fortune Journals

Case Report

ARCHIVES OF CLINICAL AND MEDICAL CASE REPORTS

ISSN: 2575-9655

Past, Present and Future of TKA: An Expert Opinion or Point of View

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Abstract

Total knee arthroplasty (TKA) has come a long way from the first resection arthroplasty performed by Ferguson in 1861 to the cutting-edge technology utilized today. From removing bone to improvement function, to interposition arthroplasty in 1863, and introducing an ivory hinged prosthesis fixed with Plaster of Paris in 1891, it has indeed been a checkered journey. The mid-20th century saw the introduction of the metallic mold hemiarthroplasties fitted to femoral condyles and hinged prosthesis made initially of acrylic and then cobalt chromium, which were used till the late 1960s. Their high failure rate was on account of large bony resections and lack of sound kinematics.

Keywords: Orthopaedic; Total knee arthroplasty; Cutting edge

Introduction

The history of unconstrained knee replacement started with the introduction of an acrylic tibial plateau prosthesis to correct deformity and reduce pain (MacIntosh 1958). The late 1960s and early 1970s saw the introduction of semi-constrained and hinged knee designs. Semi-constrained options like the Geomatic knee focused on preserving both the cruciate ligaments using two linked femoral components and a polyethylene tibial articulating surface, which was connected to the femoral component to create a constrained articulation. Constrained or the unipolar hinged knee designs (Sheehan, GUEPAR, Attenborough) offered only flexion and extension. All these failed primarily because of the poor design and the lack of understanding of the knee being a modified condyloid joint. These hinges failed as they did not allow any rotatory options.

Ever since the condylar designs were introduced initially by John Insall and Chitranjan Ranawat (IB1 option), various improvements have taken place, both in terms of the cruciate retaining and the cruciate substituting design. These designs were utilized widely among various groups of surgeons across the world, with very good outcomes in the short, mid, and long term. Various registries recorded a survivorship of 98% at 10 years and 95% at 20 years [1] both for the cruciate retaining and cruciate substituting design and the cemented and cementless options. These knees were primarily implanted using the principle of mechanical alignment. Patellar buttons were largely an issue that was individually iterated by surgeons depending on their belief and philosophy. Long-term outcomes and registry data seem to suggest almost equal satisfaction rates with both the cemented and uncemented options and the cruciate retaining and substituting designs.

In 2006, Phil Noble wrote a landmark article, suggesting that approximately about 20%–25% of patients who underwent total knee arthroplasties were dissatisfied with their outcomes [2]. This has subsequently been revisited by

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Citation: Saccomanni Bernardin, Past, Present and Future of Tka: An Expert Opinion or Point of View. Archives of Clinical and Medical Case Reports. 10 (2026): 26-28.

Received: January 27, 2026
Accepted: February 03, 2026
Published: February 04, 2026

Bernardin S., Arch Clin Med Case Rep 2026
DOI:10.26502/acmcr.96550746

various other authors who have reported dissatisfaction rates ranging from 6.2% to 10.2% [3-5].

To address this high rate of dissatisfaction, surgeons looked at possible causes for the same. The primary cause which emerged was the issue of the need for variable alignment philosophies, which encouraged surgeons to look at alternate options. Stephen Howell introduced the concept of the kinematic alignment [6] while other surgeons explored constitutional, personalized, functional, and modified mechanical alignment. There has, however, yet been no clear mandate that one alignment philosophy gives better outcomes compared to others [7].

MacDessi introduced the concept of the coronal plane alignment of the knee (CPAK) classification, dividing the knees into a grid block of nine different phenotypes, incorporating the Hip–Knee–Ankle angle and Joint Line Obliquity. He emphasized the fact that retaining the original preoperative CPAK nomenclature would result in good outcomes and higher satisfaction rates [8].

Reports in literature have, however, not demonstrated clear advantages in terms of achieving the original CPAK as a surrogate for patient satisfaction and outcomes [9].

The introduction of technology in terms of computer navigation, patient specific instrumentation (PSI), and now robotics to the armamentarium of the arthroplasty surgeon has evoked a lot of interest. The purported advantage of robotics has been early recovery with better and more predictable outcomes, by achieving a personalized knee alignment. However, the midterm results of almost all available registries report outcomes using enabling technologies, particularly the robotic platform, to be at best comparable to those achieved by using conventional manual techniques. The role of technology has been a game changer in two clinical scenarios: One to get the right version for the acetabulum in total hip replacement and the second for its role in noncompartmental replacement. In total knee arthroplasties, technology is an additive component but has yet not demonstrated better results in terms of patient outcomes, scores, or satisfaction.

Which begs the question: Is technology in its present iterations and options a game changer? The multitude of alignment options currently available, facilitated using enabling technology, certainly helps achieve predesignated goals, but outcomes have not yet shown better clinical outcomes.

Currently, looking at the recent 2024 American and the Australian registry data, almost 85% of all knees implanted are still being implanted in the mechanical cohort. The results of mechanical alignment or the adjusted variation of the same have given excellent outcomes for four decades [10] and cannot be discarded.

Good clinical results depend on sound surgical technique and patient selection, and it is hard to believe that an alignment difference of 2°–3° between different alignments can explain poor outcomes, increased implant stress, and decreased survivorship [11].

At this time, it can be safely surmised that there is no single alignment target that suits all knees. Ideal implant positioning in TKA remains a controversial and unanswered question, and we are far from replicating normal knee kinematics regardless of alignment options [12,13].

Surgeons who contemplate doing total knee replacement today, should take a cue from long-term results of already established available options.

While there is a push in terms of using technology and alternate alignments, it begs the question: have these iterations using technology and alternative alignments really been successful in giving better outcomes, with greater patient satisfaction? The answer to that question must remain NO.

Clearly, there is no BEST way to perform a TKA, nor a way that unequivocally improves outcomes [14].

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Citation: Saccomanni Bernardin, Past, Present and Future of Tka: An Expert Opinion or Point of View. Archives of Clinical and Medical Case Reports. 10 (2026): 26-28.