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Original Research Article

Effect of posterior femoral condylar offset (PCO) on clinical results of multi-radius (MR) femoral design implant/component in posterior stabilized total knee arthroplasty (PS TKA)

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ABSTRACT

Background: When a posterior condylar offset (PCO) is properly reconstructed in a Total Knee Arthroplasty (TKA), a larger posterior clearance can be achieved, which helps delay impingement posteriorly and maximizes the range of flexion (ROF). This study was conducted to investigate the effect of PCO on clinical outcomes using Multi-radius (MR) femoral design components in PS TKA.

Materials and Methods: This hospital-based prospective observational study was conducted between January 1, 2018, and December 31, 2018, with a 6-month follow-up. A total of fifty patients were operated on with a MR PS design. The PCO, flexion, and knee society scoring (KSS) system were measured preoperatively and postoperatively.

Results: The average age of the patients was 66.8 (range 58.3 to 75.3) years. The average preoperative and postoperative PCO was 27.5 (range 25.3 to 29.7) and 29.2 (range 26.2 to 32.2) mm, respectively. The average preoperative and postoperative non-weight-bearing flexion was 106.5 (range 93.7 to 119.3) and 119.9 (range 116.6 to 123.2) degrees, respectively. The average preoperative and postoperative weight-bearing flexion was 96.7 (range 86.6 to 106.8) and 123.6 (range 120.7 to 126.5) degrees, respectively. The average preoperative KSS knee score was 55.9 (range 52.6 to 59.2), and the average preoperative KSS function score was 29.4 (range 17.3 to 41.5). The average postoperative KSS knee score was 83 (range 80.5 to 85.4), and the average postoperative KSS function score was 83.2 (range 78.5 to 87.9). Among them, sixteen knees (32%) showed excellent KSS knee and function scores, while 34 knees (68%) showed good scores. There were statistically significant differences for all variables.

Conclusion: There was a significant increase in PCO, flexion (both weight-bearing and non-weight-bearing), KSS knee score, and function scores.

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1. Introduction

Osteoarthritis (OA) is one of the most prevalent conditions resulting in disability, particularly in the elderly population. It results from articular cartilage failure induced by a complex interplay of genetic, metabolic, biochemical and biomechanical factors with secondary components of inflammation. It is associated with symptoms like pain, stiffness and limitation of activity and an associated clinical signs like swelling, effusion, crepitus, impingement, instability and malalignment.[1]

Human and animal studies indicate that chondrocytes exhibit numerous abnormal metabolic features as part of the osteoarthritis process. These include increased levels of proliferative,[2,3] synthetic,[4,5] and degradative activity.[6,7]

The management principally consist of reduction of pain, stiffness, improve the physical functioning, retarding the

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disease's progression of joint damage and improvement of quality of life.

Treatment consists of the physical therapy and drug therapy. Many patients require weight reduction. Prolonged use of corticosteroids should be avoided.

Osteotomies to change the mechanical axis of weight bearing are useful for unicompartmental arthritis.[8] The goal of realignment osteotomy has been traditionally to alter the vector of forces across the knee, to unload the affected compartment, and thereby to gain relief of pain.

The gold standard treatment of choice is total knee arthroplasty (TKA).[9] The principal goal of TKA is to reduce joint pain during standing, walking and during routine daily activities. Maintenance of range of motion (ROM) is essential for all these purposes. The range of flexion or motion of the knee obtained after TKA is often limited and may be determined by several factors, including preoperative range of movements, posterior femoral condylar offset,[10] posterior tibial slope,[11] surgical technique, joint line elevation, postoperative physiotherapy and the design of the implant.[12–16]

In 2002, Belleman et al[10] was the first to propose the concept of PCO. The authors defined it as the vertical distance from the most prominent point of the posterior femoral condyle to the tangent of the posterior cortex of the femoral shaft as seen on true lateral radiographs. When a sufficient PCO is reconstructed, a larger posterior clearance may be obtained that helps delay impingement on the posterior aspect and maximizes the range of flexion (ROF). However, the potential correlation between PCO and ROF, especially after posteriorly stabilized (PS) TKA, remains controversial.

A component design which has both excellent survivorship and better function is needed for better functional outcome and quality of life. Currently, multi-radius femoral designs are usually used to provide the J-shape curve of the normal knee joint, which is similar to the normal curve, with a large axis in the front and a decrease in the back at the sagittal plane.[17] But in the multi-radius femoral design, the recovery of the quadriceps and extensor mechanism is slow and this can affect the outcome of the postoperative knee function.[18,19] As the length of the ligament changes at mid-flexion of the knee joint in multi-radius TKA and as the momentary axis changes from a long one to a short one, it may result in instability.

The aim of the study was to study the effect of femoral Posterior Condylar Offset (PCO) on clinical results in multi-radius (MR) femoral design components in posterior stabilized total knee arthroplasty. (PS TKA)

2. Material and Methods

2.1. Study design

This hospital based observational study was conducted at the department of orthopaedics at a tertiary care hospital.

2.2. Study duration

Between 1 January 2018 to 31 December 2018 with a 6 month follow up.

A total number of 50 consecutive patients were operated on with Multi radius femoral design implant – Maxx orthopaedics PS design after obtaining proper informed consent.

2.3. Inclusion and exclusion criteria

Patients with age (>50years) with end stage osteoarthritis and varus deformity of knee were selected for this study and were admitted to undergo TKA and given consent to participate in the study. While patients with revision TKA, with well functioning knee arthrodesis, compromised limb vascularity, valgus deformity knees, patients with any disease that may affect the movement of knee or hip joint, cause pain in the lower limbs, or affect lower limb function, psychiatric illness or non-compliant patient, patients with body mass index (BMI) >35 kg/m2 were excluded from the study.

Cases were evaluated pre-operatively and post surgery at 6 months follow up by measurement of posterior condylar offset, flexion (weight bearing and non-weight bearing) and knee society scoring system. Points scored were added up to give a net pain and functional score. Primary TKA was carried out under spinal/epidural anaesthesia. All patients were operated by a single surgeon. For PCO measurement methods used by Bellemans et al.[10] was used.

The PCO was measured pre-operatively and 6 months post-operatively on true lateral knee radiographs by determining the shortest distance between the line tangent to posterior femoral cortex and the most posterior point of the femoral condyle (pre- operatively) or femur prosthesis (post-operatively) respectively (Figure 1 A, B).

2.4. Data analysis

The data was analysed using SPSS Version 23 and PRIMER software. Continuous variables were summarized as mean and standard deviation and nominal /categorical variable were presented as proportion, paired-t test, chi-square test and correlation coefficient were used as the statistical method for analysis. P-value <0.05 was considered statistically significant.

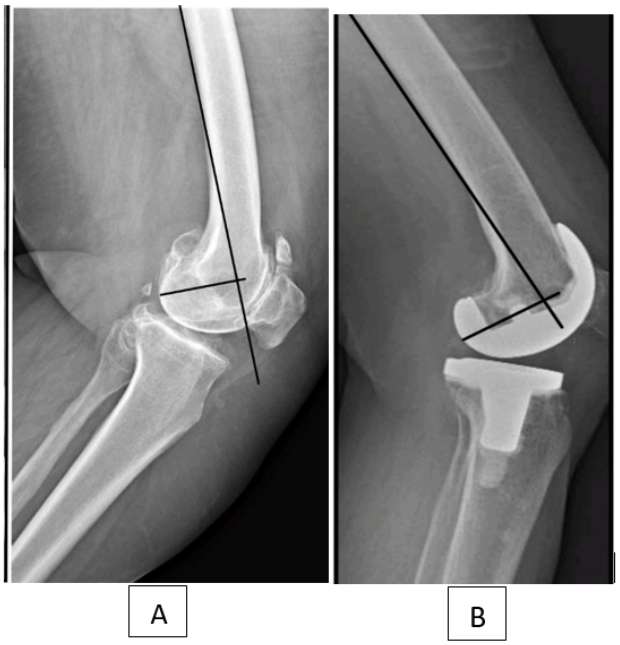

Figure 1: A): Measurement of PCO on pre-op x-ray; **B)**: Measurement of PCO on Post op x-ray

2.5. Demographic characteristics of the study population

The age of the cases was observed to be in the range of 58.3 to 75.3 years (average 66.8), with the age group of >70 years being the most common (42%). Women were predominantly seen (66%).

Of the total 50 patients, there were 23 (46%) left and 27(54%) right sided knees. (Table 1)

3. Results

Preoperative and postoperative measurement of PCO, non-weight bearing flexion (degree), weight bearing flexion (degree), KSS knee score and KSS functional score.

The pre-operative PCO was noted to be in the range of 25.3 to 29.7 mm (average 27.5) while the postoperative PCO range was 26.1 to 32.2 mm (average 29.2). There was no significant difference between the two.

The preoperative non weight bearing flexion range was 93.7 to 119.3 degrees (average 106.5) while the postoperative non weight bearing flexion range achieved was 116.6 to 123.2 degrees (average 119.9).

The preoperative weight bearing flexion range was 86.6 to 106.8 degrees (average 96.7) while the postoperative weight bearing flexion range achieved was 120.7 to 126.5 degrees (average 123.6).

Pre-operative KSS knee score range in the patients was 52.6 to 59.2 (average 55.9) while pre-operative KSS function score range was 17.3 to 41.5 (average 29.4).

Post-op KSS knee score range in the sample was 80.5 to 85.4 (average 83) while post-op KSS function score range was 78.5 to 87.9 (average 83.2). (Table 2)

Excellent and good KSS knee scores were found in 16 knees (32%) and 34 knees (68%) respectively.

Excellent and good KSS functional scores were found in 16 knees (32%) and 34 knees (68%). (Table 3)

Paired differences and paired samples test (post-operative minus pre-operative analysis of the outcome variables).

Mean differences were statistically significant for all variables. Average increase in PCO, non weight bearing flexion, KSS knee score, KSS function score and weight bearing flexion were 1.7 (range -0.6 to 3.5) mm, 13.4 (range 0.9 to 25.9) degrees, 27.1 (range 23 to 31.1), 53.8 (range 40.4 to 67.2) and 26.9 (range 16.9 to 36.9) degrees respectively. (Table 4)

There were no complications noted intra-operatively as well as post-operatively.

Table 1: Demographic distribution of study population

Characteristics	Numbers (%)
Age (years)	
50-60	17 (34)
60-70	12 (24)
>70	21 (42)
Sex	
Men	17 (34)
Women	33 (66)
Side	
Right	27 (54)
Left	23 (46)

Table 2: Preoperative and postoperative measurement of PCO, non-10 weight bearing flexion (degree), weight bearing flexion 11 (degree), KSS knee score and KSS functional score

Parameters	Mean ± SD
PCO (millimetres)	
Pre-operative	27.50 ± 2.24
Post-operative	29.20 ± 3.05
Non weight bearing flexion (degree)	
Pre-operative	106.50 ±12.83
Post-operative	119.90 ± 3.27
Weight bearing flexion (degree)	
Pre-operative	96.70 ± 10.13
Post-operative	123.60 ± 2.86
KSS Knee Score	
Pre-operative	55.92 ± 3.28
Post-operative	82.98 ± 2.45
KSS Function Score	
Pre-operative	29.40 ± 12.11
Post-operative	83.20 ± 4.71

Table 3: KSS knee score and KSS functional score

Score	Numbers (%)
KSS Knee Score	
Excellent (>85)	16 (32)
Good (70-84)	34 (68)
KSS Function Score	
Excellent (>85)	16 (32)
Good (70-84)	34 (68)

Table 4: Paired differences and paired samples test (post-operative minus pre-operative analysis of the outcome variables)

Post minus pre-op differences (Δ)	Mean ± SD	p value*
ΔPCO (millimetres)	1.70 ± 1.76	<0.001
ΔFlexion (non weight bearing)	13.40 ± 12.47	<0.001
ΔKSS Knee Score	27.06 ± 4.08	<0.001
ΔKSS Function Score	53.80 ± 13.38	<0.001
ΔFlexion (weight bearing)	26.90 ± 9.99	<0.001

*paired t test

4. Discussion

The TKA is a well-established procedure performed to relieve pain and improve the range of movement (ROM) in patients with disabling osteoarthritis. ROM after total knee arthroplasty is a very important factor in determining the functional outcome of the procedure, especially in a country like India where activities of daily living require more amount of flexion.

This study aimed to assess the possible influence of femoral posterior condylar offset (PCO) reconstruction on flexion (weight bearing and non-weight bearing) and clinical results (knee society score) in multi-radius femoral design components in posterior stabilized total knee arthroplasty.

In this prospective observational study, 50 knees were operated with multi-radius femoral design component and followed up during the study period from January 2018 to December 2018.

On the day of the final follow-up at 6 months PCO, flexion (non-weight bearing and weight bearing) and KSS (knee score and function score) were evaluated as during the pre-operative stage. The results were complied and analysed to arrive to a conclusion in this study.

Mean age in our study was 66.78 ± 8.51years. It was similar to studies done by Barrena et al[20] 73.2 years, Cook et al.[21] 65.7 years and Jenny et al[22] 68 years.

Insignificant, negative and poor correlation was observed between change in PCO and other variables like non weight bearing flexion, KSS knee score, KSS function score, and weight bearing flexion (Pearson correlation values were -0.208, P value = 0.148; -0.029, P value = 0.843; -0.223, P value =0.12 and -0.251, P value = 0.079 respectively).

This was supported by previous studies like Arabori et al,[23] Hanratty et al,[24] and Bauer et al.[25] This may be explained by the fact that flexion angle is multivariate factor. It depends on implant design, the patient, surgical technique, knee kinematics, perioperative complications, and post-operative physiotherapy.[16] According to Bauer et al[25] the most significant predictive factor for post-operative flexion after posterior-stabilized TKR without PCL retention was the pre-operative range of flexion.

The mean difference between post-operative and pre-operative values were statistically significant in all variables. Mean increased in non weight bearing flexion, KSS knee score, KSS functional score and weight bearing flexion were 13.40 ± 12.47 degrees, 27.06 ± 4.08, 53.80 ± 13.38 and 26.90 ± 9.99 respectively. These findings were supported by Palmer et al[26] and Jenny et al.[22]

5. Conclusion

There was significant increase in PCO, flexion (both weight bearing and non weight bearing), KSS knee score and function scores among the patients. This study highlights the importance of PCO in TKA and also how it influences the outcomes after TKA. Hence this must be considered while treating patients of OA knee with multi radius TKA of PS design.

6. Limitations

The value of PCO differs with the body type of the patient especially the size of the knee joint.

Flexion angle after TKA is a multivariate hence Posterior Condylar Offset and posterior condylar offset ratio which was described by Soda et al,[27] cannot be used as an independent variable for the quantification of functional outcome of TKA.

Accurate radiographic measurement of pre-operative PCO is not possible as the cartilage thickness remained was not accounted for and also there is an inherent error in the measurement techniques that accounts for inconsistent findings as reported by Clarke et al.[28]

Asymmetry of the medial and lateral femoral condyles causes difficulty in measurement of PCO.

A six months of follow up is a relatively short period. A longer follow up would have been more beneficial in yielding accurate results.

Larger number of sample size or a multicentre study would have been more conclusive with respect to the conducted study.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

8. Conflict of Interests

None.

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