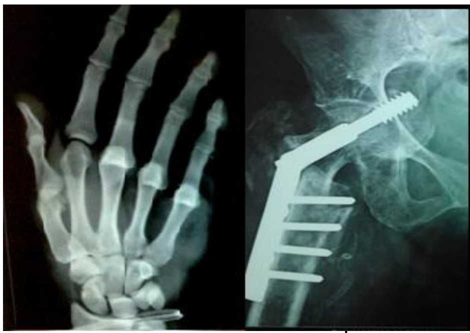

International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(3): 352-355

https://www.orthopaper.com
Received: 19-04-2023
Accepted: 17-06-2023

Dr. Kathan A Talsania
M.B.B.S., D Ortho, DNB
Registrar - Apollo Hospitals, Chennai, Tamil Nadu, India

Dr. Balachandar
Associate Consultant - Apollo Hospitals, Chennai, Tamil Nadu, India

Corresponding Author:
Dr. Kathan A Talsania
M.B.B.S., D Ortho, DNB
Registrar - Apollo Hospitals, Chennai, Tamil Nadu, India

A detailed retrospective analysis of time taken in conventional total knee arthroplasty and comparision with navigation assisted total knee arthroplasty

Dr. Kathan A Talsania and Dr. Balachandar

DOI: https://doi.org/10.22271/ortho.2023.v9.i3e.3444

Abstract

Introduction: Total knee arthroplasty (TKA) is a prevalent procedure for alleviating pain and restoring joint function in patients with knee joint deterioration. Navigation-assisted robotic total knee arthroplasty (NARTKA) is an emerging technique aiming to improve surgical precision and patient outcomes. Concerns regarding prolonged surgery duration and associated morbidities have driven interest in advanced technologies. This study investigates the impact of robotic assistance on surgery time, focusing on NARTKA and its additional steps.

Methodology: A retrospective study was conducted at Apollo Hospitals Chennai from January to June 2023, involving 60 patients who underwent conventional or NARTKA. Only experienced surgeons (≥ 15 years) were included. The study aimed to compare surgical time between conventional TKA and NARTKA, as well as analyze time consumption in various NARTKA steps.

Results: Comparative analysis revealed no statistically significant differences in mean time between Incision time, Bone pin time, Bone registration time, Balancing time, Bone preparation time, Implant trial time, and Final implantation time in robotic TKA (P=0.891). Similarly, there was no significant difference in time between Incision time and final implantation time between Conventional TKA and Robotic TKA (P=0.219).

Conclusion: While NARTKA shows slightly extended surgical duration compared to traditional TKA, the difference is not significant for highly experienced surgeons. Areas for improvement include bone registration and ligament balancing, which could enhance efficiency. Modifications to navigation-assisted robotic equipment and improved training for surgical staff are crucial. As technology evolves, advanced methods may outpace traditional approaches in terms of speed.

Keywords: Navigation-assisted robotic TKA, Conventional TKA, Surgical time, Additional steps in robotic TKA

Introduction

Total knee arthroplasty (TKA) is a common orthopeadic procedure used to alleviate pain and restore joint function in patients with significant osteochondral deterioration of the knee joint. Navigation-assisted robotic total knee arthroplasty (Nartka) is an emerging technique with the potential to enhance surgical precision and patient outcomes. The prolonged surgery duration associated with increased morbidities has been a concern for both surgeons and patients. Modern robotic systems offer capabilities such as pre-planning, data collection, and retrospective analysis, enabling the identification of trends and best practices for robotic TKA procedures. Advances in navigation technology within robotic systems have further improved precision, benefiting hip, knee, and ankle centering, accurate pin and checkpoint registrations, bone mapping, and multi-dimensional tracking. This ensures that the robotic arm maintains precision by accurately following the surgeon's movements throughout the surgery. However, literature on robotic surgery in arthroplasty is limited, particularly in terms of clinical and comparative data. This section provides an overview of the significance of surgery duration in TKA procedures and underscores the need to explore the impact of robotic assistance on surgical time, along with a time analysis of additional steps in navigation-assisted robotic total knee arthroplasty (NARTKA) performed by experienced surgeons.

Materials and Methods

A retrospective open-label randomized control study was conducted in the Orthopaedics department of Apollo Hospitals Chennai from January 2023 to June 2023. The study included 60 patients who underwent either conventional or navigation-assisted robotic total knee arthroplasty. Sample size calculation was based on a previous study's prevalence of osteoarthritis (3.91%). Patients aged 18 to 80 years undergoing primary TKA by surgeons with over 15 years of experience were included. Exclusions comprised patients undergoing revision Total Knee Arthroplasty and procedures performed by less experienced arthroplasty surgeons.

The study aimed to compare the time required for conventional TKA and navigation-assisted robotic TKA (NARTKA). The secondary objective was to analyze the time consumed by various additional steps in NARTKA and identify areas for improvement.

Methodology

To ensure result accuracy, only patients operated on by highly experienced surgeons with over 15 years of expertise were included. Patients undergoing NARTKA underwent knee joint CT scans using the Mako knee CT scanning protocol (PN 200004). A total of 60 TKA procedures were performed using the Stryker MAKO navigation and robotic system with software version 2.0. This system was employed for pre-surgical planning, ligament balancing, implant positioning, and gap assessment. Identical lines of prosthesis were used for cemented instances on the tibia and femur. Additional surgical steps in NARTKA included bone array implantation, bone tracker pin insertion, bone registration and verification, resection planning, and gap balancing. Surgical stage durations were meticulously recorded by a dedicated individual who remained present throughout the entire process.

The primary objectives were to compare the time from incision to final implantation between conventional TKA and robotic TKA, as well as to perform a comprehensive analysis of the time required for the supplementary stages in navigation-assisted robotic TKA (NARTKA).

Ethical clearance was obtained from the institutional ethics committee.

Results

Following a patient time-out at the procedure's initiation, a midline incision was made, and an arthrotomy was conducted through a medial parapatellar approach into the joint. Both the meniscus and the ACL were excised. On average, this step took 13.49 minutes (SD 4.36, Range 6.54-21.05) in standard TKA and 13.79 minutes (SD 3.96, Range 6.45-20.44) in NARTKA. In NARTKA, an average of 13.94 minutes (SD 3.95, Range 6.51-20.55) was required for the insertion of femoral and tibial biotical array pins and tracking checkpoints. Registering the tibia and femur and aligning their anatomies with the preoperative CT scan took a total of 14.07 minutes (SD 3.99, Range 6.53-21.03). Following the navigation system's accurate recognition of the anatomy, ligament balancing was determined, consuming an average of 14.24 minutes (SD 3.98, Range 6.58-21.12). Once anatomical alignment and ligament balance were established, the MAKO robot's robotic arm saw blade model was used for tibial and femoral bone cuts, requiring 14.53 minutes (SD 3.94, Range 7.03-21.27). Subsequently, all remaining marginal osteophytes and meniscus fragments were excised, followed by thorough irrigation. The trial prosthesis was tested, with an average time of 14.82 minutes (SD 3.97, Range 7.11-21.46) in NARTKA and 13.97 minutes (SD 4.95, Range 1.49-21.51) in traditional TKA. The steps of Palacos cementing and final prosthetic implantation took an average of 14.96 minutes (SD 4, Range 7.15-21.54) in NARTKA and 14.17 minutes (SD 4.98, Range 2.01-22.07) in conventional TKA (Table 1).

Table 1: Descriptive statistics of mean and SD time difference in stages of Robotic TKA and Conventional TKA

		Groups	
		Robotic TKA	**Conventional TKA**
	Frequency	30	30
Incision Time	Mean	13.79	13.49
	SD	3.96	4.36
	Minimum	6.45	6.54
	Maximum	20.44	21.05
Bone Pin Time	Mean	13.94	0
	SD	3.95	0
	Minimum	6.51	0
	Maximum	20.55	0
Bone Registration Time	Mean	14.07	0
	SD	3.99	0
	Minimum	6.53	0
	Maximum	21.03	0
Balancing Time	Mean	14.24	0
	SD	3.98	0
	Minimum	6.58	0
	Maximum	21.12	0
Bone Preparation Time	Mean	14.53	0
	SD	3.94	0
	Minimum	7.03	0
	Maximum	21.27	0
Implant Trial Time	Mean	14.82	13.97
	SD	3.97	4.95
	Minimum	7.11	1.49
	Maximum	21.46	21.51
Final Implantation Time	Mean	14.96	14.17
	SD	4	4.98
	Minimum	7.15	2.01
	Maximum	21.54	22.07

A comparison of the mean time differences between Incision time, Bone pin time, Bone registration time, Balancing time, Bone preparation time, Implant trial time, and Final implantation time in robotic TKA was described in Table 2, which yielded a p-value of 0.891, indicating statistical insignificance. Similarly, a comparison of the time differences between Incision time and final implant time between Conventional TKA and Robotic TKA was presented in Table 3, also showing statistical insignificance (Table 2, 3).

Table 2: Comparison of mean time difference between Incision time, Bone pin time, Bone registration time, Balancing time, Bone preparation time, Implant trial time and Final implantation time in robotic TKA

	N	**Mean**	**SD**	**F**	**P Value**
Incision time	30	13.79	3.96	0.38	0.891
Bone pin time	30	13.94	3.95		
Bone registration time	30	14.07	3.99		
Balancing time	30	14.24	3.98		
Bone preparation time	30	14.53	3.94		
Implant trial time	30	14.82	3.97		
Final implantation time	30	14.96	4.00		

*Statistical significance set at 0.05; N: Number of samples; SD: Standard deviation

Interpretation
Hypotheses

Null hypothesis	Alternative hypothesis
There is no difference between the 7 categories of the independent variable with respect to the dependent variable.	There is a difference between the 7 categories of the independent variable with respect to the dependent variable.

Analysis of variance
A one-factor analysis of variance has shown that there is no significant difference between the categorical variable and the dependent variable $F = 0.38$, $p = .891$ Thus, with the available data, the null hypothesis is not rejected.

Post hoc Test
The ANOVA showed that there was no significant difference, so it is not reasonably possible to compute a post hoc test.

Table 3: Comparison of the difference in time of Incision time and final implant time between Conventional TKA and Robotic TKA

	Groups	N	Mean	SD	T	P Value
Incision time - Final Implant time	Conventional TKA	30	0.68	2.14	-1.243	0.219
	Robotic TKA	30	1.17	0.31		

*Statistical significance set at 0.05; N: Number of samples; SD: Standard deviation

Interpretation
Hypotheses

Null hypothesis	Alternative hypothesis
There is no difference between the Conventional TKA and Robotic TKA groups with respect to the dependent variable Final Implant time - Incision time	There is a difference between the Conventional TKA and Robotic TKA groups with respect to the dependent variable Final Implant time - Incision time

Descriptive statistics
The results of the descriptive statistics show that the Conventional TKA group has lower values for the dependent variable Incision time - Final Implant time ($M = 0.68$, $SD = 2.14$) than the Robotic TKA group ($M = 1.17$, $SD = 0.31$).

T-Test for independent samples
A two-tailed t-test for independent samples (equal variances assumed) showed that the difference between Conventional TKA and Robotic TKA with respect to the dependent variable Final Implant time - Incision time was not statistically significant, $t(58) = -1.24$, $p = .219$, 95% confidence interval [-1.28, 0.3]. Thus, the null hypothesis is retained.

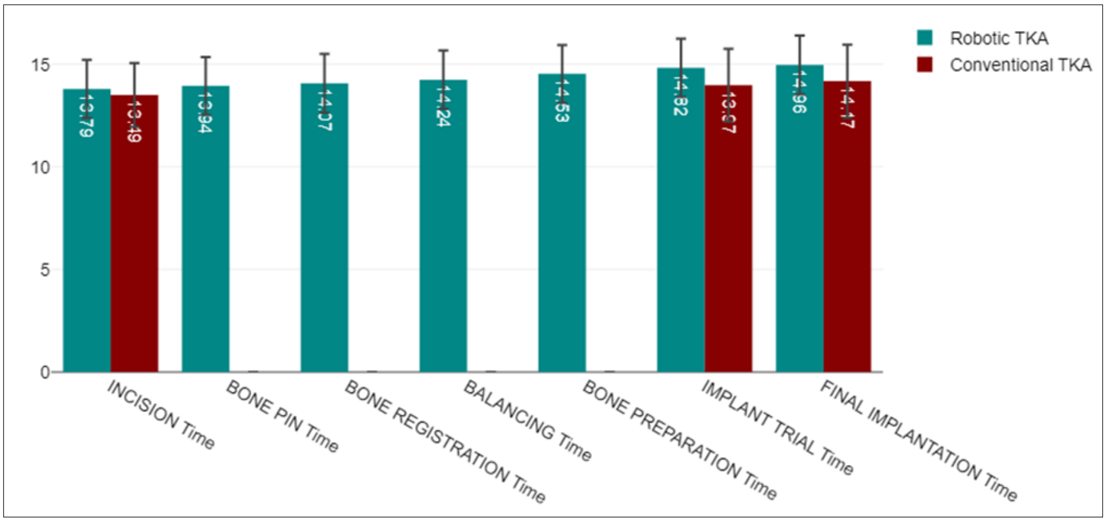

Fig 1: Mean distribution of different time levels among Robotic TKA and Conventional TKA

Discussion
The surgical exposure was then closed in layers. When comparing NARTKA to traditional TKA, the additional steps of NARTKA, such as femoral and tibial bicortical arrays and tracking checkpoints, bone registration, and ligament balancing, extend the operating time. This extension could be attributed to the surgeons' lack of experience with the new navigation system and robotic technology. Even those surgeons who have previously performed TKA with navigation guidance and now have the extra robotic guidance find that executing the additional steps of NARTKA takes more time. Both the surgical scrub team and nursing staff are unfamiliar with this navigation-assisted robotic equipment. The lack of expertise and training among the scrub nursing team also significantly contributes to the time extension in these stages. Implementing step-by-step training for the scrub team and nursing staff is expected to enhance efficiency and reduce the time required by the surgeon to complete these steps. In a recent study, Held *et al*. found a greater estimated blood loss in the robotic group, which may be attributed to the prolonged operative time [7]. Another long-term study by Kim *et al*. associated the robotic group with increased blood loss and postoperative drainage volume [8]. In NARTKA, two key steps that consume more time are bone registration and ligament balancing, which can be expedited with experience. Even during the NARTKA bony preparation process, changing the saw blade after anterior, chamfer, and distal femur cuts is necessary. Simplifying this process by designing a saw model that eliminates the need for blade changes between bony preparation stages could enhance efficiency. More time is spent on the bone preparation step in NARTKA to ensure that soft tissues do not interfere because the robotic arm's saw blade and navigation system cannot detect soft tissues during bone cutting. The presence of tracker arrays on the femur and tibia, as well as the robotic arm model arrays, makes it challenging for surgeons to reposition while making cuts. When comparing the total time difference between NARTKA and traditional TKA, the p-value is 0.219,

indicating statistical insignificance. Thus, highly experienced surgeons proficient in navigation and robotic systems can perform surgeries within the same time frame as conventional surgeries. Conversely, young arthroplasty surgeons still have a steep learning curve to achieve favorable outcomes.

Limitations
This study include a relatively small sample size and the absence of a comparison between young and highly experienced surgeons. Additionally, the study involved multiple surgeons, introducing potential variability in results and outcomes.

Conclusion
In conclusion, navigation-assisted robotic total knee arthroplasty takes longer than traditional knee arthroplasty but not significantly for highly experienced surgeons. There is room for improvement in various processes, particularly bone registration and ligament balancing, which surgeons can adapt for greater efficiency. Modifying the directions of the arrays and the robotic saw blade model could facilitate younger surgeons' execution of the steps. Scrub staff training and experience are crucial for successful navigation-assisted robotic surgery. It is anticipated that these advanced technologies will continue to evolve, eventually enabling surgeries to be performed more rapidly than traditional methods.

Acknowledgement
Research Department Apollo Hospital.

Funding: No external funding.

Conflicts of interest/Competing interests: No conflicts of interest.

Consent to participate: The patients were informed that data concerning their cases would be used for research purposes.

Consent for publication: The author of this manuscript consents for publication.

Abbreviations
NARTKA: Navigation Assisted Robotic Total Knee Arthroplasty.
TKA: Total Knee Arthroplasty.
CT: Computed tomography.

References
1. Varacallo M, Luo TD, Johanson NA. Total Knee Arthroplasty Techniques. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 [cited 2023 Jul 20]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK499896/
2. Zak SG, Yeroushalmi D, Tang A, Meftah M, Schnaser E, Schwarzkopf R. The use of navigation or robotic-assisted technology in total knee arthroplasty does Not Reduce Postoperative Pain. J Knee Surg. 2023 Mar;36(4):439-44.
3. Meschino MT, Giles AE, Rice TJ, Saddik M, Doumouras AG, Nenshi R, *et al*. Operative timing is associated with increased morbidity and mortality in patients undergoing emergency general surgery: A multisite study of emergency general services in a single academic network. Can J Surg. 2020 Aug;63(4):E321-8.
4. Ashrafian H, Clancy O, Grover V, Darzi A. The evolution of robotic surgery: Surgical and anaesthetic aspects. Br J Anaesth. 2017 Dec 1;119:i72-84.
5. Naziri Q, Burekhovich SA, Mixa PJ, Pivec R, Newman JM, Shah NV, *et al*. The trends in robotic-assisted knee arthroplasty: A statewide database study. J Orthop. 2019 May 3;16(3):298-301.
6. About strykermeded.com/media/2223/mako-tka-surgical-guide.pdf - Google Search [Internet], [Cited 2023 Jul 20]. Available from: https://www.google.com/search?q=About+https://www.strykermeded.com/media/2223/mako-tka-surgical-guide.pdf&tbm=ilp&biw=1440&bih=789&dpr=2
7. Held MB, Gazgalis A, Neuwirth AL, Shah RP, Cooper HJ, Geller JA. Imageless robotic- assisted total knee arthroplasty leads to similar 24-month WOMAC scores as compared to conventional total knee arthroplasty: A retrospective cohort study. Knee Surg Sports Traumatol Arthrosc; c2021. https://doi.org/10.1007/s00167-021-06599-4
8. Kim YH, Yoon SH, Park JW. Does robotic-assisted TKA result in better outcome scores or long-term survivorship than conventional TKA? A randomized, controlled trial. Clin Orthop. 2020;478:266-275.

How to Cite This Article
Talsania KA, Balachandar. A detailed retrospective analysis of time taken in conventional total knee arthroplasty and comparision with navigation assisted total knee arthroplasty. International Journal of Orthopaedics Sciences. 2023;9(3):352-355.