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Is There a Difference in the Outcome of Primary Total Knee Arthroplasty Performed Using Kinematic Versus Mechanical Alignment?



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Question: Is there a difference in the outcome of primary total knee arthroplasty performed using kinematic versus mechanical alignment?

Response/Recommendation: Kinematic alignment shows improved patient-reported outcome measurements in early recovery but equivalence past mid-term follow-up. Kinematic alignment targets a native joint line obliquity and reapproximates prearthritic alignment, thus less soft-tissue adjustment may account for early differences. Several randomized controlled trials and systematic reviews fail to identify a durable clinically meaningful difference. Further noncommercial, nonbiased, and level-one studies are needed to elucidate long-term clinical outcomes and cost-effectiveness.

Level of Evidence: Moderate.

Voting: Figure 1.

Rationale

Mechanical alignment (MA) targets a joint line that is neutral to the mechanical axis to achieve implant stability and longevity [1,2]. However, the conventional MA technique does not consider

individual variations in prearthritic knee anatomy, while the persistence of pain and patient dissatisfaction reported with MA have motivated alternative strategies like kinematic alignment (KA), which seeks to replicate the patient's predisease joint alignment [3,4]. The KA scheme aims to reproduce patients' native joint line obliquity in the pursuit of natural kinematics and the hope of improved patient satisfaction [5]. Scopus, Pubmed, and Cochrane Library were searched for randomized controlled trials (RCTs) published by May 2024. Parameters including patient-reported outcome measurements, radiological evaluation, survival rates, and complications were compared between KA and MA.

There were eleven RCTs analyzed, with three reporting on the same cohort at three time points (6 months, 2 years, and 13 years).

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1. Agree

2. Disagree

3. Abstain

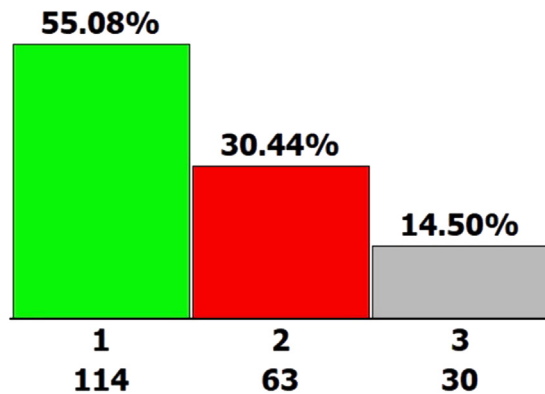


Figure 1. The result of the voting in Question N.30.

Dossett et al. reported better clinical outcomes and flexion with KA at six months with similar hip-knee-ankle alignment [6]. Their 2-year study reported better pain relief, further walking before discharge, and higher flexion with better patient-reported outcome measurements in the KA group [7]. At 13 years, there was a similar survival rate between the two and a nonsignificant trend for higher satisfaction in the KA group [8].

Calliess et al. reported comparable or superior outcomes over MA when performing KA with patient-specific instrumentation [9]. At 12 months, the KA group had better Knee Society Scores (KSS) and Western Ontario and McMaster Universities Arthritis Index scores, but with two revisions for multidirectional instability. The KA group with patient-specific instrumentation showed inaccurate alignment with an average deviation of $1 \pm 3^\circ$ valgus compared to $1 \pm 1^\circ$ varus in the MA group. The KA group showed a negative correlation between alignment deviation and KSS, but higher femoral component flexion correlated with higher Western Ontario and McMaster Universities Arthritis Index scores.

Matsumoto et al. showed greater varus alignment with KA and less valgus joint line orientation angles in double-leg and single-leg positions. The mechanical axis passing position was more central with KA. The KA group had better flexion and KSS scores [5]. Tibial component migration did not differ [2].

In a study of computer-assisted bilateral TKAs, no significant differences in flexion or functional scores were observed, but fewer releases were needed and more patients preferred KA [10]. Mac-Dessi et al. similarly found fewer releases and bone recuts in the KA group, with fewer signs of imbalance like lift-off [11].

There were three RCTs that found no significant differences between the two alignment methods past mid-term follow-up [12–14]. At 2 years, Young et al. found no difference in pain or functional outcomes [12]. Waterson et al. found that KA may offer

some early benefits, but longer-term follow-up is necessary to fully understand its impact on function and implant survivorship [13]. At five years, no differences were found between the two methods, and survivorship from reoperation was similar with KA at 95.9% and MA at 94.1% [14].

This growing body of literature is currently limited by heterogeneous use of technology and the inclusion of several variants to the KA technique, including unrestricted KA, restricted KA, inverse KA, and functional alignment. KA has shown early recovery benefits, though long-term differences have not been demonstrated compared to MA.

CRediT authorship contribution statement

George A. Komnos: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Tom Meade:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Mohammadmahdi Sarzaem:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Mark Spangehl:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation. **Goksel Dikmen:** Writing – review & editing, Writing – original draft, Resources, Methodology, Formal analysis, Data curation. **Nifon K. Gkekakos:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Ibrahim Azboy:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Roshan P. Shah:** Writing – review & editing, Writing – original draft, Visualization, Validation, Data curation.

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