

Does the use of robotics improve the outcome of primary total knee arthroplasty?

Alisagib A. Dzhavadov, Goksel Dikmen, Jenna A. Bernstein, Jose I. Fregeiro, Xiang Li, Ming Han Lincoln Liow, David Liu, Bharat S. Mody, Javad Parvizi, Jan Victor, Guoqiang Zhang

Response/Recommendation: The use of robotics appears to improve radiographic alignment for primary total knee arthroplasty (TKA) but there is no clear improvement in function or outcome measures, based on a number of meta-analyses of randomized controlled trials.

Rationale:

Total knee arthroplasty (TKA) is an effective surgical procedure alleviating pain and restoring function to patients with arthritis of the knee [1,2]. However, persistence of pain and patient dissatisfaction is not uncommon after primary TKA [3]. Various technological advancements have been developed over time with the intention of improving the results of primary TKA [4]. One such technology is robotic-assisted total knee arthroplasty (RA-TKA) [5]. The purpose of this review is to summarize the results of systematic reviews and meta-analyses of randomized controlled trials (RCT) comparing the results of RA-TKA and conventional total knee arthroplasty (CO-TKA).

Initially, 1086 records were retrieved. After removing 502 duplicates, the titles and abstracts of 584 studies were screened. 78 studies were then subjected to full-text review. Ultimately, 3 systematic reviews and meta-analyses of RCT were included in the review [6,7,8]. Synopsis of relevant studies are presented here.

Only one study, Bensa et al. [6] found improvement in patient recorded outcome measurements (PROMs) in the RA-TKA group compared to the CO-TKA group, specifically the Western Ontario and McMaster Universities Osteoarthritis Index and Oxford Knee Score. The authors emphasized that the difference between the study groups did not reach the minimal clinically important difference (MCID).

In a meta-analysis by Alrajeb et al. [7] patients receiving RA-TKA had better mechanical axis deviation (MAD) and tibio-femoral axis deviation (TFAD). However, the heterogeneity for TFAD was 86%. Similarly, the study by Ruangsomboon et al. [8] demonstrated benefits in the RA-TKA group compared with the CO-TKA group in terms of MAD and mechanical axis outliers, but the MCID were not achieved.

Ruangsomboon et al. [8] and Bensa et al. [6] both found that the CO-TKA group had shorter operative times compared with the RA-TKA group. However, one of the meta-analyses did not provide heterogeneity data and another meta-analysis noted high heterogeneity of 99%.

There were no differences in complications, implant survival, blood loss, hospital length of stay and range of motion [6,7,8].

There are scant high level studies comparing RA-TKA with CO-TKA. However, based on the available data, RA-TKA does not show clear benefits in terms of clinical outcomes or function, while there seems to be some benefits in radiographic precision. There is a need for future non-commercial studies of high methodological quality, that can evaluate the role of robotics in joint arthroplasty. In the digital age, new evaluation tools need to be developed, which may help to discover potential outcome differences. Each robotic system needs to be assessed on its own merits, as they differ in workflow, execution tool and corresponding prosthesis design. Future studies investigating RA-TKA will have to not only consider the effect of robotic delivery systems, but also consider the affect of the alignment target and prosthesis design on differences in outcome.

References

[1] Carr AJ, Robertsson O, Graves S, Price AJ, Arden NK, Judge A, Beard DJ. Knee replacement. *Lancet*. 2012 Apr 7;379(9823):1331-40. [https://doi.org/10.1016/S0140-6736\(11\)60752-6](https://doi.org/10.1016/S0140-6736(11)60752-6).

- [2] Preobrazhensky P.M., Fil A.S., Kornilov N.N., Panteleev A.N., Guatsaev M.S., Kazemirsky A.V., Mazurenko A.V., Sereda A. Current State of Knee Arthroplasty in Russia: Analysis of 36,350 Cases from the Register of the Vreden National Medical Research Center of Traumatology and Orthopedics // Traumatology and Orthopedics of Russia. - 2023. - Vol. 29. - N. 3. - P. 73-85. <https://doi.org/10.17816/2311-2905-9349>
- [3] Gunaratne R, Pratt DN, Banda J, Fick DP, Khan RJK, Robertson BW. Patient Dissatisfaction Following Total Knee Arthroplasty: A Systematic Review of the Literature. J Arthroplasty. 2017 Dec;32(12):3854-3860. <https://doi.org/10.1016/j.arth.2017.07.021>. Ep
- [4] Hinloopen JH, Puijk R, Nolte PA, Schoones JW, de Ridder R, Pijls BG. The efficacy and safety of patient-specific instrumentation in primary total knee replacement: a systematic review and meta-analysis. Expert Rev Med Devices. 2023 Mar;20(3):245-252. <https://doi.org/10.1080/17434440.2023.2177152>.
- [5] Park SE, Lee CT. Comparison of robotic-assisted and conventional manual implantation of a primary total knee arthroplasty. J Arthroplasty. 2007 Oct;22(7):1054-9. <https://doi.org/10.1016/j.arth.2007.05.036>.
- [6] Bensa A, Sangiorgio A, Deabate L, Illuminati A, Pompa B, Filardo G. Robotic-assisted mechanically aligned total knee arthroplasty does not lead to better clinical and radiological outcomes when compared to conventional TKA: a systematic review and meta-analysis of randomized controlled trials. Knee Surg Sports Traumatol Arthrosc. 2023 Nov;31(11):4680-4691. <https://doi.org/10.1007/s00167-023-07458-0>.
- [7] Alrajeb R, Zarti M, Shuia Z, Alzobi O, Ahmed G, Elmhiregh A. Robotic-assisted versus conventional total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. Eur J Orthop Surg Traumatol. 2024 Apr;34(3):1333-1343. <https://doi.org/10.1007/s00590-023-03798-2>.

[8] Ruangsomboon P, Ruangsomboon O, Pornrattanamaneeewong C, Narkbunnam R, Chareancholvanich K. Clinical and radiological outcomes of robotic-assisted versus conventional total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. *Acta Orthop.* 2023 Feb 20;94:60-79. <https://doi.org/10.2340/17453674.2023.94>