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Robot-assisted total vs. unicompartmental knee arthroplasty: A systematic review and meta-analysis

Syeda Bushra Rizvi[1], Naseer Ullah[2], Mursala Tahir[3], Yousaf Ali[4], Shahnawaz Tahir[5], Nemer Alotaibi[6], Hasan Nawaz Tahir[7]

[1]Clinic of General Surgery, Jinnah Postgraduate Medical Center, Karachi, Pakistan
[2]Department of Community Medicine, Khyber Medical College Peshawar, Peshawar, Pakistan
[3]Department of Community Medicine, Liaquat National Hospital and Medical College, Karachi, Pakistan
[4]Shaqra University College of Medicine, Shaqra, Saudi Arabia
[5]Dow University of Health Sciences, Karachi, Pakistan
[6]Department of Pediatrics, Shaqra University College of Medicine, Shaqra, Saudi Arabia
[7]Department of Community Medicine, Shaqra University College of Medicine, Shaqra, Saudi Arabia

ABSTRACT

Objective: Robot-assisted (RA) surgeries are a major advancement in the medical field, allowing surgeons to operate remotely with minimal direct involvement. Over the past decade, robotic systems have been increasingly used in many areas, including orthopedic procedures. This systematic review and meta-analysis aimed to evaluate the effectiveness of RA-total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (RA-UKA).

Material and Methods: A systematic review and meta-analysis of 12 randomized controlled trials was conducted to compare total and unicompartmental RA-TKA with each other and with the conventional method. A total of 1.538 participants were included in the studies, which were published between January 2014 and November 2024. The main outcomes of interest were range of motion (ROM) and pain measured by the visual analogue scale (VAS). The Cochrane RoB2 tool was used to assess the risk of bias. Subgroup analyses were carried out for RA-TKA and RA-UKA outcomes.

Prospero Registration: CRD42024627463.

Results: RA knee arthroplasty and conventional knee arthroplasty showed no significant differences in either outcome ROM or VAS score for pain with results of [MD =2.30, 95% CI: -1.56 to 6.16] and (MD =0.05, 95% CI: -0.14 to 0.23), respectively. Similarly, the comparison between RA-TKA and RA-UKA in the subgroup analysis also showed no significant difference, with combined results of (MD =2.30, 95% CI: -1.56 to 6.16) and (MD =0.05, 95% CI: -0.14 to 0.23), respectively.

Conclusion: RA knee arthroplasties (RA-TKA and RA-UKA) show similar outcomes to each other and to conventional methods in terms of ROM and pain reduction (VAS), with both robotic techniques showing comparable alternatives to traditional methods. These techniques also offer advantages such as greater precision and less direct involvement from the surgeon, which may help reduce human error. RA-TKA and RA-UKA produce similar results, and either can be used depending on the patient's knee condition and availability of experienced surgeons in robotics. Future studies with standardized protocols, larger sample sizes, and longer follow-up periods are needed to better understand and confirm the long-term benefits and differences between RA-TKA and RA-UKA techniques.

Keywords: Robot-assisted surgery, total knee arthroplasty, unicompartmental knee arthroplasty, range of motion, pain, meta-analysis, RCT

INTRODUCTION

Osteoarthritis (OA) is a progressive, degenerative joint disease and a leading cause of disability worldwide. It is marked by the gradual breakdown of articular cartilage, changes in the subchondral bone, and inflammation of the synovial lining. OA causes pain, stiffness, and limited movement, which can severely affect quality of life especially in people over the age of 50. About 70% of those over 55 years old are affected, and 60% of them are women (1,2). The knee joint is one of the most commonly affected areas, with knee OA making up a large number of cases (1). In the early stages, non-surgical treatments such as physical therapy, medication, and joint injections are often helpful. However, in advanced OA, surgery is usually needed to restore joint function and reduce pain (2,3).

In orthopedics, especially in knee arthroplasty, robot-assisted (RA) techniques have gained significant attention. For end-stage OA in the knee, the main surgical treatment options are total knee arthroplasty (TKA) and unicompartmental knee arthroplasty (UKA) (4,5). TKA focuses only on the damaged part of the knee, preserving the healthy areas, while TKA involves replacing the entire knee joint.

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Corresponding Author
Naseer Ullah

E-mail: khannasir965@gmail.com
ORCID ID: orcid.org/0009-0006-8964-7071

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Traditional manual methods, though effective, rely heavily on the surgeon's skill and experience. In contrast, RA surgery has become a major advancement in modern medicine, improving the surgical treatment of OA by offering greater precision and allowing surgeons to operate with minimal direct involvement through remote control (4).

Previous systematic reviews and meta-analyses have compared RA-TKA with conventional techniques, showing better results for the robotic approach (6-12). However, RA-TKA and RA-UKA have not been compared with each other in any meta-analysis to determine which gives better outcomes.

This systematic review and meta-analysis aim to fill this gap by comparing the outcomes of RA-TKA and UKA with each other, as well as with conventional methods. By focusing on range of motion (ROM) and the visual analog scale (VAS) for pain, this study seeks to provide strong evidence on the functional and clinical effectiveness of robotic systems in knee arthroplasty.

MATERIALS and METHODS

Search Strategy and Databases

A comprehensive search was conducted in PubMed, Google Scholar, and the Cochrane Library for studies on RA-TKA. Randomized controlled trials (RCTs) published between January 2014 and November 2024 were identified. Search terms included " RA-TKA", "TKA","UKA", "ROM" and "pain". Only articles published in English were included.

Inclusion and Exclusion Criteria

RCTs were included if they evaluated RA-TKA in patients over and 18 years old diagnosed with OA requiring arthroplasty. The outcomes of interest were ROM and VAS score for pain. Studies were excluded if they did not report these outcomes, if the authors did not respond, or if the full text was not available.

Study Selection

Title and abstract screening was performed by two independent reviewers. Full texts of eligible or unclear articles were then reviewed independently by the same reviewers based on the inclusion criteria. Any disagreements were resolved through discussion or, if needed, with the help of a third reviewer. The selection process was documented using a PRISMA flow diagram, as shown in Figure 1.

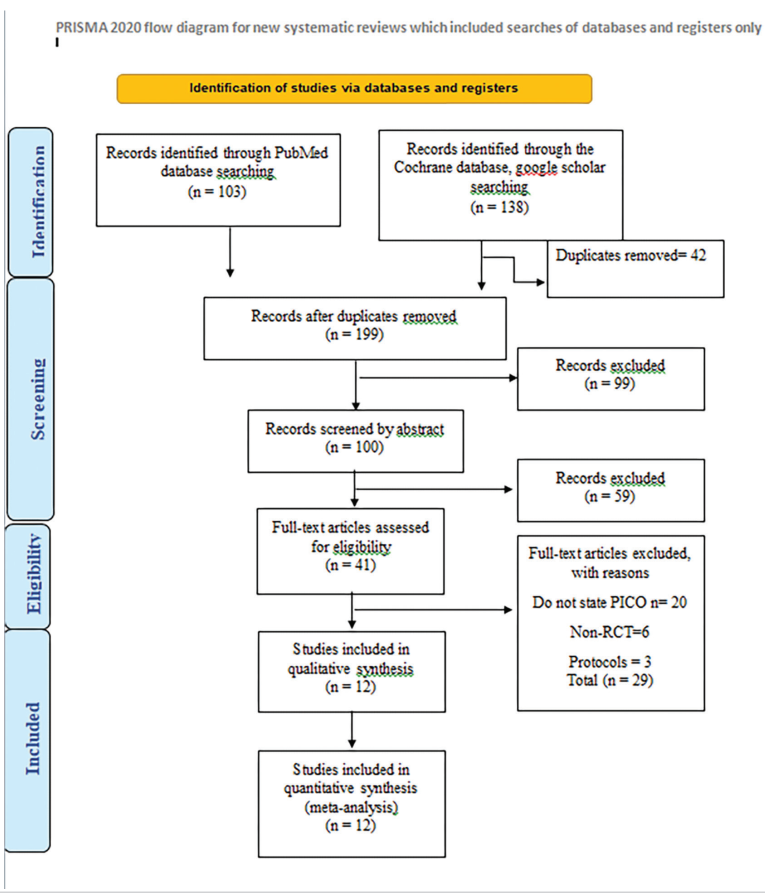


Figure 1. PRISMA flow diagram for study selection.
RCT: Randomized controlled trials

Data Extraction

A specially designed form was used for data extraction. The extracted information included study characteristics (study design, sample size, intervention details, comparison group, follow-up period, and implant used), outcomes of interest (ROM and VAS score for pain), and indicators of study quality. Excel tables were used to manage and organize the data, and review manager 5.4 was used for analysis. Any disagreements were resolved with the help of a third reviewer.

Quality Assessment

Each included study underwent an independent risk of bias assessment by two reviewers using the cochrane risk of bias tool. This tool evaluates key areas such as allocation concealment, random sequence generation, blinding of outcome assessment, blinding of participants and personnel, incomplete outcome data, selective reporting, and other biases (Figure 2). The final risk of bias results were used to determine the strength of the evidence in this study (Figure 3).

Synthesis of Results

A random-effects model was used for all analyses, as differences among study populations were expected. Since all outcomes were continuous data, results were analyzed using mean differences only. No other effect measures were used. Results were reported with a 95% confidence interval (CI). Both primary and secondary outcomes were analyzed. Heterogeneity was assessed using the I^2 statistic, and subgroup analysis was performed to compare RA-TKA and RA-UKA within the RA-TKA group for the outcomes in this meta-analysis.

RESULTS

Study Characteristics

Twelve RCTs met the inclusion criteria after full-text review. These studies evaluated either ROM or VAS score for pain in RA-TKA, including both TKA and UKA. Out of the 12 studies, eight compared RA-TKA with conventional TKA (13-20), three compared RA-UKA with conventional UKA (21-23), and one study compared two RA-TKA alignment techniques, specifically the individualized alignment group and the default alignment group (24). Eleven of the studies reported ROM as an outcome (13-23) while six studies reported VAS scores for pain (Table 1) (13,20,22-24). In the study by Adamska et al. (13) two robotic systems NAVIO and CORI were used, and separate data were provided for each system for both ROM and VAS outcomes as shown in Table 2.

A total of 1.657 participants were included across all 12 studies, with sample sizes ranging from 60 to 351. These studies were conducted across a broad geographic population. Full details are presented in Table 1.

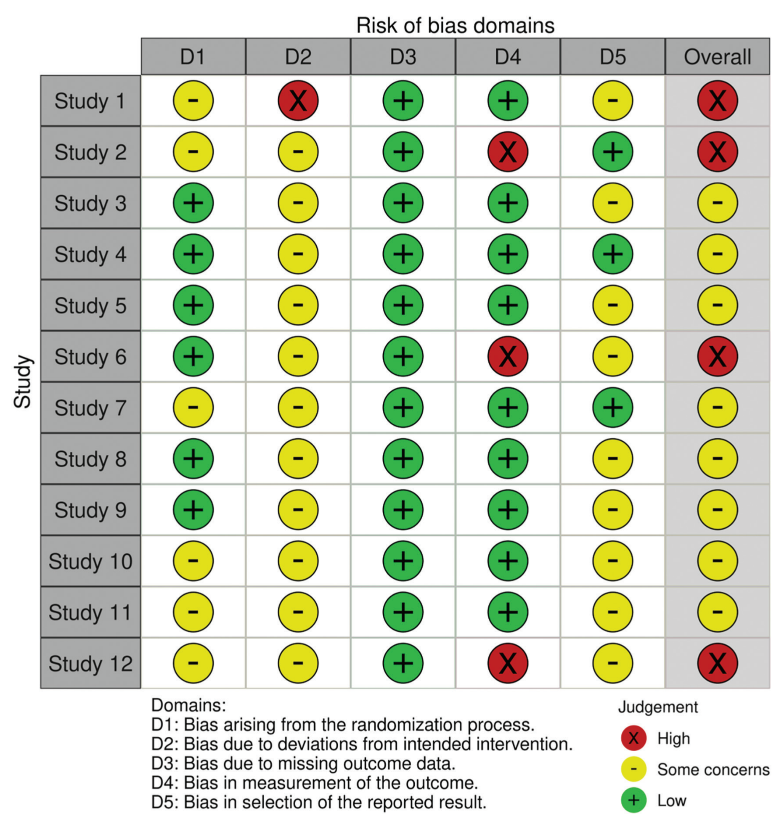


Figure 2. Risk of bias traffic plot.

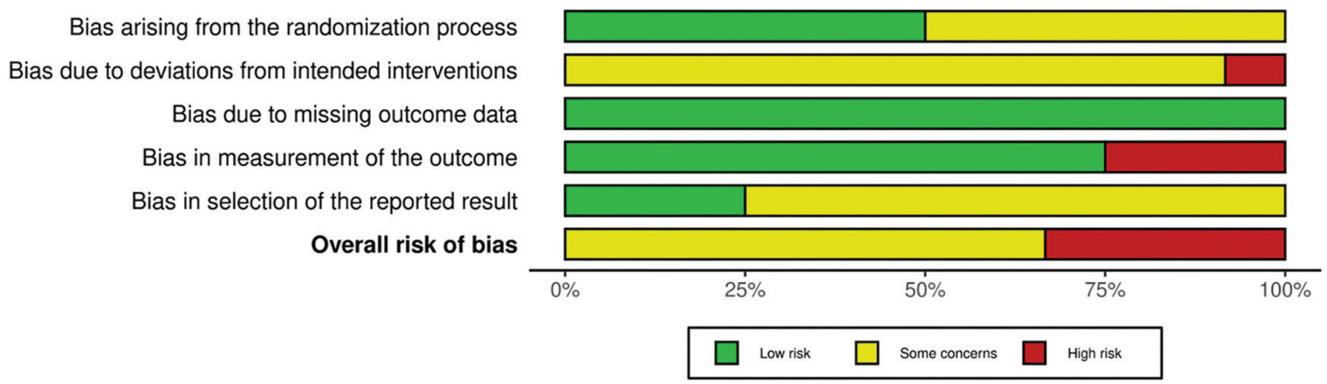


Figure 3. Risk of bias summary plot.

Outcomes

RA and conventional knee arthroplasty showed no significant difference in both outcomes ROM and VAS score for pain. Neither technique showed clear superiority over the other. The combined effect for ROM was (MD =2.30, 95% CI: -1.56 to 6.16), showing a slight tilt in favor of the conventional technique, as seen in Figure 4. For the VAS pain outcome, the combined effect was (MD =0.05, 95% CI: -0.14 to 0.23), as shown in Figure 5.

Subgroup Analysis

In the subgroup analysis of ROM, the RA-TKA subgroup showed a pooled effect of (MD: 2.61, 95% CI: -1.95 to 7.16) with high heterogeneity (I^2=96%), indicating large variation among the studies and no statistical significance (p=0.26), as the CI crosses zero. Similarly, the RA-UKA subgroup had a pooled effect of (MD: 1.38, 95% CI: -3.17 to 5.94) with moderate heterogeneity (I^2=65%) and also no statistically significant effect (p=0.55). Numerically, RA-TKA showed a greater potential improvement in ROM than RA-UKA. However, when comparing the two subgroups (RA-TKA vs. RA-UKA), the test for subgroup differences showed no statistically significant difference (p=0.71, I^2=0%), suggesting that both techniques have a similar effect on ROM. The overall pooled mean difference across both subgroups was (MD: 2.30, 95% CI: -1.56 to 6.16), further supporting the conclusion that RA-TKA and RA-UKA produce similar ROM outcomes, as shown in Figure 6.

Similarly, for the second outcome, VAS score for pain, the pooled mean difference for the RA-TKA subgroup was (MD: 0.06, 95% CI: -0.18 to 0.30) with moderate heterogeneity (I^2=37%) and no statistical significance (p=0.61). For the RA-UKA subgroup, the pooled mean difference was (MD: 0.26, 95% CI: -0.74 to 1.26) with low heterogeneity (I^2=0%) and no statistical significance (p=0.55). The test for subgroup differences showed no significant difference between RA-TKA and RA-UKA (p=0.71), suggesting that both techniques had similar outcomes in terms of pain reduction. The overall pooled mean difference for VAS across both subgroups was 0.05 (95% CI: -0.14 to 0.23), indicating a similar effect in pain relief, as shown in Figure 7.

Risk of Bias

In the risk of bias assessment, four studies were found to have a high risk of bias, while eight studies showed a moderate risk of bias. The main reasons for these ratings were issues in the randomization process, deviations from the intended interventions, and selective reporting of results. No studies were rated as having a low risk of bias. The detailed risk of bias assessment for each study is shown in Figures 2 and 3.

DISCUSSION

This systematic review and meta-analysis aimed to evaluate the comparative effectiveness of RA-TKA and UKA, both in comparison with each other and with conventional surgical techniques. The analysis focused on two key clinical outcomes: ROM and pain, measured by the VAS. Our findings show that robotic techniques, whether used for total or unicompartmental procedures, produce similar results to conventional methods, with no statistically significant advantage in either ROM or VAS scores.

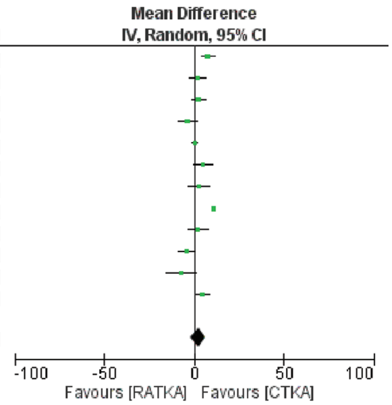
Subgroup analyses further confirmed that RA-TKA and RA-UKA had similar outcomes, with both showing comparable pooled effects for ROM and pain. Although RA-TKA showed slightly better results numerically for improving ROM compared to RA-UKA, this difference was not statistically significant. These findings suggest that the choice between RA-TKA and RA-UKA should depend on patient-specific factors, such as the severity and location of joint damage, the surgical indication, and any existing medical conditions.

Our results suggest that robotic techniques in knee arthroplasty lead to similar clinical outcomes as conventional methods. Although robotic systems may provide better precision and more consistent surgical planning, their clinical benefits in terms

Table 1. Characteristics of included studies

Study	Publication year	Study design	Blinding	Country	No. of participants	Intervention group	Comparison group	Follow-up period	Implant	Robotic arm
Cho et al. (14)	2019	RCT	Not blinded	South Korea	351	Robotic TKA	Conventional TKA	11 years	NexGen	ROBODOC® system
Wang et al. (24)	2024	RCT	Double blind	China	113	Individualized alignment group TKA	Default alignment group TKA	3 months	KUNWU-TKA	KUNWU-TKA system
Batailler et al. (21)	2023	RCT	Not blinded	United States	66	Robotic UKA	Conventional UKA	6.5±0.7 months	Journey II Uni	BlueBelt Navio image-free robotic surgical system
Gilmour et al. (23)	2018	RCT	Single blinded	UK	139	Robotic UKA	Conventional UKA	2 years	Restoris MCK	Mako robotic-arm interactive orthopedic system
Blyth et al. (22)	2021	RCT	Double blind	UK	139	Robotic UKA	Conventional UKA	3 months-1 years	Restoris MCK	Mako robotic arm-assisted system
Yuan et al. (19)	2024	RCT	Single blinded	China	60	Robotic TKA	Conventional TKA	1 year	Cemented posterior stabilized (PS)	YUANHUA-TKA robot
Tian et al. (18)	2023	RCT	Not mentioned	China	144	Robotic TKA	Conventional TKA	3 months	Zimmer Biomet	Hangzhou Jianjia Robot
Yuan et al. (20)	2021	RCT	Single blinded	China	60	Robotic TKA	Conventional TKA	3 months	YUANHUA-TKA	YUANHUA-TKA system
Adamska et al. (13)	2023	RCT	Triple blinded	Poland	215	Robotic TKA	Conventional TKA	1 year	Journey II prosthesis	NAVIO and CORI robotic systems
Thiengwittayaporn et al. (17)	2021	RCT	Single blinded	Thailand	152	Robotic TKA	Conventional TKA	Not mentioned	Legion® PS	NAVIO® system
Lychagin et al. (16)	2022	RCT	Double blind	United States	68	Robotic TKA	Conventional TKA	1 year	TSolution-one	TSolution-one robot
Li et al. (15)	2022	RCT	Single blinded	China	150	Robotic TKA	Conventional TKA	3 months	Legion system	HURWA-ROBOT technology

RCT: Randomized controlled trials, TKA: Total knee arthroplasty, UKA: Unicompartmental knee arthroplasty.

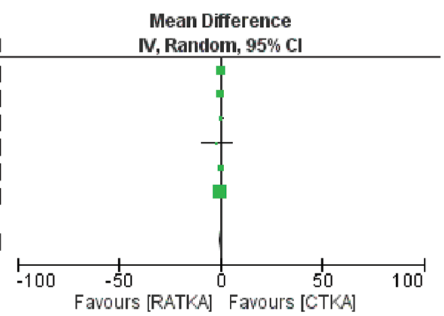


Study or Subgroup	Robotic surgery Mean	SD	Total	Conventional surgery Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Adamska CORI 2023	132.1	9	71	124.3	12.6	68	8.7%	7.80 [4.15, 11.45]
Adamska NOVIO 2023	126.3	14.2	76	124.3	12.6	68	8.4%	2.00 [-2.38, 6.38]
Batailler 2021	52.1	7	33	49.6	8.2	33	8.7%	2.50 [-1.18, 6.18]
Blyth 2021	107.1	12.9	34	110.7	9.4	42	8.1%	-3.60 [-8.78, 1.58]
Cho 2018	130.7	4.4	113	130	7.6	140	9.3%	0.70 [-0.80, 2.20]
Gilmour 2017	130	17.5	58	125	10	54	8.1%	5.00 [-0.23, 10.23]
Li 2022	114.5	18.41	69	111.6	18.75	74	7.7%	2.90 [-3.19, 8.99]
Lychagin 2022	127.3	2.1	33	116.2	1.3	35	9.4%	11.10 [10.26, 11.94]
Mingcheng 2021	107.1	10.97	28	105	10.91	32	7.9%	2.10 [-3.45, 7.65]
Thiengwittayaporn 2021	122	14.1	75	126	14.1	77	8.4%	-4.00 [-8.48, 0.48]
Tian 2023	109.57	15.29	23	116.64	10.89	14	6.5%	-7.07 [-15.53, 1.39]
Yuan 2024	110.82	7.42	28	106.05	7.88	32	8.7%	4.77 [0.90, 8.64]
Total (95% CI)			**641**			**669**	**100.0%**	**2.30 [-1.56, 6.16]**

Heterogeneity: Tau² = 40.90; Chi² = 226.38, df = 11 (P < 0.00001); I² = 95%
Test for overall effect: Z = 1.17 (P = 0.24)

Figure 4. Forest plot for comparison of robotic and conventional technique for ROM.

CI: Confidence interval, SD: Standard deviation, IV: Intravenous, ROM: Range of motion

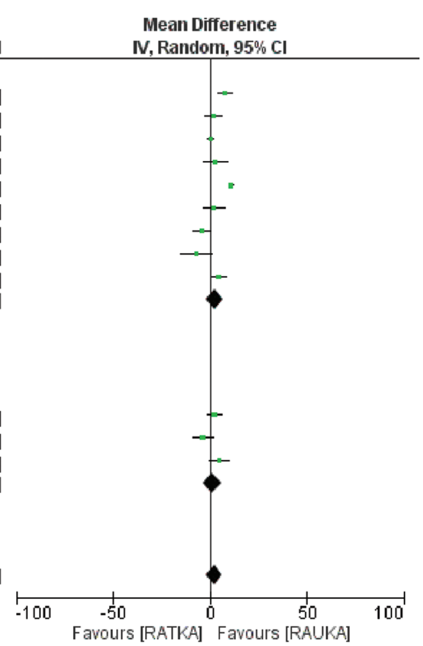


Study or Subgroup	Robotic surgery Mean	SD	Total	Conventional surgery Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Adamska CORI 2023	2.39	1.012	71	2.12	1.23	68	22.5%	0.27 [-0.11, 0.65]
Adamska NOVIO 2023	2	1.3598	76	2.12	1.23	68	18.1%	-0.12 [-0.54, 0.30]
Blyth 2021	2.4	2.4	34	2.1	2	42	3.4%	0.30 [-0.71, 1.31]
Gilmour 2017	3	25	58	5	14.8	54	0.1%	-2.00 [-9.55, 5.55]
Mingcheng 2021	2.6	1	28	2.2	1.2	32	10.8%	0.40 [-0.16, 0.96]
Wang 2024	1.9	0.7	61	2	0.7	59	45.2%	-0.10 [-0.35, 0.15]
Total (95% CI)			**328**			**323**	**100.0%**	**0.05 [-0.14, 0.23]**

Heterogeneity: Tau² = 0.00; Chi² = 5.33, df = 5 (P = 0.38); I² = 6%
Test for overall effect: Z = 0.48 (P = 0.63)

Figure 5. Forest plot for comparison of robotic and conventional technique for VAS for pain.

CI: Confidence interval, SD: Standard deviation, IV: Intravenous, VAS: Visual analogue scale



Study or Subgroup	Robotic surgery Mean	SD	Total	Conventional surgery Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.5.1 ROM RATKA								
Adamska CORI 2023	132.1	9	71	124.3	12.6	68	8.7%	7.80 [4.15, 11.45]
Adamska NOVIO 2023	126.3	14.2	76	124.3	12.6	68	8.4%	2.00 [-2.38, 6.38]
Cho 2018	130.7	4.4	113	130	7.6	140	9.3%	0.70 [-0.80, 2.20]
Li 2022	114.5	18.41	69	111.6	18.75	74	7.7%	2.90 [-3.19, 8.99]
Lychagin 2022	127.3	2.1	33	116.2	1.3	35	9.4%	11.10 [10.26, 11.94]
Mingcheng 2021	107.1	10.97	28	105	10.91	32	7.9%	2.10 [-3.45, 7.65]
Thiengwittayaporn 2021	122	14.1	75	126	14.1	77	8.4%	-4.00 [-8.48, 0.48]
Tian 2023	109.57	15.29	23	116.64	10.89	14	6.5%	-7.07 [-15.53, 1.39]
Yuan 2024	110.82	7.42	28	106.05	7.88	32	8.7%	4.77 [0.90, 8.64]
Subtotal (95% CI)			**516**			**540**	**75.1%**	**2.61 [-1.95, 7.16]**
Heterogeneity: Tau² = 43.09; Chi² = 200.29, df = 8 (P < 0.00001); I² = 96%								
Test for overall effect: Z = 1.12 (P = 0.26)								
1.5.2 ROM RAUKA								
Batailler 2021	52.1	7	33	49.6	8.2	33	8.7%	2.50 [-1.18, 6.18]
Blyth 2021	107.1	12.9	34	110.7	9.4	42	8.1%	-3.60 [-8.78, 1.58]
Gilmour 2017	130	17.5	58	125	10	54	8.1%	5.00 [-0.23, 10.23]
Subtotal (95% CI)			**125**			**129**	**24.9%**	**1.38 [-3.17, 5.94]**
Heterogeneity: Tau² = 10.49; Chi² = 5.71, df = 2 (P = 0.06); I² = 65%								
Test for overall effect: Z = 0.60 (P = 0.55)								
Total (95% CI)			**641**			**669**	**100.0%**	**2.30 [-1.56, 6.16]**

Heterogeneity: Tau² = 40.90; Chi² = 226.38, df = 11 (P < 0.00001); I² = 95%
Test for overall effect: Z = 1.17 (P = 0.24)
Test for subgroup differences: Chi² = 0.14, df = 1 (P = 0.71), I² = 0%

Figure 6. Forest plot of sub-group analysis for ROM.

CI: Confidence interval, SD: Standard deviation, IV: Intravenous, ROM: Range of motion

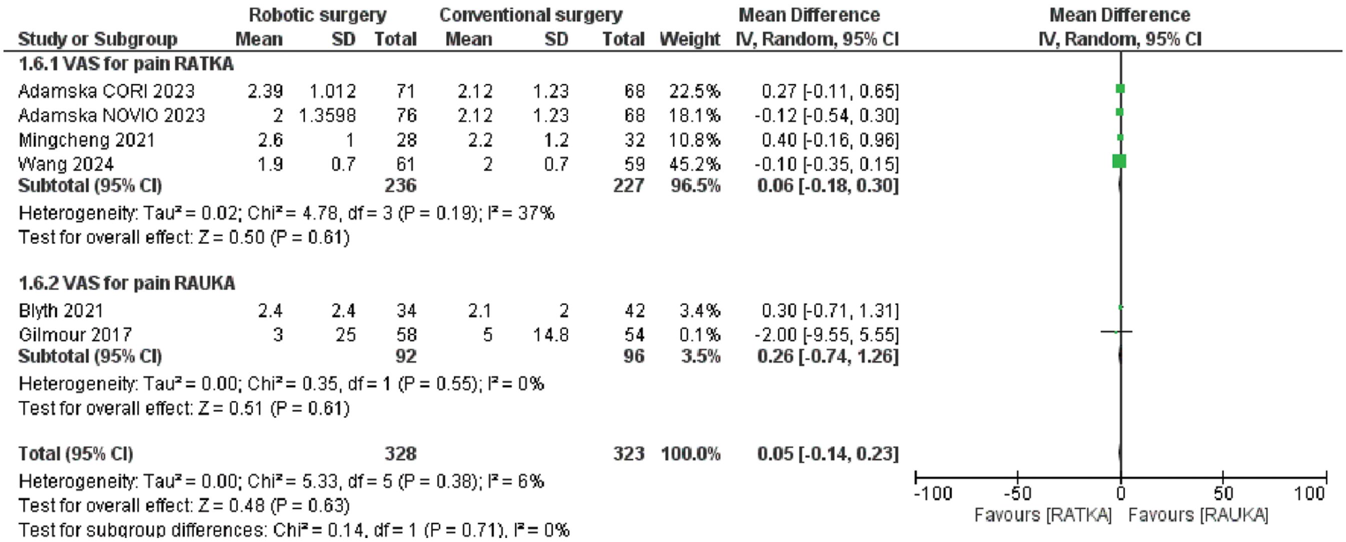


Figure 7. Forest plot of sub-group analysis for VAS for pain.

CI: Confidence interval, SD: Standard deviation, IV: Intravenous, VAS: Visual analogue scale

Table 2. Results for outcomes

Study	Outcome	Robotic surgery		Conventional surgery		Mean difference	CI at 95%
		Events/SD	Total	Events/SD	Total		
Cho et al. (14)	Range of motion	130.7 (4.4)	113	130.0 (7.6)	140	0.7	[-0.80, 2.20]
Batailler et al. (21)	Range of motion	52.1±7 [40;67]	33	49.6±8.2 [33.8;69.5]	33	2.5	[-1.18, 6.18]
Gilmour et al. (23)	Range of motion	130.0 (17.5)	58	125.0 (10.0)	54	5	[-0.23, 10.23]
	PVAS	3.0 (25.0)	58	5.0 (14.8)	54	-2	[-9.55, 5.55]
Blyth et al. (22)	Range of motion	107.1 (12.9) UKA	34	110.7 (9.4) TKA	42	-3.6	[-8.78, 1.58]
	PVAS	2.4 (2.4)	34	2.1 (2.0)	42	0.3	[-0.71, 1.31]
Yuan et al. (19)	Range of motion	110.82 (7.42)	28	106.05 (7.88)	32	4.77	[0.90, 8.64]
Tian et al. (18)	Range of motion	109.57±15.29	23	116.64±10.89	14	-7.07	[-15.53, 1.39]
Yuan et al. (20)	Range of motion	107.10±10.97	28	105.00±10.91	32	2.1	[-3.45, 7.65]
	PVAS	2.6±1.0	28	2.2±1.2	32	0.4	[-0.16, 0.96]
Adamska et al. (13)	Range of motion	126.3±14.2	76	124.3±12.6	68	2	[-2.38, 6.38]
	PVAS	2±1.3598	76	2.12±1.23	68	-0.12	[-0.54, 0.30]
Adamska CORI 2023	Range of motion	132.1±9.0	71	124.3±12.6	68	7.8	[4.15, 11.45]
	PVAS	2.39±1.012	71	2.12±1.23	68	0.27	[-0.11, 0.65]
Thiengwittayaporn et al. (17)	Range of motion	122.0 (14.1)	75	126.0 (14.1)	77	-4	[-8.48, 0.48]
Lychagin et al. (16)	Range of motion	(127.3±2.1°)	33	(116.2±1.3°)	35	11.1	[10.26, 11.94]
Li et al. (15)	Range of motion	114.5 (18.41)	69	111.6 (18.75)	74	2.9	[-3.19, 8.99]
Wang et al. (24)	PVAS	1.9±0.7	61	2.0±0.7	59	-0.1	[-0.35, 0.15]

CI: Confidence interval, SD: Standard deviation, PVAS: Visual analogue scale for pain, TKA: Total knee arthroplasty.

of ROM and pain are not clearly superior. It is also important to note that the idea that robotic surgery reduces the need for surgical skill should be viewed with caution. In practice, robotic-assisted arthroplasty requires dedicated training and experience. Many early-career orthopedic surgeons may not yet be skilled in using robotic systems. Therefore, both conventional and robotic techniques require a high level of surgical expertise, though the skills needed may differ.

This study is also the first to directly compare RA-TKA and RA-UKA. While both robotic techniques showed similar outcomes, the high heterogeneity found in the ROM subgroup analysis highlights the differences among the included studies in terms of design, patient characteristics, and surgical methods.

Implications

The findings of this study have important implications for both clinical practice and future research. RA-TKA and RA-UKA offers a viable alternative to conventional techniques, especially in hospitals where robotic systems are already part of the surgical process. The similar outcomes between RA-TKA and RA-UKA suggest that either technique can be chosen based on the patient's specific condition and the surgeon's familiarity with the method, without expecting a clear clinical advantage.

For healthcare systems, adopting robotic technology in orthopedic surgery requires careful consideration of cost-effectiveness, the learning curve for surgeons, and institutional training programs. As robotic systems continue to improve, future efforts should focus not only on technological development but also on strong training pathways to help surgeons use these systems safely and effectively. Standardizing surgical protocols and including patient-reported outcomes will also be important for understanding the real-world benefits of robotic surgery.

Study Limitations

This study has several limitations that should be acknowledged. First, there was significant variability among the included studies, which contributed to the high heterogeneity observed in the ROM analysis. Second, the number of studies directly comparing RA-TKA and RA-UKA was limited, which made it difficult to draw strong conclusions about which technique is more effective. Third, many of the included studies had a moderate to high risk of bias, highlighting the need for better-designed trials with standardized methods and proper blinding. Lastly, the outcomes analyzed in this study ROM and VAS for pain do not fully reflect other important clinical and functional aspects of robotic knee arthroplasty, such as alignment accuracy, implant longevity, or patient-reported satisfaction.

CONCLUSION

RA-TKA shows clinical outcomes similar to those of conventional methods in terms of ROM motion and pain reduction. Subgroup analysis further supports that RA-TKA and RA-UKA provide comparable results, making both techniques suitable options for the surgical treatment of knee OA. While robotic methods may offer greater precision, they also come with a steep learning curve and require specialized training an important consideration, especially for early-career orthopedic surgeons who may not yet have hands-on experience with robotic systems. Therefore, the choice between RA-TKA and RA-UKA should be based on individual patient needs, the surgeon's expertise, and the resources available at the healthcare institution.

Future research should aim to overcome the current limitations by conducting high-quality RCTs with larger sample sizes and standardized protocols. It will also be important to explore the long-term outcomes of robotic knee arthroplasty to better understand its potential benefits and support its wider adoption in clinical practice.

Ethics

Ethics Committee Approval: There is no need for ethical approval as this study does not involve primary data collection from human participants and is a systematic review and meta-analysis of published data.

Informed Consent: Not necessary.

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Footnotes

Author Contributions

Concept - S.B.R., N.U.; Design - S.B.R., N.U.; Data Collection or Processing - N.U., M.T., Y.A., S.T., H.N.T.; Analysis or Interpretation - S.B.R., N.U., S.T., N.A., H.N.T.; Literature Search - S.B.R., N.U., Y.A.; Writing - S.B.R., M.T.

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