

Kinematic Alignment Technique Outperforms Mechanical Alignment in Simultaneous Bilateral Total Knee Arthroplasty; A Randomized Controlled Trial

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INTRODUCTION:

In the classic mechanical alignment (MA) technique for total knee arthroplasty (TKA), prosthetic components are placed perpendicular to the mechanical axis of the lower limb (femur and tibia). The rationale of the mechanical method is to create a joint surface parallel to the ground and perpendicular to the body mechanical axis, rather than the slightly varus alignment in the native knee. However, these changes alter the knee biomechanics, which partially explains the abnormal gait features and dissatisfaction after TKA. In kinematic alignment (KA) technique, the cuts respect the kinematics of the native knee and align the limb in its original layout in an attempt to restore the plane of the knee joint based on the patient's original condition before the onset of osteoarthritis and to achieve more normal biomechanics. The aim of this study was to compare the clinical results of KA with those of MA in single-stage bilateral TKA. Identifying the more effective method may serve to improve the future outcomes of TKA for treating knee osteoarthritis. However, studies have shown controversial results in this regard. Several studies have reported more normal gait and better functional outcomes for KA compared with MA, while some others have not found a considerable difference in terms of outcome or complication rate and survivorship between KA and MA. To mitigate the above concern in this study, the clinical results of the KA technique in one knee were compared with those of MA in the opposite knee of the same patient receiving simultaneous bilateral knee replacement. The hypothesis was that the clinical outcomes of KA and MA would be similar.

METHODS:

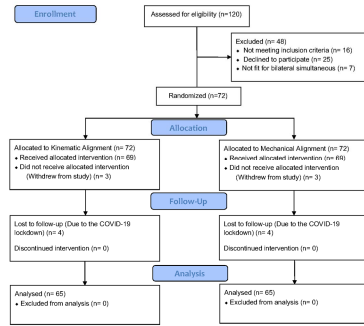
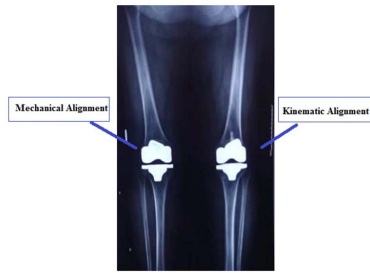
In this double-blinded randomized controlled trial, patients diagnosed with bilateral knee degenerative joint disease (DJD) and disabling pain, for whom TKA was indicated and were in acceptable general condition for a simultaneous bilateral TKA, were included. One knee was randomly selected to be operated on with the calipered-KA method and the other with MA. The participants were assessed via the Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire, and Visual Analogue Scale (VAS) before the surgery and the same plus the Forgotten Joint Score (FJS) at their last follow-up visit, two years postoperatively. The time to maximum knee flexion, named the recovery time, was also recorded. Hip-knee-ankle (HKA) angle, medial proximal tibial angle (MPTA), and lateral distal femoral angle (LDFA) were measured before and after the surgery using three-joint-view radiographs; 0.05 is set as the critical threshold for significance.

RESULTS:

Finally, 65 patients (51 women), with an average age of 65.9 ± 5.2 and BMI of 29.0 ± 2.7 were enrolled in the study (Figure 1). Preoperative functional scores and radiological parameters were similar for the two groups ($P > 0.05$), indicating similar baseline severity of the knee pathology. Knee ROM and all functional scores improved at the last follow up compared to the preoperative values ($P < 0.001$). At two years, there were significant differences between the KA and MA methods in terms of duration of surgery, recovery time, and final WOMAC, FJS, and maximum flexion range in favor of KA ($P < 0.05$), but no significant difference in VAS score and OKS ($P > 0.05$) (Table 1). Considering FJS and preferred knee questions, the satisfaction rates were significantly higher in KA knees and the KA knee was preferred over the MA knee by most patients. Although KA knees have comparatively varus alignment after surgery, in the radiological evaluation, there was no significant difference between the two groups regarding HKA, LDFA, and MPTA ($P > 0.05$) (figure 2). There was no prosthesis failure and reoperation in both groups during two years of follow up, and the two-year survivorship rates for both kinematic and mechanical alignment were high and similar. Other complications included superficial infections, which were fully treated with oral antibiotics (two in the MA group and one in the KA group).

DISCUSSION AND CONCLUSION:

The present study's findings indicate that both KA and MA TKA techniques efficiently enhance patient-reported outcomes and ROM and have similar survivorship rates, complications, and pain scores. Therefore, each approach has its own advantages in certain aspects. However, the KA method appears to offer superior results concerning shorter surgery duration, faster recovery time, greater maximum flexion, better patient-reported functional scores (FJS, WOMAC), and patient preference. Nonetheless, it is recommended that further studies be conducted with a larger sample size to compare the failure and survivorship rates and functional outcomes of the two methods over the long term.



	Kinematic (N=66)			Mechanical (N=66)			P values* [Difference]
	Pre-op	Post-op	difference	Pre-op	Post-op	difference	
QAS	17.8 ± 4	27.4 ± 4.8	72.0 ± 5.3	18.0 ± 4.0	27.9 ± 5.9	72.0 ± 4.7	< .1
VAS	8.3 ± 1.0	0.6 ± 0.6	-7.0 ± 1.2	8.4 ± 0.9	1.0 ± 1.1	-7.4 ± 1.3	< .1
WOMAC	33.1 ± 3	23.1 ± 3.7	42.7 ± 1	32.4 ± 5	23.3 ± 4.1	39.1 ± 7.0	0.019
Minimum flexion	112.0 ± 1.8	119.7 ± 1.8	75.1 ± 3	118.5 ± 1.4	117.3 ± 3.6	12.3 ± 1.5	0.001
Extension pain score		30.2 ± 3.4		30.6 ± 3.9			0.026
Duration of surgery (min)		23.7 ± 4.1		51.1 ± 4.8			0.001
Recovery time (weeks)		6.7 ± 2.2		10 ± 2.5			0.001
IKDC	3.8 ± 1	4.9 ± 1.7	8.7 ± 5.6	3.7 ± 1	4.2 ± 2	4.0 ± 2.0	0.029
MPFA	30.5 ± 3.6	35.2 ± 2.8	38.3 ± 2.5	30.9 ± 4.6			0.001
TDR V	30.7 ± 2.7	39.6 ± 3.9	30.9 ± 1.9	38.7 ± 4.8			0.074

*All values are stated as the mean ± standard deviation. P values < 0.05 are considered statistically significant. Measurements: QAS = Oxford Knee Score, VAS = visual analogue scale, WOMAC = Western Ontario and MacMaster Universities Osteoarthritis Index, IKDC = International Knee Injury and Function score, MPFA = modified proximal femoral angle.