Original Research

ROBOTIC-ASSISTED VS. CONVENTIONAL TOTAL KNEE ARTHROPLASTY: EARLY FUNCTIONAL OUTCOMES AND PATIENT SATISFACTION

Dr. Nitin Sanadhya[1*], Dr Soniya Sanaadhya[2]
[1*]Associate Professor, Department of Orthopaedics, Geetanjali Medical College and Hospital Udaipur, Rajasthan, 313001, India.
[2]Assistant Professor, Department of Pathology, Jawahar Lal Nehru Medical College and Hospital, Ajmer 305001, India.
***Corresponding Author:** Dr Nitin Sanadhya
Email: [1]nitin_sanadhya@yahoo.com, [2]soniyasanaadhya@gmail.com

ABSTRACT

Background: Robotic-assisted total knee arthroplasty (RA-TKA) has been increasingly adopted with the aim of improving surgical precision, implant alignment, and soft-tissue balancing. These technical advantages are hypothesized to enhance early postoperative functional recovery and patient satisfaction when compared with conventional total knee arthroplasty (C-TKA). However, prospective single-center data evaluating these early outcomes remain limited.

Objective: To compare early functional outcomes and patient satisfaction between robotic-assisted and conventional total knee arthroplasty in a prospective single-center cohort.

Methods: This prospective observational study was conducted at a single tertiary care center between September 2024 and September 2025. A total of 90 patients undergoing primary unilateral total knee arthroplasty for end-stage osteoarthritis were included, with 45 patients undergoing RA-TKA and 45 undergoing C-TKA. Functional outcomes were assessed using the Knee Society Score (KSS – function) and KOOS JR at 6 weeks and 3 months postoperatively. Patient satisfaction was evaluated at 3 months using a standardized 5-point Likert scale. Secondary outcome measures included operative time, length of hospital stay, early postoperative complications, and radiographic alignment accuracy, with alignment outliers defined as a deviation greater than 3° from the neutral mechanical axis. Statistical analysis was performed using appropriate parametric and non-parametric tests, with statistical significance set at $p<0.05$.

Results: Baseline demographic characteristics and preoperative functional scores were comparable between the two groups. Patients in the RA-TKA group demonstrated significantly higher KSS-function and KOOS JR scores at both 6 weeks and 3 months compared with those in the C-TKA group ($p<0.05$). At 3 months, a greater proportion of patients in the RA-TKA group reported being "very satisfied" with their surgical outcome compared with the C-TKA group (71.1% vs 51.1%; $p=0.048$). Radiographic alignment outliers were significantly fewer in the RA-TKA group (6.7% vs 20.0%; $p=0.041$). Operative time was longer in the RA-TKA group, while length of hospital stay and early complication rates were similar between groups.

Conclusion: Robotic-assisted total knee arthroplasty is associated with superior early functional outcomes, improved patient satisfaction, and more accurate limb alignment compared with conventional total knee arthroplasty, albeit with increased operative time.

Keywords: Total Knee Arthroplasty, Robotic-Assisted Surgery, Functional Outcomes, Patient Satisfaction, Prospective Study.

INTRODUCTION

Total knee arthroplasty (TKA) is a well-established and effective treatment for end-stage knee osteoarthritis, providing substantial pain relief and functional improvement for the majority of patients [1,2].

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 01-01-2025
Date Acceptance: 17-01-2026
Date of Publication: 18-02-2026

However, despite advances in implant design, surgical technique, and perioperative care, up to 15–20% of patients remain dissatisfied following TKA [1, 3]. Persistent pain, stiffness, instability, and unmet expectations are commonly cited factors contributing to suboptimal patient-reported outcomes, emphasizing the need for continued refinement of surgical techniques [3,4].

Conventional TKA relies on manual instrumentation and surgeon experience to achieve accurate component positioning and soft-tissue balancing. Variability in bone cuts, ligament balancing, and limb alignment may result in mechanical axis deviation and component malposition, which have

been associated with inferior functional outcomes and reduced implant longevity [5,6]. In recent years, robotic-assisted total knee arthroplasty (RA-TKA) has been introduced with the aim of improving surgical precision through preoperative planning, real-time intraoperative feedback, and controlled execution of bone resections [7,8].

Several studies have demonstrated that RA-TKA can reduce alignment outliers and improve the accuracy of component placement compared with conventional techniques [6,9–11]. Systematic reviews and meta-analyses have further reported improved radiographic outcomes and greater precision with robotic-assisted techniques [10–12]. However, evidence regarding the clinical relevance of these technical improvements, particularly in terms of early functional recovery and patient satisfaction, remains inconsistent [9,13]. Many available studies are retrospective, involve heterogeneous surgical protocols, or originate from high-volume centers, limiting their generalizability to routine clinical practice [12,14].

Prospective single-center studies provide valuable insight into real-world outcomes by minimizing variability in surgical technique, perioperative protocols, and rehabilitation pathways [14]. Early postoperative functional outcomes and patient satisfaction are especially important, as they strongly influence patient perception of surgical success and overall quality of life during the recovery phase [1,3,15].

The present study aimed to prospectively compare early functional outcomes and patient satisfaction between robotic-assisted and conventional total knee arthroplasty in a single-center cohort. We hypothesized that robotic-assisted TKA would result in superior early functional outcomes and higher patient satisfaction compared with conventional TKA, while acknowledging the potential for increased operative time.

MATERIALS AND METHODS

Study Design

This was a **prospective single-center comparative study** conducted between **September 2024 and September 2025**. The study aimed to compare early functional outcomes and patient satisfaction between robotic-assisted total knee arthroplasty (RA-TKA) and conventional total knee arthroplasty (C-TKA). Institutional Ethics Committee approval was obtained prior to study initiation, and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Study Population

Patients undergoing primary unilateral total knee arthroplasty for end-stage knee osteoarthritis were prospectively screened and recruited.

Inclusion Criteria

- Age ≥50 years
- Primary knee osteoarthritis (Kellgren–Lawrence grade III or IV)
- Planned primary unilateral total knee arthroplasty
- Ability to provide informed consent and complete functional outcome assessments

Exclusion Criteria

- Inflammatory arthritis
- Previous major surgery on the ipsilateral knee
- Revision or bilateral total knee arthroplasty
- Severe extra-articular deformity requiring complex reconstruction
- Neuromuscular disorders affecting lower-limb function

Group Allocation

A total of **90 patients** were enrolled and allocated into two groups:

- **Robotic-assisted total knee arthroplasty (RA-TKA):** 45 patients
- **Conventional total knee arthroplasty (C-TKA):** 45 patients

Group allocation was based on robotic system availability and routine surgical workflow. Randomization was not performed. All procedures were performed by experienced arthroplasty surgeons following a standardized perioperative protocol.

Surgical Technique

All surgeries were performed using a standard medial parapatellar approach under regional or combined anesthesia. Cemented implants of the same design were used in both groups. Patellar resurfacing was performed selectively based on intraoperative assessment.

In the RA-TKA group, a semi-active robotic-assisted system was used to facilitate preoperative planning and intraoperative execution of bone cuts, enabling real-time assessment of component positioning and soft-tissue balance. In the C-TKA group, conventional jig-based instrumentation was employed. Perioperative care, including antibiotic prophylaxis, tranexamic acid administration, thromboprophylaxis, and postoperative rehabilitation protocols, was standardized across both groups.

FOLLOW-UP

All patients were followed prospectively according to a standardized postoperative follow-up protocol. Clinical and functional assessments were performed at **6 weeks and 3 months** following surgery. At each follow-up visit, patients underwent a clinical examination, evaluation of wound healing, and assessment for any postoperative complications.

Functional outcomes were assessed using the **Knee Society Score (KSS – function)** and **KOOS JR** at both follow-up time points. Patient satisfaction was evaluated at the 3-month follow-up using a 5-point Likert scale. Postoperative radiographs were obtained at the 6-week visit to assess component

positioning and limb alignment. Any complications, readmissions, or reoperations occurring within the 90-day postoperative period were recorded.

Patients who were unable to attend in-person follow-up visits were contacted by telephone to complete functional outcome assessments and to identify any postoperative complications. All efforts were made to minimize loss to follow-up, and patients with incomplete data at the final follow-up were excluded from the final analysis.

STATISTICAL ANALYSIS

Statistical analysis was performed using **IBM SPSS Statistics for Windows, Version 26.0** (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test and inspection of histograms. Normally distributed data were expressed as mean ± standard deviation and compared using the independent samples *t*-test. Non-normally distributed data were presented as median with interquartile range and compared using the Mann–Whitney *U* test.

Categorical variables were summarized as frequencies and percentages and analyzed using the chi-square test or Fisher's exact test, as appropriate. Functional outcome measures, including the **Knee Society Score (KSS – function)** and **KOOS JR**, were compared between the two groups at 6 weeks and 3 months postoperatively. Within-group comparisons over time were performed using paired *t*-tests or Wilcoxon signed-rank tests, depending on data distribution.

Multivariable linear regression analysis was conducted to assess the independent effect of surgical technique (robotic-assisted versus conventional total knee arthroplasty) on 3-month functional outcomes, adjusting for potential confounders such as age, sex, body mass index, comorbidities, and baseline functional scores.

All statistical tests were two-tailed, and a *p*-value of <0.05 was considered statistically significant. Missing data were minimal and were handled using complete-case analysis.

Study Variables

Baseline variables included age, sex, body mass index, comorbidities, and preoperative functional scores (Knee Society Score–function and KOOS JR). Surgical variables comprised type of procedure (robotic-assisted or conventional), operative time, and implant-related factors. Primary outcome variables were early functional outcomes (KSS–function and KOOS JR) and patient satisfaction at 3 months. Secondary outcomes included length of hospital stay, radiographic alignment, and early postoperative complications.

OUTCOME MEASURES

Primary Outcome Measures

The primary outcome measures focused on early postoperative recovery and included functional outcomes assessed using the Knee Society Score (KSS–function) and KOOS JR, recorded preoperatively and at 6 weeks and 3 months following surgery. Patient satisfaction was evaluated at the 3-month follow-up using a standardized 5-point Likert scale ranging from very satisfied to very dissatisfied.

Secondary Outcome Measures

Secondary outcome measures included perioperative and early postoperative parameters. These comprised operative time measured from skin incision to wound closure, length of hospital stay, and radiographic assessment of limb alignment. Alignment accuracy was evaluated using postoperative radiographs, with alignment outliers defined as deviation greater than 3° from the neutral mechanical axis. Early postoperative complications, including wound-related problems, infection, stiffness requiring manipulation under anesthesia, thromboembolic events, and hospital readmissions within 90 days of surgery, were recorded and analyzed.

RESULTS

Patient Demographics and Baseline Characteristics

A total of **90 patients** were included in the final analysis, with **45 patients in the robotic-assisted total knee arthroplasty (RA-TKA) group** and **45 patients in the conventional total knee arthroplasty (C-TKA) group**. All patients completed the 3-month follow-up. Baseline demographic and clinical characteristics, including age, sex distribution, body mass index, comorbidities, and preoperative functional scores, were comparable between the two groups, with no statistically significant differences observed (Table 1).

Functional Outcomes

At 6 weeks postoperatively, patients in the RA-TKA group demonstrated significantly higher Knee Society Score (KSS–function) and KOOS JR scores compared with the C-TKA group ($p<0.05$). These differences persisted at the 3-month follow-up, with the RA-TKA group showing superior functional outcomes in both scoring systems (Table 2).

Patient Satisfaction

Patient satisfaction assessed at 3 months revealed a significantly higher proportion of patients reporting "very satisfied" outcomes in the RA-TKA group compared with the C-TKA group (71.1% vs 51.1%, $p=0.048$). Overall satisfaction distribution differed significantly between the two groups (Table 3).

Perioperative and Secondary Outcomes

Mean operative time was significantly longer in the RA-TKA group compared with the C-TKA group ($p<0.001$). Length of hospital stay was similar between groups. Radiographic analysis showed significantly fewer alignment outliers (>3° from neutral mechanical axis) in the RA-TKA group

compared with the C-TKA group (p=0.041). Early postoperative complications were infrequent and did not differ significantly between the two groups (Table 4).

Tables

Table 1. Baseline Demographic and Clinical Characteristics

Variable	RA-TKA (n=45)	C-TKA (n=45)	p-value
Age (years), mean ± SD	66.0 ± 7.5	66.4 ± 8.1	0.80
Female sex, n (%)	29 (64.4)	27 (60.0)	0.67
BMI (kg/m²), mean ± SD	28.1 ± 3.6	28.5 ± 3.8	0.60
Diabetes mellitus, n (%)	14 (31.1)	13 (28.9)	0.82
Hypertension, n (%)	24 (53.3)	26 (57.8)	0.67
Preop KSS–function, mean ± SD	45.6 ± 10.8	44.9 ± 11.2	0.76
Preop KOOS JR, mean ± SD	42.1 ± 9.7	41.3 ± 10.1	0.71

Table 1. Notes: Values are presented as mean ± standard deviation or number (percentage), as appropriate. No statistically significant differences were observed between the groups at baseline.

Table 2. Functional Outcome Scores

Outcome Measure	Time Point	RA-TKA (mean ± SD)	C-TKA (mean ± SD)	p-value
KSS–function	6 weeks	74.1 ± 9.6	68.0 ± 10.4	0.006
KSS–function	3 months	82.6 ± 8.3	77.1 ± 9.1	0.004
KOOS JR	6 weeks	63.9 ± 11.5	58.2 ± 12.2	0.028
KOOS JR	3 months	74.8 ± 10.1	69.3 ± 11.0	0.018

Table 2. Notes: Values are presented as mean ± standard deviation. Higher scores indicate better functional outcomes; p-values represent comparisons between groups at each follow-up time point.

Table 3. Patient Satisfaction at 3 Months

Satisfaction Level	RA-TKA (n=45)	C-TKA (n=45)
Very satisfied	32 (71.1%)	23 (51.1%)
Satisfied	10 (22.2%)	15 (33.3%)
Neutral	2 (4.4%)	5 (11.1%)
Dissatisfied	1 (2.2%)	2 (4.4%)
Very dissatisfied	0 (0%)	0 (0%)
Overall p-value (χ^2)		0.048

Table 3. Notes: Values are presented as number (percentage). Overall group comparison was performed using the chi-square test.

Table 4. Secondary Outcomes and Complications

Variable	RA-TKA (n=45)	C-TKA (n=45)	p-value
Operative time (min), mean ± SD	101.5 ± 14.2	89.8 ± 12.6	<0.001
Length of stay (days), median (IQR)	3 (3–4)	3 (3–4)	0.22
Alignment outliers (>3°), n (%)	3 (6.7)	9 (20.0)	0.041
Early complications, n (%)	2 (4.4)	3 (6.7)	0.64
90-day readmission, n (%)	1 (2.2)	2 (4.4)	0.56

Table 4. Notes: Values are presented as mean ± standard deviation, median (interquartile range), or number (percentage), as appropriate. Group comparisons were performed using independent *t*-tests or chi-square/Fisher's exact tests.

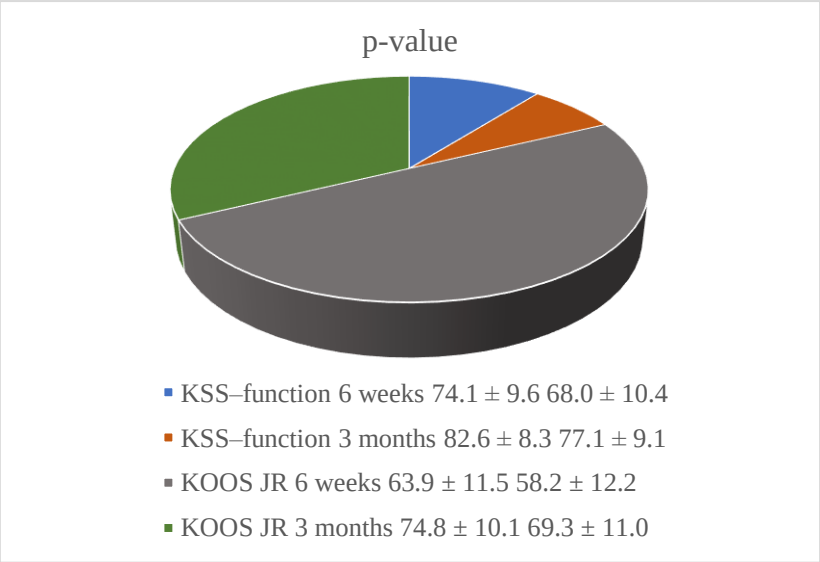

Figure 1. Early Functional Outcomes Following Robotic-Assisted and Conventional Total Knee Arthroplasty

Figure Notes: Values represent mean scores at each follow-up time point. Higher scores indicate better functional outcomes; comparisons are shown between robotic-assisted and conventional total knee arthroplasty groups.

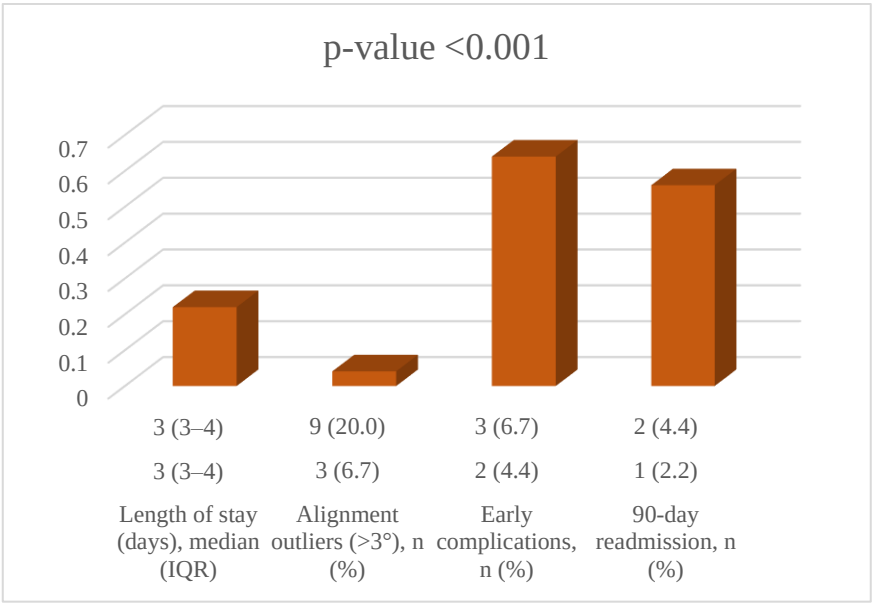

Figure 2. Comparison of Secondary Outcomes and Early Postoperative Complications Between Robotic-Assisted and Conventional Total Knee Arthroplasty

Figure Notes: Values are presented as mean ± standard deviation or number (percentage), as appropriate. Comparisons are shown between robotic-assisted and conventional total knee arthroplasty groups; alignment outliers were defined as deviation greater than 3° from the neutral mechanical axis.

DISCUSSION

The principal finding of this prospective single-center study was that robotic-assisted total knee arthroplasty (RA-TKA) resulted in superior early functional outcomes and higher patient satisfaction compared with conventional total knee arthroplasty (C-TKA). Patients undergoing RA-TKA demonstrated significantly better Knee Society Score (KSS–function) and KOOS JR scores at both 6 weeks and 3 months postoperatively, along with a higher proportion reporting being “very satisfied” at early follow-up. These findings are consistent with previous studies reporting improved early recovery and patient-reported outcomes following robotic-assisted TKA [7–9]. These clinical benefits were accompanied by fewer radiographic alignment outliers, although operative time was longer in the

robotic-assisted group, as has been reported previously [6,10].

Early functional recovery is a critical determinant of overall patient perception following TKA [1,3]. In the present study, improved early functional scores in the RA-TKA group may be attributed to enhanced accuracy of bone resections and more consistent soft-tissue balancing afforded by robotic assistance. Improved limb alignment and component positioning have been associated with better early stability and reduced postoperative pain, which may facilitate faster rehabilitation and functional gains [5,6,11]. The significantly lower rate of alignment outliers observed in the robotic-assisted group in this study further supports this proposed mechanism and aligns with findings from both randomized trials and meta-analyses [10–12].

Patient satisfaction following TKA is multifactorial and influenced by pain relief, functional improvement, patient expectations, and the early postoperative recovery experience [1,3,15]. The higher satisfaction rates observed in the RA-TKA group are consistent with the improved functional outcomes noted at early follow-up. Although the absolute differences in patient-reported outcome scores were modest, these differences occurred during the early postoperative period, when patients are most sensitive to residual pain, stiffness, and functional limitations [3,9].

Consistent with previous reports, RA-TKA was associated with a significantly longer operative time compared with conventional techniques [7,8,13]. This increase is likely related to additional steps required for system registration, intraoperative planning, and robotic execution, particularly during the learning curve phase. Importantly, the increased operative time did not translate into longer hospital stay or higher early complication rates, suggesting that robotic-assisted procedures can be safely integrated into routine clinical practice when standardized perioperative protocols are followed [8,13].

The strengths of this study include its prospective design, standardized surgical and rehabilitation protocols, and the use of validated patient-reported outcome measures. However, several limitations should be acknowledged. The non-randomized design introduces potential selection bias, and the relatively short follow-up period limits assessment to early outcomes only. Long-term functional results, implant survivorship, and cost-effectiveness could not be evaluated. Additionally, as a single-center study, the findings may not be generalizable to all practice settings [12,14].

Future studies should focus on well-designed randomized controlled trials with longer follow-up to determine whether the early functional advantages of robotic-assisted TKA are sustained over time and whether they translate into improved implant longevity, cost-effectiveness, and long-term patient satisfaction [10,12].

CONCLUSION

This prospective single-center study demonstrated that robotic-assisted total knee arthroplasty is associated with superior early functional outcomes and higher patient satisfaction when compared with conventional total knee arthroplasty. Patients undergoing robotic-assisted procedures showed significantly improved Knee Society Score–function and KOOS JR scores at early follow-up, along with a greater proportion reporting high satisfaction levels. These findings suggest that the technical precision offered by robotic assistance may positively influence early postoperative recovery.

In addition to improved functional outcomes, robotic-assisted total knee arthroplasty resulted in more accurate limb alignment, with fewer alignment outliers compared with conventional techniques. Although operative time was longer in the robotic-assisted group, this did not translate into increased length of hospital stay or higher rates of early postoperative complications, indicating that robotic-assisted surgery can be safely integrated into routine clinical practice.

Despite these encouraging early results, the study is limited by its non-randomized design and short follow-up duration. Further randomized controlled trials with larger sample sizes and long-term follow-up are necessary to determine whether the early functional and satisfaction benefits observed with robotic-assisted total knee arthroplasty are sustained over time and whether they justify the additional operative time and resource utilization.

REFERENCES

1. Guo J, Jin Z, Xia M. Evaluating surgical outcomes of robotic-assisted versus conventional total knee arthroplasty: a large-scale comparative analysis. *J Orthop Surg Res.* 2025;20:166.
2. Alrajeb R, Zarti M, Shuia Z, et al. Robotic-assisted versus conventional total knee arthroplasty: systematic review and meta-analysis of randomized controlled trials. *Eur J Orthop Surg Traumatol.* 2024;34:1333–1343.
3. Mert Ü, Khasawneh MY, Ghandour M, et al. Comparative efficacy and precision of robot-assisted vs conventional total knee arthroplasty: systematic review and meta-analysis. *J Clin Med.* 2025;14(9):3249.
4. Fu X, She Y, Jin G, et al. Comparison of robotic-assisted TKA and manual TKA: updated systematic review and meta-analysis. *J Robotic Surg.* 2024;18:292.
5. Patient-Reported Outcomes in robotic-assisted vs manual TKA with long-term follow-up. *Arthroplasty Today.* (2024).

6. Marchand RC, Sodhi N, Khlopas A, et al. Short-term evaluation of patient satisfaction after robotic arm-assisted total knee arthroplasty. *J Knee Surg.* 2017;30(9):849–853.
7. Kayani B, Konan S, Tahmassebi J, Pietrzak JRT, Haddad FS. Early functional rehabilitation and hospital discharge in robotic-arm assisted vs conventional TKA. *Bone Joint J.* 2019;101-B(1):24–33.
8. Liow MHL, Xia Z, Wong MK, Tay KJD, Yeo SJ. Robot-assisted total knee arthroplasty restores joint line and mechanical axis. *J Arthroplasty.* 2014;29(12):2373–2377.
9. Hampp EL, Scholl LY, Prieto M, et al. Improved accuracy of robotic-assisted TKA versus conventional. *Bone Joint J.* 2019;101-B(6_Supple_B):74–80.
10. Sloan M, Sheth NP, Lee GC. Are complication rates lower with robotic-assisted total knee arthroplasty? *J Arthroplasty.* 2018;33(1):S13–S17.
11. Plaskos C, Blum C, Lynch B, et al. Conventional vs robotic/computer-assisted TKA: a meta-analysis. *J Orthop Exper Innov.* 2021;2(1).
12. Zabat MA, Giakas AM, Hohmann A, Lonner JH. Fragility analysis of RCTs comparing robotic vs conventional TKA. *Int Orthop.* 2023.
13. Duboy J, Negrin R, Soto J, et al. Robotic-assisted TKA increases proportion of patients achieving clinically meaningful PROM thresholds. *Int Soc Arthrosc Knee Surg.* 2025.
14. Cao J, Lee SN, Lee DN, et al. Accuracy of robotic-assisted TKA vs conventional TKA in complex cases (failed HTO). *PLoS ONE.* 2024;19(11):e0313391.
15. Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD. Patient satisfaction after TKA: who is satisfied and who is not? *Clin Orthop Relat Res.* 2010;468(1):57–63

How to cite this article: Dr. Nitin Sanadhya, Dr Soniya Sanaadhya, ROBOTIC-ASSISTED VS. CONVENTIONAL TOTAL KNEE ARTHROPLASTY: EARLY FUNCTIONAL OUTCOMES AND PATIENT SATISFACTION, Asian J. Med. Res. Health Sci., 2026; 4 (1):180-186.
Source of Support: Nil, Conflicts of Interest: None declared.