



# Medial Ball and Socket Total Knee Arthroplasty in Indian Population: 5-Year Clinical Results

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**Background:** Medial pivot total knee arthroplasty aims to restore native knee kinematics through highly conforming medial tibio-femoral articulation with survival comparable to contemporary knee designs. The aim of this study was to report preliminary clinical results of medial pivot total knee arthroplasty in an Indian population.

**Methods:** A retrospective analysis of 45 patients (average age, 62 years; 40 women and 5 men) with end-stage arthritis (Kellgren-Lawrence grade 4) operated with a medial pivot prosthesis was done. All patients were assessed using Knee Society Score (satisfaction, expectation, and functional scores) and Oxford Knee Score, and range of motion was recorded at the end of 5-year postoperative follow-up. In addition, all patients underwent standardized radiological assessment.

**Results:** At the final follow-up, patients reported significant improvement in mean Knee Society Score (satisfaction, expectation, and functional scores) and Oxford Knee Score ( $p < 0.05$ ). The mean range of motion achieved at the end of 5 years ranged from 0° (extension) to 118.4° (further flexion). There was no evidence of loosening or osteolysis at a minimum follow-up of 5 years.

**Conclusions:** These results demonstrated satisfactory clinical and radiological outcomes at 5 years after total knee arthroplasty with a medial pivot design, which may be related to better replication of natural knee kinematics with the medial pivot knee and inherent advantages of this design.

**Keywords:** Medial, Knee, Arthroplasty, Clinical, Radiological

Total knee arthroplasty (TKA) is a successful surgery with reliable and predictable outcomes. Still there are 20% of patients who are not satisfied with the procedure.<sup>1)</sup> Various causes have been postulated for dissatisfaction, which include residual pain, paradoxical roll forward, and kinematic conflict.<sup>2)</sup> Modern knee arthroplasty designs aim to recreate tibiofemoral rollback and anteroposterior stability using the cam-post mechanism and ultracongruent bearing surfaces.<sup>3-5)</sup> Medial pivot (MP) TKA is a fixed-bearing asymmetric pivot prosthesis with a highly congruent me-

dial side and a relatively flat lateral side.<sup>6)</sup> Various studies have shown favorable clinical outcomes with MP TKA at medium to long-term follow-up.<sup>7-11)</sup> In India, patients undergoing TKA present at a very advanced stage of osteoarthritis with more physiological genu varum, tibial torsion, lateral bowing of the femur, and different femoral-tibial aspect ratio, and functional outcome is based on the ability to perform activities based on various socio-cultural habits.<sup>12,13)</sup>

The performance of MP TKA in the Indian population has not been studied and whether this improved kinematic design translates into better clinical outcome as per activity of daily living needs to be elucidated. The aim of the present study was to evaluate the clinical and radiological outcome of an MP prosthetic knee design in an Indian population.

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## METHODS

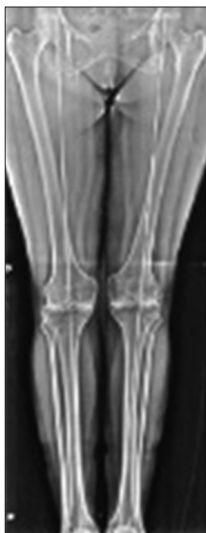
A retrospective analysis of prospectively collected data of adult patients with end-stage knee arthritis (Kellgren-Lawrence grade 4) operated in a University Teaching Hospital from January 2015 to June 2015 was performed. A total of 245 patients were identified. Only patients (45 patients) who underwent MP TKA (ADVANCE Medial Pivot, MicroPort Orthopedics, Arlington, TN, USA) were included in the study. MP TKA was introduced to our system in 2014. Institutional Review Board approval was taken for the study (IRB No. IEC-486).

The primary outcome measures for this study were patient satisfaction and met-expectations with the MP prosthesis using Knee Society Score (KSS) satisfaction, expectation, and functional scores. The secondary outcome measures were Oxford Knee Score (OKS), range of motion, and radiological assessment.

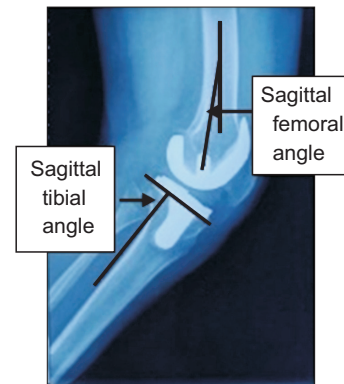
All TKAs were performed by the same surgeon (RM) using the standard medial parapatellar approach. All patients were given an antibiotic (Cefuroxime axetil 1.5 g) 30–45 minutes prior to skin incision. All patients were given intravenous tranexamic acid (15 mg/kg) 10–15 minutes prior to tourniquet deflation. The posterior cruciate ligament (PCL) was sacrificed in all cases and implants were fixed with a single mix of Palacos bone cement with gentamicin (Heraeus Medical, Warsaw, IN, USA). Whenever there was mediolateral overhang as per the anteroposterior size of the femoral component, the authors used a stature femoral component (narrow mediolateral) available with this prosthesis. The stature femoral component was used

in 70% of the patients and the most common size of femur and tibia used in the study was 2. Patelloplasty was done. Surgical and rehabilitation protocol was standardized for all patients.

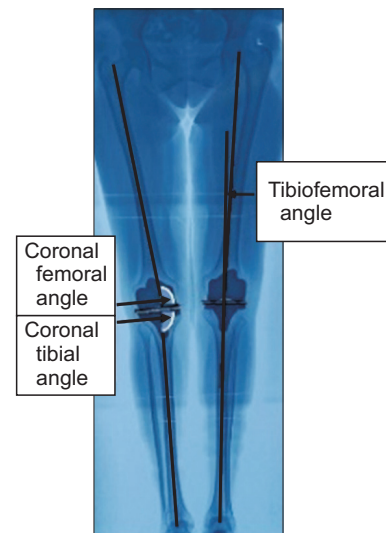
For each patient, demographic data, type of arthritis, body mass index (BMI), and preoperative scores were documented from the patient record and postoperative evaluation was done at the latest follow-up using KSS (satisfaction, expectation, and functional scores), OKS, and range of motion (measured using a goniometer). Flexion deformity, if any, was also recorded. Serial standard preoperative and postoperative radiographs at baseline and the latest follow-up were evaluated by an independent radiologist (NS) as per the protocol defined by the modern knee society radiographic evaluation system (Figs. 1-3).<sup>14)</sup>



**Fig. 1.** Preoperative radiograph showing grade 4 osteoarthritis bilateral.



**Fig. 2.** Postoperative radiograph showing the sagittal femoral angle and tibial angle.



**Fig. 3.** Postoperative radiograph showing the tibiofemoral angle, coronal femoral angle, and coronal tibial angle.

TKA loosening was defined as a complete radiolucent line of more than 2 mm in width, a visible cement mantle fracture around the component, or a change in component position. The interclass correlation coefficient was excellent (0.92) for clinical evaluation and good (0.84) for radiographic evaluation.<sup>15)</sup>

### Statistical Analysis

Baseline characteristics were described for each patient using mean  $\pm$  standard deviation, median (range), or frequency/percentage. KSS (satisfaction, expectation, and functional scores) and OKS were compared using a generalized estimating equation because the observations were correlated preoperatively and postoperatively. Within group comparison for all other parameters was performed using paired *t*-test or Wilcoxon rank-sum test (Mann-Whitney *U*-test). Correlation between two continuous variables was analysed using Pearson correlation coefficients. All analyses were conducted using Stata ver. 13.0 (Stata Corp., College Station, TX, USA). A *p*-value  $< 0.05$  was considered statistically significant.

## RESULTS

All patients reported improved satisfaction and functional outcome after TKA at a minimum follow-up of 5 years. The average age at the time of TKA was 62 years and 88.9% of the patients were women. There were 26 left knees and 24 right knees. The average BMI was 28.4 kg/m<sup>2</sup>. Five patients underwent bilateral TKA (total 50 MP TKAs). There were 4 cases of inflammatory arthritis, while the rest were degenerative osteoarthritis (Table 1).

The mean preoperative KSS was 4.4  $\pm$  1.7 (range, 0–6) for satisfaction score, 11.8  $\pm$  1.6 (range, 7–15) for expectation score, and 19.6  $\pm$  4.4 (range, 6–27) for functional score. The mean postoperative KSS was 34.6  $\pm$  3.0 (range, 26–38) for satisfaction score, 12.5  $\pm$  1.4 (range, 10–15) for expectation score, and 61.3  $\pm$  6.7 (range, 42–69) for functional score at the latest follow-up. The mean OKS was 9.5  $\pm$  2.5 (range, 4–12) preoperatively and 44.2  $\pm$  2.2 (range, 40–48) at the latest follow-up. Patients reported clinically and statistically significant improvements (*p*  $< 0.001$ ) for all patient-reported outcome measures (Table 2). The mean range of motion showed a statistically significant improvement from 97.6°  $\pm$  11.2° (70°–120°) to 118.4°  $\pm$  8.4° (100°–130°). Three patients had flexion deformity of less than 10° at the final follow-up.

There was no evidence of implant failure or subsidence in any of the postoperative radiographs. Nonprogressive radiolucent lines ( $< 2$  mm) were seen in 5 TKAs. The average tibiofemoral angle improved from a mean of 4.8° varus (2.2°–7.4°) preoperatively to a mean of 4.1° valgus (3.3°–4.9°) at the latest follow-up (Table 3). None of the patients were lost to follow-up or died due to surgery-related or unrelated causes. One patient with rheumatoid arthritis developed mid-substance quadriceps tendon rupture, which was managed with mesh repair. The patient did well and was able to perform activities of daily living.

**Table 1.** Patient Demographic Data

Parameter	Value
Female : male	40 (88.9) : 5 (11.1)
Age (yr)	61.7 $\pm$ 6.9
BMI (kg/m <sup>2</sup> )	28.4 $\pm$ 3.3
OA : IA	46 (92) : 4 (8)

Values are presented as number (%) or mean  $\pm$  standard deviation. OA: osteoarthritis, IA: inflammatory arthritis.

**Table 2.** Descriptive Statistics of KSS, OKS, Range of Motion, and Flexion Deformity Preoperatively and at the Latest Follow-up

MP (n = 50)	Preoperative	Latest follow-up	<i>p</i> -value
KSS (satisfaction)	4.4 $\pm$ 1.7	34.6 $\pm$ 3.0	$< 0.001$
KSS (expectation)	11.8 $\pm$ 1.6	12.5 $\pm$ 1.4	$< 0.001$
KSS (function)	19.6 $\pm$ 4.4	61.3 $\pm$ 6.7	$< 0.001$
OKS	9.5 $\pm$ 2.5	44.4 $\pm$ 2.2	$< 0.001$
Range of motion (°)	97.6 $\pm$ 11.2	118.4 $\pm$ 8.4	$< 0.001$

Values are presented as mean  $\pm$  standard deviation. KSS: Knee Society Score, OKS: Oxford Knee Score, MP: medial pivot.

**Table 3.** Descriptive Analysis of Radiological Outcomes

MP (n = 50)	Preoperative	Latest follow-up	p-value
Tibiofemoral angle (°)	4.8 ± 2.6	-4.1 ± 0.8	< 0.001
Posterior condylar offset (mm)	17.71 ± 0.64	17.84 ± 0.6	NS
Patellar tilt (°)	4.6 ± 2.7	4.5 ± 1.9	NS
Position of implant		Postoperative	
Coronal femoral angle (°)		94.9 ± 0.5	
Coronal tibial angle (°)		90.3 ± 1.3	
Sagittal femoral angle (°)		2.5 ± 0.7	
Sagittal tibial angle (°)		85.9 ± 0.8	

Values are presented as mean ± standard deviation.  
MP: medial pivot, NS: not significant.

## DISCUSSION

Traditional methods of TKA have failed to recreate normal knee kinematics, which may contribute to up to 20% suboptimal outcomes.<sup>16)</sup> Attempts have been made to refine prostheses to achieve normal kinematics and elongate implant survivorship. The most important finding of this study is satisfactory outcome with MP-TKA without any major complications at a minimum follow-up of 5 years in the Indian population. This may be related to better replication of natural knee kinematics with MP knees and inherent advantages of this design.

The clinical results of our study are encouraging and satisfactory with all the patients reporting significant improvement in the patient-reported outcome measures. These results are in agreement with other studies in the literature.<sup>7-11)</sup> All patients in the present study felt their knees stable. None of the patients developed any symptomatic anteroposterior instability. Single radius curvature of the femoral component in MP TKA maximizes quadriceps efficiency, limits paradoxical roll forward, and provides potential advantages to the extensor apparatus.<sup>2)</sup> Pritchett<sup>17)</sup> reported that 77% of patients preferred MP to the posterior-stabilized (PS) design. Macheras et al.<sup>10)</sup> reported excellent long-term clinical results with an MP design and survival of 98.8% at 17 years of follow-up.

The average flexion reported in the present study was 118.4°, which is comparable to other studies with similar knee designs.<sup>7-11,17-19)</sup> Although the maximum flexion was less than that in other high-flex knees and mobile-bearing designs, this may be related to late presentation with advanced arthritis in the Indian population.<sup>20)</sup> The

advantage of the MP design is that patients feel their knees are stable in activities requiring deep flexion due to its medial conformity. Furthermore, it has been reported that the increased range of motion correlates with increased satisfaction after TKA in Asian patients.<sup>21)</sup>

The medial conformity of this design also obviates the need for ligament release for balancing the knee, which is required in severe varus deformity; severe deformities necessitate PCL release to balance the knees. The posterior-stabilized type of MP TKA does not require a box cut for post-cam mechanism; instead, its ultracongruent polyethylene with anterior lip provides anteroposterior stability without any post. This also preserves bone stock in already smaller bones in Asian patients and, if required, for future revision surgery.<sup>18)</sup> Bae et al.<sup>22)</sup> showed that there was no difference in clinical and radiological results of TKA with an MP design regardless of whether the PCL was retained (67 knees) or sacrificed (70 knees).

The radiographic results were similar to those of other studies.<sup>7-11,17-19)</sup> There was no evidence of loosening or osteolysis in the present study, which may be attributed to the fact that the MP design produces fewer wear particles due to its ultracongruent nature.<sup>23)</sup> We note certain inherent limitations of the study, such as the single center study, small number of patients, retrospective study design, absence of control group, and relatively short follow-up. The current study has demonstrated satisfactory clinical and radiological outcomes at 5 years following MP-TKA in an Indian population.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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## REFERENCES

- Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after total knee arthroplasty: who is satisfied and who is not? *Clin Orthop Relat Res.* 2010;468(1):57-63.
- van Duren BH, Pandit H, Beard DJ, et al. How effective are added constraints in improving TKR kinematics? *J Biomech.* 2007;40 Suppl 1:S31-7.
- Dorr LD, Ochsner JL, Gronley J, Perry J. Functional comparison of posterior cruciate-retained versus cruciate-sacrificed total knee arthroplasty. *Clin Orthop Relat Res.* 1988; (236):36-43.
- Insall JN, Lachiewicz PF, Burstein AH. The posterior stabilized condylar prosthesis: a modification of the total condylar design: two to four-year clinical experience. *J Bone Joint Surg Am.* 1982;64(9):1317-23.
- Wolterbeek N, Nelissen RG, Valstar ER. No differences in vivo kinematics between six different types of knee prostheses. *Knee Surg Sports Traumatol Arthrosc.* 2012;20(3):559-64.
- Freeman MA, Pinskerova V. The movement of the normal tibio-femoral joint. *J Biomech.* 2005;38(2):197-208.
- Karachalios T, Varitimidis S, Bargiotas K, Hantes M, Roidis N, Malizos KN. An 11- to 15-year clinical outcome study of the Advance Medial Pivot total knee arthroplasty: pivot knee arthroplasty. *Bone Joint J.* 2016;98(8):1050-5.
- Fitch DA, Sedacki K, Yang Y. Mid- to long-term outcomes of a medial-pivot system for primary total knee replacement: a systematic review and meta-analysis. *Bone Joint Res.* 2014;3(10):297-304.
- Chinzei N, Ishida K, Tsumura N, et al. Satisfactory results at 8 years mean follow-up after ADVANCE® medial-pivot total knee arthroplasty. *Knee.* 2014;21(2):387-90.
- Macheras GA, Galanakos SP, Lepetsos P, Anastasopoulos PP, Papadakis SA. A long term clinical outcome of the Medial Pivot Knee Arthroplasty System. *Knee.* 2017;24(2):447-53.
- Bordini B, Ancarani C, Fitch DA. Long-term survivorship of a medial-pivot total knee system compared with other cemented designs in an arthroplasty registry. *J Orthop Surg Res.* 2016;11:44.
- Thilak J, George MJ. Patient - implant dimension mismatch in total knee arthroplasty: is it worth worrying? An Indian scenario. *Indian J Orthop.* 2016;50(5):512-7.
- Siow WM, Chin PL, Chia SL, Lo NN, Yeo SJ. Comparative demographics, ROM, and function after TKA in Chinese, Malays, and Indians. *Clin Orthop Relat Res.* 2013;471(5):1451-7.
- Meneghini RM, Mont MA, Backstein DB, Bourne RB, Dennis DA, Scuderi GR. Development of a modern knee society radiographic evaluation system and methodology for total knee arthroplasty. *J Arthroplasty.* 2015;30(12):2311-4.
- Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med.* 2016;15(2):155-63.
- Lee GC. Patient-specific cutting blocks: of unproven value. *Bone Joint J.* 2016;98(1 Suppl A):78-80.
- Pritchett JW. Patients prefer a bicruciate-retaining or the medial pivot total knee prosthesis. *J Arthroplasty.* 2011;26(2):224-8.
- Youm YS, Cho SD, Lee SH, Cho HY. Total knee arthroplasty using a posterior cruciate ligament sacrificing medial pivot knee: minimum 5-year follow-up results. *Knee Surg Relat Res.* 2014;26(3):135-40.
- Samy DA, Wolfstadt JI, Vaidee I, Backstein DJ. A retrospective comparison of a medial pivot and posterior-stabilized total knee arthroplasty with respect to patient-reported and radiographic outcomes. *J Arthroplasty.* 2018;33(5):1379-83.
- Huang HT, Su JY, Wang GJ. The early results of high-flex total knee arthroplasty: a minimum of 2 years of follow-up.

- J Arthroplasty. 2005;20(5):674-9.
21. Ha CW, Park YB, Song YS, Kim JH, Park YG. Increased range of motion is important for functional outcome and satisfaction after total knee arthroplasty in Asian patients. J Arthroplasty. 2016;31(6):1199-203.
  22. Bae DK, Song SJ, Cho SD. Clinical outcome of total knee arthroplasty with medial pivot prosthesis a comparative study between the cruciate retaining and sacrificing. J Arthroplasty. 2011;26(5):693-8.
  23. Vecchini E, Christodoulidis A, Magnan B, Ricci M, Regis D, Bartolozzi P. Clinical and radiologic outcomes of total knee arthroplasty using the advance medial pivot prosthesis: a mean 7 years follow-up. Knee. 2012;19(6):851-5.