

Does the use of robotic technology improve outcomes in primary total hip arthroplasty?

Alisagib A. Dzhavadov, Goksel Dikmen, Ömer Faruk Bilgen, Emrah Caliskan, Michele R. D'Apuzzo, Javad Parvizi, Todd Sekundiak, Ibrahim Tuncay, Seng Jin Yeo, Luigi Zagra

Response/Recommendation: Based on available evidence, robotic-assisted total hip arthroplasty does not provide clear advantages over conventional total hip arthroplasty.

Rationale:

Conventional total hip arthroplasty (CO-THA) has proven to be effective in the treatment of end-stage osteoarthritis of the hip [1]. Despite this, ongoing efforts are being made to improve the results of primary total hip arthroplasty (THA) through the development of various innovative technologies. Robotics have been introduced recently with the intention of improving the outcome of THA [2]. In recent years, a number of systematic reviews and meta-analyses have been published comparing the results of robotic-assisted total hip arthroplasty (RA-THA) and CO-THA. The purpose of this review is to summarize the results of systematic reviews and meta-analyses comparing the results of RA-THA and CO-THA.

Using the search strategy, 192 records were found. After removing 54 duplicates, the titles and abstracts of 138 studies were screened. A full-text review of 27 studies was carried out. The full-text review resulted in the exclusion of 19 studies. Ultimately, 8 systematic reviews and meta-analyses were included in the review [3,4,5,6,7,8,9,10]. A brief analysis of relevant studies is presented here.

Samuel et al. [3] and Ng et al. [6] in their meta-analyses reported better results in the RA-THA group compared with the CO-THA group using the Harris Hip Score and Western Ontario McMaster Universities Osteoarthritis Index, respectively. However, Ng et al. [6] emphasize that the minimal clinically important difference

was not achieved. At the same time, Samuel et al. [3] conclude that, collectively, RA-THA and CO-THA demonstrate comparable functional results.

Emara et al. [7], Kumar et al. [4] and Wang et al. [5] found that postoperative limb length discrepancy after RA-THA was less compared with CO-THA, but there was high heterogeneity in the meta-analysis. For other radiographic parameters, RA-THA also showed better results in terms of component positioning [4,5,6,7,8,9].

A lower incidence of intraoperative and total complications was noted in the RA-THA group [5,8,9], on the other hand, a number of meta-analyses indicated a higher frequency of dislocations [5,9], revisions [9] and heterotopic ossifications [8] after RA-THA. The authors of meta-analyses associate the high frequency of dislocations with muscle insufficiency, which arose due to the need in some cases for RA-THA to use a greater surgical exposure and thereby cause greater damage to the abductor muscles [5,9]. There was also an association between dislocations and revision rate in the RA-THA group [9]. Chen et al. [8] suggested that the increased incidence of heterotopic ossification after RA-THA may be related to locator pin placement and potential bias in etiology.

The current meta-analysis showed that the CO-THA group had shorter operative time than the RA-THA. The longer operative time with RA-THA most likely relates to pin placement, stages of registration, as well the learning curve [4,5,9].

This review found no clear benefit of RA-THA in comparison to CO-THA. There remains a need to conduct methodologically high-quality research, including comparative cost analysis to evaluate if the additional costs associated with robotics are justified.

References

[1] Shubnyakov II, Riahi A, Denisov AO, Korytkin AA, Aiev AG, Veber EV, et al. The main trends in hip arthroplasty based on the data in the vreden's arthroplasty

register from 2007 to 2020. *Traumatol Orthop Russ* 2021;27:119-42. <https://doi.org/10.21823/2311-2905-2021-27-3-119-142>.

[2] Emara AK, Zhou G, Klika AK, Koroukian SM, Schiltz NK, Higuera-Rueda CA, Molloy RM, Piuzzi NS. Is there increased value in robotic arm-assisted total hip arthroplasty?: a nationwide outcomes, trends, and projections analysis of 4,699,894 cases. *Bone Joint J* 2021;103-B(9):1488-1496. <https://doi.org/10.1302/0301-620X.103B9.BJJ-2020-2411.R1>.

[3] Samuel LT, Acuña AJ, Mahmood B, Emara AK, Kamath AF. Comparing early and mid-term outcomes between robotic-arm assisted and manual total hip arthroplasty: a systematic review. *J Robot Surg* 2022;16(4):735-748. <https://doi.org/10.1007/s11701-021-01299-0>.

[4] Kumar V, Patel S, Baburaj V, Rajnish RK, Aggarwal S. Does robotic-assisted surgery improve outcomes of total hip arthroplasty compared to manual technique? A systematic review and meta-analysis. *Postgrad Med J* 2023;99(1171) 375–383 <https://doi.org/10.1136/postmj/postgradmedj-2021-141135>.

[5] Wang Y, Wang R, Gong S, Han L, Gong T, Yi Y, et al. A comparison of radiological and clinical outcomes between robotic-assisted and conventional total hip arthroplasty: A meta-analysis. *Int J Med Robot* 2023;19(1):e2463. <https://doi.org/10.1002/rcs.2463>.

[6] Ng N, Gaston P, Simpson PM, Macpherson GJ, Patton JT, Clement ND. Robotic arm-assisted versus manual total hip arthroplasty: a systematic review and meta-analysis. *Bone Joint J* 2021;103-B(6):1009-1020. <https://doi.org/10.1302/0301-620X.103B6.BJJ-2020-1856.R1>.

[7] Emara AK, Samuel LT, Acuña AJ, Kuo A, Khlopas A, Kamath AF. Robotic-arm assisted versus manual total hip arthroplasty: Systematic review and meta-analysis of radiographic accuracy. *Int J Med Robot* 2021;17(6):e2332. <https://doi.org/10.1002/rcs.2332>.

- [8] Chen X, Xiong J, Wang P, Zhu S, Qi W, Peng H, et al. Robotic-assisted compared with conventional total hip arthroplasty: systematic review and meta-analysis. *Postgrad Med J* 2018;335-341. <https://doi.org/10.1136/postgradmedj-2017-135352>.
- [9] Han PF, Chen CL, Zhang ZL, Han YC, Wei L, Li PC, et al. Robotics-assisted versus conventional manual approaches for total hip arthroplasty: A systematic review and meta-analysis of comparative studies. *Int J Med Robot.* 2019;15(3):e1990. <https://doi.org/10.1002/rcs.1990>.
- [10] Karunaratne S, Duan M, Pappas E, Fritsch B, Boyle R, Gupta S, et al. The effectiveness of robotic hip and knee arthroplasty on patient-reported outcomes: A systematic review and meta-analysis. *Int Orthop* 2019;43(6):1283-1295. <https://doi.org/10.1007/s00264-018-4140-3>.