International Journal of Research in Orthopaedics
Paravath SA et al. Int J Res Orthop. 2024 May;10(3):606-612
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20241112

Comparison of surgical times of various total knee replacement techniques and assessment of learning curve of robotic total knee replacement: a retrospective study

Sameer Ali Paravath[1], Amarnath Anand Bhavan Prasad[2]*, Nabeel Mohammed Therakka Parambil[1], Basheer Abdul Gafoor[1], Lulu Damsas[1], Alwin Prince[2], Swetha Punathil[2]

[1]Centre for Bone, Joint and Spine, Meitra Hospital, Calicut, Kerala, India
[2]Meitra Hospital, Calicut, Kerala, India

Received: 10 February 2024
Revised: 20 March 2024
Accepted: 22 March 2024

***Correspondence:**
Dr. Amarnath Anand Bhavan Prasad,
E-mail: amarnathprasad96@gmail.com

ABSTRACT

Background: This study aims to compare the operating times of manual, computer-assisted and robotic- assisted TKA and to calculate the learning curve for image-less robotic-assisted TKA (RATKA).
Methods: This retrospective observational study, conducted at the Centre of Excellence, Bone, Joint and Spine, Meitra Hospital, Kozhikode, Kerala, India, focused on patients aged 60 and above undergoing total knee replacement for stage 4 osteoarthritis. The study included 75 consecutive cases of manual, computer-assisted, and robotic-assisted unilateral total knee arthroplasties performed between May 2021 and September 2022 (18 months). Data was collected from the hospital records.
Results: The surgeon transitioned from learning to proficiency phase of RATKA after 14 cases. In the robotic learning phase, the overall operative time was 113.14 minutes (±8.96), significantly longer than the robotic proficiency phase's average of 98.24 minutes (±2.98) and that of CATKA (99.57±10.700 minutes) and manual TKAs(97.01±7.17 minutes). No statistically significant difference was observed in the global operative time between the proficiency phase RATKAs and the CATKA and manual groups (p=0.139).
Conclusions: By optimizing techniques and modifying workflow, one can swiftly overcome the initial learning curve of RATKA and achieve operating times comparable to manual TKA. To enhance efficiency and productivity,the study proposes a revised workflow modifying various rate limiting surgical steps.

Keywords: Total knee arthroplasty, Robotic total knee arthroplasty, Learning curve

INTRODUCTION

With a 91% survival rate at 23 years, total knee arthroplasty (TKA) is an established and cost-effective solution for individuals with symptomatic end-stage knee osteoarthritis.[1,2] However, recent studies have shown that 20% of patients still remain dissatisfied following TKA.[3,4] Following total knee arthroplasty, patient satisfaction, clinical outcomes, and long-term implant survivability are all impacted by the accuracy of implant position and limb alignment.[5-8] Evolution in surgical technology has led to the development of Computer Assisted TKA (CATKA), followed by Robotic assisted TKA (RATKA) both ofwhich use computer-aided technology to complement conventional surgical procedures. CATKA can be considered as a connecting bridge between manual and

RATKA as its technique is closer to conventional methods, where a cutting jig is placed, and bone cuts are taken. RATKA stays one step ahead of CATKA in that it accurately executes the surgical plan avoiding even the small errors in placement of cutting jig and taking bone cuts. In RATKA, preoperative and intraoperative planning permits an individualized surgical approach, which is designed to allow for optimal implant sizing, positioning and soft tissue balancing.[9,10] When compared to manual TKA, RATKA decreases outliers in postoperative limb alignment, iatrogenic bone and periarticular soft tissue injury and improves bone resection accuracy.[8,11-13] Imageless robotic systems are accurate in terms of coronal alignment and bone resections and achieved accurate implementation of the surgical plan with only small errors in implant placement and is superior to conventional instrumentation in precision. Moreover, it needs less preoperative time, and the preparation is more cost effective compared to image based robotic systems.[14,15] Nevertheless, despite the potential advantages of this new technology, downsides are longer operative duration, higher intraoperative cost and the learning curve, which prevent wider adoption of the robotic system.[16,17] Studies on the RATKA learning curve which were done previously, have used operative times as exclusive markers of surgical competence and found that high-volume arthroplasty surgeons can become proficient in robotic assisted surgery in a matter of months. Most of these studies have compared the operative time for RATKA with conventional manual TKAs.[18,19] In this study we are analysing the learning curve of RATKA of a surgeon who is routinely doing manual and CATKAs by assessments of operative duration. The findings of this study will enable clinicians and healthcare professionals to better understand the usefulness of training with CATKA for a shorter learning curve when they start using RATKA. The two objectives of the study are to calculate the learning curve necessary for image-less RATKA for a surgeon who was routinely doing computer-assisted TKA and to compare the operating times of manual, computer assisted and robotic assisted TKA.

METHODS

A retrospective observational study was undertaken. Computer assisted TKA were done in our institution prior to installation of the robotic assisted TKA. Our team began usingthe Brainlab Knee 3 motion assisted system in January 2018. The Senior Surgeon SAP has received specialist training in computer assisted technique and has been doing it for 3 years. In June 2021, the Smithand Nephew CORI real intelligence robotic surgical system was introduced into the department. All thecases were operated by a senior arthroplasty surgeon (SAP) and he was assisted by the same surgical team. This is a retrospective observational study conducted at Centre of excellence - Bone, Joint and Spine, Meitra Hospital, Kozhikode, Kerala, India among patients above 60 years of age who underwent total knee replacement for stage 4 osteoarthritis of knee.75 consecutive cases of manual, computer assisted, and robotic assisted unilateral total knee replacements done between May 2021 to September 2022 (18 months) were included in the study. The data was collected from the hospital records.

Sample size determination

The mean difference between robotic and computer-assisted procedures was found to be 4.22 in a pilot trial, and the pooled standard deviation was 7.9. α=0.05 is the significance criterion at a 95% confidence level. 1.96 is the value that corresponds to α=0.05. 0.84 is the value that corresponds to type-2 error ß 0.20. We have determined a sample size of 55 in each group by placing these values into the below formula.

$$n = \frac{2s_p^{\,2}\left[z_{1-\alpha/2} + z_{1-\beta}\right]^2}{\mu_d^2}$$

$$s_p^2 = \frac{s_1^2 + s_2^2}{2}$$

Inclusion criteria

Adults aged 60 years and above with stage 4 osteoarthritis of knee who underwent primary unilateral total knee replacement were included.

Exclusion criteria

Exclusion criteria were; Conversion from unicompartmental knee arthroplasty to total knee arthroplasty, Total knee arthroplasty in patient with previous high tibial osteotomy and Posttraumatic osteoarthritis with severe knee deformity.

Surgeries in all 3 groups were performed via midvastus approach and under tourniquet. Tourniquet was inflated just before the skin incision and deflated after the application of surgical wound dressing. In this study, the operating time is defined as the time between skin incision and application of surgical wound dressing.

Robotic TKR-surgical technique

In all instances, we aim for functional alignment of the knee. The extremity is prepared and draped as in standard fashion. The surgical procedure commences after the time out is over. In every situation, we take a mini-midvastus approach. All the tibial and femoral osteophytes that are accessible are removed. The first assistant, or the product specialist, finishes the robotic hand-held device's calibration and registration while the surgeon completes the standard TKR exposure. Additionally, they drape and set the table side monitor.Soft tissue releases are done appropriately for each case. For medial side retraction, a long suture thread passed through the soft tissue on the medial side at joint line level is used. Positioning the knee in 90-degree flexion, the tibial and femoral reflective arrays are secured with threaded Schantz pins inserted into the distal femur and proximal tibia. The surgeon then uses the robotic probe to define the femoral and tibial check points. After registering the femoral and tibial centres, the hip centre is registered by taking the extremity through short arcs of rotatory motion. Medial and lateral malleoli are registered. Following that, joint range of motion is collected and recorded. Tibial and femoral free collection is done to create three-dimensional models on the screen. To aid in implant planning, special points can be defined to point out bony landmarks and defects in the bone. The implant planning menu allows the surgeon to alter the size and position of the implant, and then the knee is carried through its full range of motion, both stressed and unstressed, to detect the flexion and extension gaps. The implant position and gaps are then finalized as per the desired alignment principle. The plan may be worked out through a pair of primary methods: the jig-assisted technique or the all-burr technique. Once the cuts are completed, the trial components are placed, and gaps and range of motion areassessed. In patients with grade 3 or 4 arthritic changes to the patellofemoral joint, we do selective patellarre surfacing. Thorough pulsatile lavage of the joint is done using 1.5 l of normal saline, and a peri-articular Ranawat cocktail injection is given, after which the prostheses are cemented and fixed. Until the cement sets, the joint remains under axial compression. Then, povidone-iodine rinse is given and is allowed to soak for 3 minutes (according to Rothman protocol), followed by pulsatile lavage using the remaining. 1.5 litres of normal saline solution. (Total: 3 litres). Wound closure is done with a running barbed Stratafix (Polydioxanone) suture for the knee joint capsule, interrupted No. 1 and No. 2-0 Vicryl (Polyglactin 910) sutures for the dermal layer, followed by a 2-0 Monocryl (Poliglecaprone 25) continuous subcuticular closure. An intra-articular tranexamic acid injection is given to limit postoperative bleeding. A wound dressing and crepe bandage are applied. The tourniquet is then deflated.

Key modifications in surgical workflow of RATKA that minimized the learning curve

An ergonomically optimised surgical field is important. The robotic equipment is positioned on the contralateral side, at the level of the foot support used to position the leg. The guidance laser is then targeted at the knee kept at 90 degrees' flexion. This arrangement guarantees that the reflective arrays are always in line of sight of the sensing camera, durin all the surgical steps and through a full range of motion. The robotic hand piece is kept in a cautery/instrument bag. The tablet covered with steriletransparent plastic and the point probe are kept on a Mayo trolley positioned at the foot end (Figure 2).

To maximise efficiency, try to adhere as closely as possible to the standard surgical exposure. By listening to the robotic device's confirmation sounds, checkpoint definition and point collection can be completed swiftly without having to constantly glance back and forth between the screen and the surgical field. Rather than using individual femoral and tibial check point divots, fixed spots on femoral and tibial Schantz pin clamps can serve as checkpoints. By omitting a surgical step, this saves time and reduces the possibility of divots getting in the way of bone cuts or loosening in osteoporotic bones (Figure 3A). To save operating time, several steps are done in tandem. The implant technician sets up the burr and checks the robotic burr device and robotic probe while the surgeon finishes the standard TKR exposure. In order to retract the medial side of the joint without blocking the view of the reflective arrays,we utilise a long suture thread that is passed through the medial structures of the joint. Pull thisthread while standing on the lateral side to retract the medial soft tissues (Figure 3B).

The lateral thigh support used features a rotary attachment that enables rapid tightening and loosening during circumduction of limb for hip centre location without compromising the surgical field's sterility. A right-angle foot positioner is also used to place the knee at 90 degrees (Figure 3C). Wherever the point probe is used, use both hands - hold its shaft with one hand and stabilize the tip with the other. Be mindful especially during free collection of femoral and tibial articular surface, as the probe may break contact and slip off the surface while painting which can erroneously alter the created 3D model (Figure 4A). Use a surgical mop to cover the Z retractor (tensioner) while stressing the gaps to prevent it from slipping while stressing the flexion and extension gaps (Figure 4B). By modifying the burring process, burring time can also be reduced. Using the robotic burr device,create full thickness troughs at the anterior and posterior ends of the targeted distal femur cut. The center piece can then be quickly cut free hand with a saw. Similar to this, while making a proximaltibial cut, use the robotic burr device to create a full thickness trough in the front part of the targeted cut, and then use a saw to finish cutting the remaining bone. The robotic burr device can be used to refine both of these preliminary cuts (Figure 4C). We found that the use of cutting jigs for femur and tibia is a faster alternative to the all-burr milling technique as burring the posterior femoral condyles and posterolateral tibia can often be tricky and time consuming, especially for beginners (Figure 4D).

Statistical analysis

A series of data points were analysed using CUMSUM (cumulative sum) technique to identify trends. It is helpful for spotting minute adjustments that could be challenging to spot visually. The cumulative sum of the variances over time is displayed via the learning curve. If the surgeon gains experience, the curve tends to slope downward. If the surgeon is not improving, the curve rises.

Searching for an abrupt shift in the learning curve's direction can help identify a turning point in the surgeon's progress. The variables were chosen for this purpose only after the learning curve was established (only cases done after achieving the learning curve were utilised for comparison). A comparison is made between the mean time for robotic, computer-assisted, and manual TKAs.

RESULTS

The study's participant gender distribution is as follows: 17 (22.7%) of the males took part in computer assisted, 18 (24%) in robotic, and 14 (18.7%) in manual. In the computer-assisted, there were 58 (77.3%) female participants, 57 (76%) in the robotic, and 61 (81.3%) in the manual.

The average age of participants in each group is between sixty-two and sixty-four. The study participants' maximum age range is 80 years old, while their lowest age range is 40 years old.

When it came to computer assistance, the mean proficiency phase time was roughly 99 seconds; in the robotic group, it was 98 seconds, and in the manualgroup, it was 97 seconds.

A maximum of 141 seconds is allotted to the Computer Assisted group, 107 seconds to the Robotic group, and 125 seconds to the Manual group during the proficiency phase. The Robotic TKR has an average learning phase time of 113.14 seconds (Table 1).

Table 1: Time-demographic profile of the study participants.

Variables	Computer assisted	Robotic	Manual
Gender, N (%)			
Males	17 (22.7)	18 (24)	14 (18.7)
Females	58 (77.3)	57 (76)	61 (81.3)
Side involved			
Right	35	39	38
Left	40	36	37
Age in years			
N	75	75	75
Mean (±SD)	64.71 (±7.7)	62.8 (±7.3)	62.66 (±8.7)
Median	65	63	62
Minimum	43	50	42
Maximum	79	83	79
Proficiency phase time			
Mean (±SD)	99.57 (10.7)	98.24 (± 2.98)	97.01 (± 7.17)
Maximum	141	107	125
minimum	80	90	86
Learning Phase Mean (±SD)	113.14 (±8.96)		

Table 2: One-way ANOVA result.

Variables	Sum of Squares	Degrees of freedom	Mean Square	F value	Significance
Between Groups	245.858	2	122.929	1.995	0.139
Within Groups	12816.65	208	61.618		
Total	13062.5	210	-		

Table 3: Independent sample t test.

Variables		Levene's Test for Equality of Variances		T test for equality of means						
		F value	Sig.	T value	df	Sig. (2 tailed)	Mean Difference	Std. Error Difference	95% CI of the Difference	
									Lower	Upper
Robotic phase	Equal variances assumed	14.347	0.001	-10.802	73	0.001	-14.897	1.3791	-17.6456	-12.1483
	Equal variances not assumed			-6.137	13.668	0.001	-14.897	2.4273	-20.1149	-9.679

The proficiency phase time values for each of the three groups are compared using a one-way ANOVA. For robotic, computer-assisted, and manual TKA in the proficiency phase, there is no statistically significant difference in the mean time determined by one-way ANOVA; F (2, 208)=1.99, p=0.139 (Table 2). An independent-samples t-test was conducted to compare the time of TKA in learning phase and the time of TKA in proficiency phase. There was a statistically significant difference in the learning phase time (M=113.14, SD=8.96) and proficiency phase time (M=98.24, SD=2.98) conditions; t (-10.802) =73, p≤0.001 (Table 3). After 14 consecutive cases there was a sudden decline in the average operating time of RATKA (Figure 1).

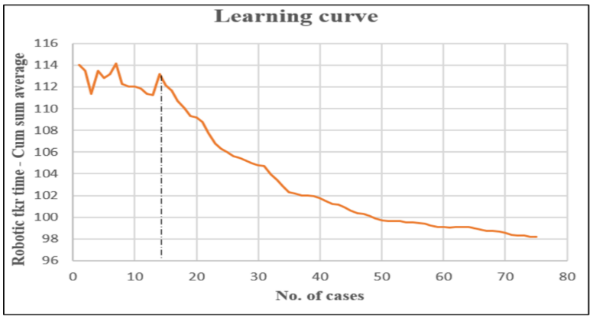

Figure 1: Learning curve; after 14 consecutive cases there is a sudden decline in the average operating time of RATKA.

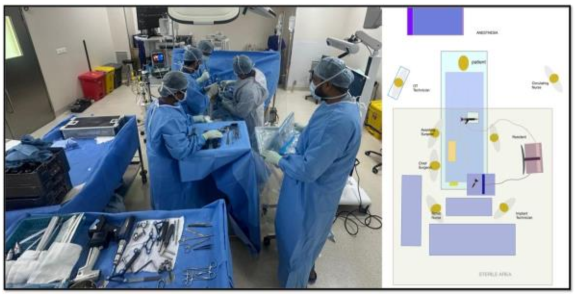

Figure 2: Ergonimically optimised surgical field.

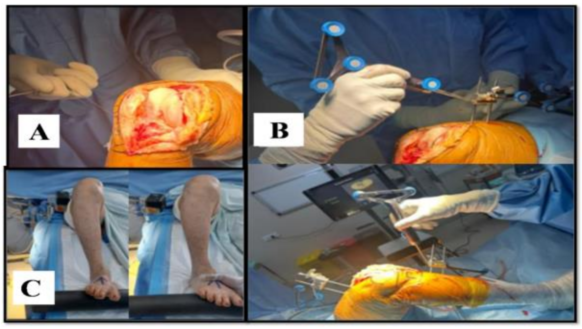

Figure 3: (A) Medial side retraction using long suture thread standing on the lateral side; (B) using fixed spots on femoral and tibial schantz pin clamps can serve as checkpoint; and (C) lateral thigh support with a rotary attachment that enables rapid tightening and loosening.

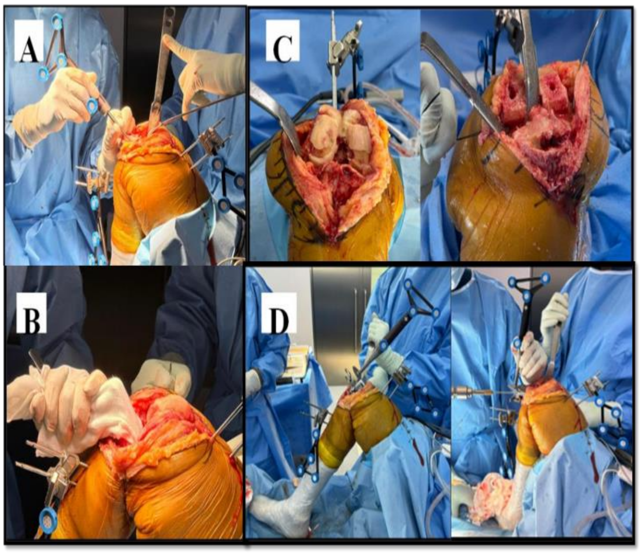

Figure 4: (A) Hold point probe with both hands; (B) use a mop to cover the tensioner; (C) creating full thickness troughs using to swiftly take bone cuts; and (D) aligning cutting jigs by visualizing the cuts in the screen.

DISCUSSION

The surgeon transitioned from learning to proficiency phase of RATKA after 14 cases. The overall operative time in the robotic learning phase was 113.14 (±8.96), significantly longer compared to the average of 98.24±2.98 min in the robotic proficiency phase (p≤0.001) and that of the computer assisted (99.57±10.700 min) and manual TKAs (97.01±7.17 min). No statistically significant difference was recorded between the global operative time for the proficiency phase TKAs versus the computer assisted and manual groups (p=0.139). A team consisting of members with established responsibilities and the practice of repeatable and reproducible surgical steps are required to streamline the surgical process. The surgical team is comprised of the primary surgeon, assistant surgeon, scrub nurse, circulating nurse, operating room technician, and the product specialist. Members performing their duties in an overlapping manner is the key. A dedicated "robotic operation room (OR)" houses all the robotic equipment, facilitating the effective use of available resources. This affords easy access, saves time, and streamlines the transfer of equipment. [21] The Smith and Nephew CORI real intelligence robotic system is portable and has a small OR footprint, making transportation straightforward. When Grau et al. reviewed the tourniquet times of their first 132 RATKAs, they found that inflection point of the learning curve occurred in under 40 cases. They showed that tourniquet times can regularly average less than 60 minutes when performed correctly and that this shouldn't be a major deterrant to surgeons implementing this new technology.[20] In a case-control study, Savov et al matched the operating times of their first 70 RATKAs with those of 70 TKAs performed manually. After 11 instances, they finished the learning curve, and there was no discernible difference in the overall length of surgery between manual and RATKAs (69 vs. 67 min, respectively; $p<0.05$). [21] The surgical times of 60 MTKAs and 60 RATKAs, operated by a surgeon with prior cadaveric training with RATKA, were compared by Kayani et al.[16] After 7 cases, they accomplished the learning curve.[21] 39 patients who had RATKA and 45 control patients who had manual TKA were compared in the study by Dragosloveanu et al. Their three surgeons progressed from learning to proficiency phase after 6, 4, and 3 cases respectively. Their three doctors completed 6, 4, and 3 cases, respectively, before moving on to the proficiency level. The operative time in learning phase (111.54±20.45 minutes) was significantly longer than both the times of surgeries performed in the proficiency phase (86.43±19.09 minutes) and that of manual TKAs (80.56±17.03 minutes) similar to our study. There was no statistically significant difference in the global operative time between the proficiency phase TKAs and the controls similar to our study.[22]

Limitations

The study has some limitations. Firstly, this was not conducted as a randomized controlled study. Considering high volume of arthroplasty procedures and experienced surgical staff in our institution, a short learning curve is expected. These findings may not be generalisable for other institutions were focus on arthroplasty is less intense. Future studies should explore functional outcome and cost effectiveness of RATKA to ascertain its superiority over conventional methods.

CONCLUSION

The study aims to guide surgeons during the initial learning phase, aiding in procedure planning, scheduling, and integrating robotic technology. By optimizing techniques and modifying workflow, one can swiftly overcome the initial learning curve of RATKA and achieve operating time comparable to manual TKA. To enhance efficiency and productivity, the study proposes a revised workflow modifying various rate limiting surgical steps. Clinicians with prior experience in CATKA can swiftly implement these methods. For busy doctors, a specialized robotic operating room and a skilled surgical team prove beneficial.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Pavone V, Boettner F, Fickert S, Sculco TP. Total condylar knee arthroplasty: a long-term followup.Clin Orthop Relat Res. 2001;(388):18-25.
2. Gill GS, Joshi AB, Mills DM. Total condylar knee arthroplasty. 16- to 21-year results. Clin Orthop Relat Res. 1999;(367):210-5.
3. Baker PN, van der Meulen JH, Lewsey J, Gregg PJ. National Joint Registry for England and Wales.The role of pain and function in determining patient satisfaction after total knee replacement. Data from the National Joint Registry for England and Wales. J Bone Joint Surg Br. 2007;89(7):893- 900.
4. Ritter MA, Faris PM, Keating EM, Meding JB. Postoperative alignment of total knee replacement. Its effect on survival. Clin Orthop Relat Res. 1994;299:153-6.
5. Khlopas A, Chughtai M, Hampp EL, Scholl LY, Prieto M, Chang TC, et al. Robotic-Arm Assisted Total Knee Arthroplasty Demonstrated Soft Tissue Protection. Surg Technol Int. 2017;30:441-6.
6. Peersman G, Laskin R, Davis J, Peterson MGE, Richart T. Prolonged operative time correlates withincreased infection rate after total knee arthroplasty. HSS J. 2006; 2(1):70-2.
7. Coon TM. Integrating robotic technology into the operating room. Am J Orthop. 2009;38(2):7-9.
8. Marchand RC, Sodhi N, Bhowmik-Stoker M, Scholl L, Condrey C, Khlopas A, et al. Does the Robotic Arm and Preoperative CT Planning Help with 3D Intraoperative Total Knee Arthroplasty Planning? J Knee Surg. 2019; 32(8):742-9.
9. Lonner JH. Robotically Assisted Unicompartmental Knee Arthroplasty with a Handheld Image-Free Sculpting Tool. Orthop Clin North Am. 2016;47(1):29-40.
10. Pastides P, Nathwani D. The role of newer technologies in knee arthroplasty. Orthop Trauma. 2017;31(1):47-52.
11. Mont MA, Cool C, Gregory D, Coppolecchia A, Sodhi N, Jacofsky DJ. Health Care Utilization and Payer Cost Analysis of Robotic Arm Assisted Total Knee Arthroplasty at 30, 60, and 90 Days. J KneeSurg. 2021; 34(3):328-37.
12. Li C, Zhang Z, Wang G, Rong C, Zhu W, Lu X, et al. Accuracies of bone resection, implant position,and limb alignment in robotic-arm-assisted total knee arthroplasty: a prospective single-centre study.J Orthop Surg Res. 2022;17(1):61.
13. Moon YW, Ha CW, Do KH, Kim CY, Han JH, Na SE, et al. Comparison of robot-assisted and conventional total knee arthroplasty: a controlled cadaver study using multiparameter quantitative three-dimensional CT assessment of alignment. Comput Aided Surg. 2012; 17(2):86-95.
14. Casper M, Mitra R, Khare R, Jaramaz B, Hamlin B, McGinley B, et al. Accuracy assessment of a novel image-free handheld robot for Total Knee Arthroplasty in a cadaveric study. Comput Assist Surg. 2018;23(1): 14-20.
15. Schrednitzki D, Horn CE, Lampe UA, Halder AM. Imageless robotic-assisted total knee arthroplasty is accurate in vivo: a retrospective study to measure the postoperative bone resection and alignment. Arch Orthop Trauma Surg. 2023;143(6):3471-9.
16. Kayani B, Konan S, Huq SS, Tahmassebi J, Haddad FS. Robotic-arm assisted total knee arthroplasty has a learning curve of seven cases for integration into the surgical workflow but no learning curve effect for

accuracy of implant positioning. Knee Surg Sports Traumatol Arthrosc. 2019;27(4):1132-41.
17. Nogalo C, Meena A, Abermann E, Fink C. Complications and downsides of the robotic total knee arthroplasty: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2023;31(3):736-50.
18. Kim SM, Park YS, Ha CW, Lim SJ, Moon YW. Robot-assisted implantation improves the precision of component position in minimally invasive TKA. Orthopedics. 2012;35(9):e1334- 9.
19. Siebert W, Mai S, Kober R, Heeckt PF. Technique and first clinical results of robot-assisted total knee replacement. Knee. 2002;9(3):173-80.
20. Grau L, Lingamfelter M, Ponzio D, Post Z, Ong A, Le D, et al. Robotic arm assisted total knee arthroplasty workflow optimization, operative times and learning curve. Arthroplast Today. 2019;5(4):465-70.
21. Savov P, Tuecking LR, Windhagen H, Ehmig J, Ettinger M. Imageless robotic handpiece-assisted total knee arthroplasty: a learning curve analysis of surgical time and alignment accuracy. Arch Orthop Trauma Surg. 2021;141(12):2119-28.
22. Dragosloveanu S, Petre MA, Capitanu BS, Dragosloveanu CDM, Cergan R, Scheau C. Initial learning curve for robot-assisted total knee arthroplasty in a dedicated orthopedics center. J Clin Med. 2023; 12(21):123-9.

Cite this article as: Paravath SA, Amarnath AP, Mohammed NTP, Gafoor BA, Damsas L, Prince A, et al. Comparison of surgical times of various total knee replacement techniques and assessment of learning curve of robotic total knee replacement: a retrospective study. Int J Res Orthop 2024;10:606-12.