TKA was not noted after PCL-sacrificing TKA.[15] Walker et al, in a computer modelling study, studied the effects of a 10^0 posterior tilt, neutral tilt, and a 10^0 anterior tilt and were compared. They concluded that a 10^0 posterior tilt produced no less than 30^0 of additional flexion when compared with the neutral tilt and anterior tilt had the opposite effect.[20] Bellemans et al reported that an increase in 1^0 PTS leads to mean increase of knee flexion by 1.7^0 after PCL-retaining TKA based on evaluation of knees with 0^0, 4^0, and 7^0 PTS.[2] Malviya et al observed that an increase of 1^0 of PTS had increased the flexion angle by an average of 2.3^0 in 101 knees after PCL-retaining TKA.[31] Kim et al observed statistically significant positive correlation between PTS and maximal flexion angle after PCL-sacrificing TKA using a medial pivot implant. They also stated that, understanding the design characteristics of the PCL-sacrificing medial pivot knee system that has a larger contact area in the medial compartment compared to the PCL-substituting knee implants could contribute to the correlation between PTS and flexion range.[3] Catani et al. found a significant correlation between the tibial slope and flexion in an in vivo video-fluoroscopic study on the knee kinematics of the PCL-substituting TKA implants.[32] Shi et al stated that the PTS is positively correlated with the postoperative maximal knee flexion (r=0.681). Increasing the tibial slope by 1^0 in the posterior-stabilized TKA can increase the maximal knee flexion by an average of 1.8^0. In addition, if the flexion and extension gap are symmetrical and well balanced during the surgery, the tibial slope does not affect the joint stability even though the posterior slope exceeds10^0.[33] In our study flexion angle of the knee after PCL-substituting TKA was correlated with PTS. There was improvement in postoperative ROM in all the patients. Postoperative ROM was more in the group with higher PTS (p<0.001). Therefore, we conclude that PTS is one of the surgeons factor that influences flexion angle after PCL-substituting TKA. Limitations in our study are cases operated by multiple surgeons, the lack of comparison with other implants, the possibility of error in

measurement of the maximal flexion angle, intraoperative factors like soft tissue balancing were not considered.

CONCLUSION

The results of our study validate the hypothesis that a positive correlation exists between the post-operative flexion and the PTS in the PCL-substituting TKA, an increase in PTS can lead to a greater degree of the knee flexion for every extra degree of PTS.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Kanugula SK, Rathod M, Venugopal SM, Lebaku MB. Influence of posterior tibial slope on knee flexion in posterior stabilized fixed bearing primary total knee arthroplasty. Int J Res Orthop 2020;6:487-91.