Committed to Create Value for Researchers

Journal of Orthopedics & Bone Disorders
ISSN: 2577-297X MEDWIN PUBLISHERS

Restoring Nature or Compromising Fixation? Reconsidering the Paradigm Shift towards Kinematic Alignment in Total Knee Arthroplasty

Victoria S and Helen V*

Research Scholar, USA

***Corresponding author:** Veronica Helen, Research Scholar, USA

Research Article
Volume 10 Issue 3
Received Date: August 26, 2026
Published Date: August 29, 2026

Abstract

For over four decades, orthopedic surgery operated on the rigid assumption that total knee arthroplasty must enforce a neutral 0° mechanical axis. Yet, up to 20% of patients remain functionally dissatisfied. The shift toward kinematic and personalized alignment promises to restore native joint obliquity and improve kinematics, but clinical consensus remains split. This editorial critically examines the historical origins, phenotypic realities, settled benefits, and lingering uncertainties of kinematic alignment in modern knee reconstruction.

Keywords: Total Knee Arthroplasty; Kinematic Alignment; Mechanical Alignment; Knee Phenotypes; CPAK Classification; Patient-Reported Outcome Measures

Abbreviations

TKA: Total Knee Arthroplasty; HKA: Hip Knee Ankle; MA: Mechanical Alignment; KA: Kinematic Alignment; CPAK: Coronal Plane Alignment of the Knee; RKA: Restricted Kinematic Alignment.

Editorial

The Mechanical Paradox and Historical Antecedents

Few paradoxes in adult reconstructive orthopedics are as persistent as the dissatisfied total knee arthroplasty (TKA) patient whose post-operative standing radiograph displays textbook execution. For nearly forty years, orthopedic training was underpinned by John Insall's foundational principles established in the late 1970s and 1980s. Insall's paradigm was straightforward: resect bone perpendicular to the mechanical axes of the femur and tibia, impose a uniform 0° hip-knee-ankle (HKA) mechanical alignment, and release soft tissues surgically until a symmetrical coronal flexionextension gap is achieved. This standardized, systematic philosophy brought reproducible implant survivorship and revolutionized joint replacement. Yet, it also created a persistent clinical blind spot. Despite radiographic perfection, up to 20% of primary TKA recipients continue to report residual tightness, unnatural joint awareness, midflexion instability, or anterior knee discomfort.

The underlying flaw in classical mechanical alignment (MA) lies in its fundamental assumption: that human knee anatomy is universally homogenous. By enforcing a 90° resection angle relative to the mechanical axis on both tibia and femur, MA routinely alters the patient's individual joint line orientation and soft-tissue envelope. In 2006, Stephen Howell introduced a disruptive alternative: Kinematic

Alignment (KA). Rather than reshaping the extremity to conform to a systematic geometric average, Howell proposed resurfacing the femoral and tibial articular surfaces to restore the patient's pre-arthritic joint line obliquity and natural rotational centres without releasing healthy collateral ligaments. By preserving constitutional joint orientation, KA sought to eradicate the kinematic conflict between implant geometry and native soft-tissue tension.

Phenotypic Heterogeneity and the Rise of Kinematic Variants

Modern anatomical mapping has decisively dismantled the myth of the universal 'neutral knee.' In a landmark 2021 investigation, MacDessi and colleagues established the Coronal Plane Alignment of the Knee (CPAK) classification system. Analysing thousands of arthritic and non-arthritic limbs, they demonstrated that fewer than 15% of individuals possess a true neutral mechanical alignment combined with a horizontal joint line. Instead, over 60% of the population exhibits constitutional varus paired with varying degrees of joint line obliquity. When a mechanically aligned TKA is performed on a patient with severe constitutional varus, the surgeon must execute asymmetrical bone cuts and extensive ligamentous releases to force the limb into neutral alignment. This process essentially creates an iatrogenic deformity, trading anatomical harmony for mechanical neutrality.

However, the enthusiasm for unrestricted Kinematic Alignment resurfacing the bone regardless of the degree of native deformity triggered immediate concern among joint replacement traditionalists. Critics pointed out that replicating extreme constitutional varus (HKA > 5° or tibial component varus > 5°) concentrates mechanical loads on the medial compartment, theoretically accelerating polyethylene wear, loosening of cement bonds, and early aseptic failure. To address these biomechanical vulnerabilities, Pascal-Andre Vendittoli introduced Restricted Kinematic Alignment (RKA). Restricted KA adopts the philosophy of replicating native anatomy but applies strict boundary conditions: individual bone cuts are restricted to within ±5° of the mechanical axis, and the overall postoperative HKA angle is constrained within ±3° of neutral. In limbs presenting with extreme constitutional deformities, RKA adjusts the alignment into a safe biomechanical window while minimizing the magnitude of soft-tissue releases required.

What the Evidence Settles vs. Where Uncertainty Persists

As clinical adoption of personalized alignment expands, it is vital to distinguish where scientific consensus is firmly established from areas where evidence remains contested or preliminary. Aggregate data from recent high-level metaanalyses and randomized controlled trials confirm several key findings.

First, Kinematic Alignment is unequivocally safe in shortto-midterm follow-up. Concerns that non-neutral alignment would lead to catastrophic early implant failure have proven unfounded. Multiple RCTs and registry studies demonstrate that KA and RKA achieve overall revision rates (≤ 2.0–2.5%) comparable to conventional mechanical alignment at 5 to 10 years post-operatively.

Second, patient-reported outcome measures consistently favour kinematic strategies in early recovery. Patients undergoing KA routinely achieve faster pain relief, superior early range of motion, improved Oxford Knee Scores, and significantly higher Forgotten Joint Score values compared to those managed with traditional mechanical alignment.

Nevertheless, critical gaps in the literature prevent an unqualified declaration of superiority. A primary issue is that while statistically significant improvements in PROMs are frequently documented for KA, the absolute difference often falls below established Minimal Clinically Important Difference thresholds when evaluated across unselected, heterogeneous patient cohorts. Furthermore, while 10year survivorship data from Howell and Vendittoli are encouraging, robust 15-to-20-year registry data evaluating highly cross-linked polyethylene performance under nonorthogonal shear loads in constitutionally varus knees remain sparse.

Clinical Synthesis and the Path Forward

Rather than viewing Mechanical Alignment and Kinematic Alignment as mutually exclusive dogmas, the modern reconstructive surgeon should embrace a spectrum of alignment philosophies guided by patient phenotype. For the minority of patients with neutral constitutional alignment, traditional mechanical principles remain highly effective. However, for the majority presenting with constitutional varus or joint line obliquity, a tailored approach such as Restricted Kinematic Alignment or Functional Alignment offers the optimal compromise: preserving native knee kinematics and soft-tissue balance while restricting implant orientation within proven long-term biomechanical limits.

Moving forward, the orthopaedic community must focus on identifying which specific knee phenotypes derive the greatest functional benefit from personalized alignment. Rather than asking whether kinematic alignment is universally superior to mechanical alignment, future research must determine which alignment philosophy is best suited for each distinct patient knee phenotype.

Victoria S and Helen V. Restoring Nature or Compromising Fixation? Reconsidering the Paradigm Shift towards Kinematic Alignment in Total Knee Arthroplasty. J Ortho Bone Disord 2026, 10(2): 000296.

Copyright© Victoria S and Helen V.