

EDITORIAL

Robotic-assisted Total Knee Arthroplasty versus Conventional Total Knee Arthroplasty

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It has been reported that robotic arm-assisted arthroplasty ensures optimal implant position.¹⁻³ In 2023, Poursalehian et al. reported a bibliometric analysis of publications on total knee arthroplasty (TKA) in the journal Archives of Bone and Joint Surgery, covering the period from 2018 to 2022. One of the hotspots in TKA research mentioned by the aforementioned authors in their article was robotic-assisted TKA (RA-TKA).⁴

According to Khan et al, RA-TKA is foreseen to make up more than 70 % of all TKAs carried out in the USA by 2030.⁵ In this study two national databases (Nationwide Inpatient Database and National Ambulatory Surgery Service Database) from 2012 to 2020 were examined for conventional TKA (C-TKA) and RA-TKA utilizing ICD-10 and CPT codes. The use of RA-TKA increased from 0.01% in 2008 to 8.5% in 2020. It is expected that by 2030, RA-TKA will account for 70.1% of the 2,631,972 TKAs performed. C-TKA had statistically significant higher rates of mechanical (1.8% vs. 0.7%), non-mechanical (30.1% vs. 24.9%), and infectious (1.8% vs. 0.7%) complications than RA-TKA. In addition, the length of stay (LOS) in patients undergoing RA-TKA was shorter than in patients undergoing C-TKA (1.9 vs. 2.8 days, statistically significant difference). However, the results of this study should be interpreted with caution, as it was retrospective, based on administrative codes that could lead to misclassifications, and did not include outpatient data prior to 2018.⁵

It is currently still unknown whether the medium- and long-term results of RA-TKA are superior to those of C-TKA. Therefore, the purpose of this Editorial has been to identify articles published in PubMed between January 1, 2025, and August 28, 2025, using the keywords "Robotic-assisted TKA 2025." A total of 168 articles were found, of which only five were ultimately analyzed because they were considered to be of the greatest interest in relation to the title of this Editorial.⁵⁻⁹

In a systematic review and meta-analysis that included all reported randomized controlled trials (RCTs) from inception to August 2024, Mostafa et al. reported that RA-TKA achieved better mechanical alignment accuracy than C-TKA, but did not yield better short- to medium-term functional results. Besides, RA-TKA required longer

surgical times. These authors also stated that the clinical benefits and cost-effectiveness of RA-TKA needed further assessment, particularly in long-term studies.⁶ However, this systematic review and meta-analysis has significant limitations. One of these is that it was quite difficult to compare studies due to the heterogeneity in the outcome measurement parameters and follow-up periods. The lack of long-term results in most studies did not allow for a correct assessment of the possible long-term benefits of the improved alignment provided by RA-TKA. In addition, the rapid evolution of robotic technology means that some previous studies may not have reflected the capabilities of current systems. For all these reasons, I agree with Mostafa et al. that the decision to use RA-TKA should be made with caution, taking into account its cost, the necessary learning curve, and the needs of each surgical team and institution. Future studies should focus on the long-term results of RA-TKA, its potential cost-effectiveness, and its possible benefits in complex cases or revision surgeries.⁶

Chen et al. found that C-TKA was non-inferior to RA-TKA at both short-term and long-term follow-up regarding implant survival, adverse events, and postoperative pain scores, while RA-TKA showed subtle improvements in functional outcome measures. In this systematic review and meta-analysis, Chen et al. found that at ten years postoperatively, survivorship rates in the C-TKA were 97% and 98% in the RA-TKA cohort. There were no significant differences between the cohorts ($P = 0.3$).⁷ Although in this study the short- and long-term prosthetic survival of RA-TKAs was slightly higher (but not statistically significant) than the prosthetic survival of C-TKAs, Chen et al did not have sufficient data to reach definitive conclusions about the comparisons between semi-active and active robotic systems.⁷ Therefore, I agree with Chen et al that more high-quality studies with longer follow-up periods are needed to confirm that the functional advantages observed by these authors translate into greater long-term survival.

In the study of Ziedas et al. RA-TKA and C-TKA had similar revision rates at 5-year follow-up: cemented RA-TKA, 3.9%; cemented C-TKA, 3.5%; cementless RA-TKA, 1.8%; cementless C-TKA, 2.8%.⁸ In this collaborative

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study based on the Michigan Arthroplasty Registry quality initiative, all primary TKAs performed between January 2012 and July 2023 were analyzed. RA-TKAs and C-TKAs were compared for revisions and adverse events at 90 days, including emergency department (ED) visits, readmissions, and return to surgery. Cemented RA-TKAs required more revisions for periprosthetic infection, more ED visits at 90 days, and more readmissions for wound complications than cemented C-TKAs. Cementless RA-TKAs required more readmissions at 90 days due to wound complications, while C-TKAs had more 90-day ED visits due to postoperative pain. The duration of surgery was longer in cemented and cementless RA-TKAs. However, their LOS and revision time were shorter.⁸ As this was a retrospective study with level III evidence, I believe that its conclusions should be taken with caution. Therefore, high-quality randomized trials or prospective studies would be needed to confirm its findings.

In a study with a minimum 15-year follow-up, Yang et al. stated that compared to C-TKA, RA-TKA might be associated with fewer alignment outliers and enhanced aseptic implant survivorship. A retrospective analysis with level III of evidence was conducted on 150 individuals who experienced RA-TKA and 147 individuals who experienced C-TKA for knee osteoarthritis between March 2005 and December 2008, with a minimum follow-up of 15 years. Both cohorts showed significant clinical improvement, with no significant differences in clinical scores between them. However, the RA-TKA cohort had significantly fewer alignment outliers for the hip-knee-ankle (HKA) axis and sagittal component positioning compared to the C-TKA cohort. The RA-TKA cohort also showed a significantly lower rate of revision due to aseptic mechanical failure (0.6% vs. 4.8%). Kaplan-Meier analysis utilizing aseptic failure as the endpoint estimated a 17.3-year survival rate of 98.7% in the RA-TKA cohort and 95.2% in the C-TKA cohort. Younger age, postoperative varus malalignment, and femoral component varus malpositioning were significant risk factors for mechanical failure. However, Yang et al. also noted that their conclusions should be interpreted with caution because of the retrospective design of their study and the high percentage of loss to follow-up.⁹

According to Khan et al., the increasing integration of robotic technology highlights the need for more in-depth investigations into cost efficiency and long-term outcomes to understand the consequences of widespread adoption of RA-TKA as a standard surgical procedure.⁵ I find Khan et al's conclusion very reasonable and, in fact, I completely agree with it.

Conclusion

In conclusion, my opinion is that the most recent literature has not yet demonstrated in a scientifically sound manner that the long-term results of RA-TKA are better than those of C-TKA. Therefore, considering that C-TKA currently offers excellent long-term results for patients with advanced pain osteoarthritis, I believe that RA-TKA cannot be routinely recommended.

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