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Original Research Article

A comparison study of robotic and conventional knee replacements using the oxford knee score

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Abstract

Background: Robotic-assisted knee replacement surgery has grown in popularity due to its potential for increased precision and functional outcomes. The purpose of this study was to evaluate the functional outcomes of the robotic-assisted and conventional knee replacement procedures using the Oxford Knee Score.
Methodology: A case-comparison study was undertaken on 50 patients undergoing knee replacement surgery at Tunga group of hospitals between January to June 2024. Participants were evaluated using the OKS, a validated method for measuring knee function, with values ranging from 0 (worst) to 48 (best).
Results: Robot-assisted operations had a slightly higher mean OKS score than conventional procedures, although the difference was not statistically significant.
Conclusion: Functional outcomes improved slightly, but not significantly, following robotic-assisted knee replacement surgery. This shows that factors other than the type of surgery, such as patient characteristics and rehabilitation, may play an important role in recovery.

Keywords: Robotic surgery, Oxford knee score, Knee replacement surgery.

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1. Introduction

One of the most common conditions requiring knee replacement surgery is osteoarthritis (OA) of the knee. Due to the epidemic of global obesity and longer life expectancies, the prevalence of knee OA is growing rapidly, increasing the demand for knee replacement surgery.[1] Knee osteoarthritis, a prevalent ailment that lowers quality of life and causes persistent pain and impairment, affects up to 19% of those over 45.[2]

Symptomatic treatment for knee OA typically consists of pain medication in conjunction with physiotherapy or rehabilitation. The primary method for easing pain and regaining joint function in cases when knee OA does not improve with medication or physical therapy, as well as in more severe stages of knee OA, is surgery, such as the total knee arthroplasty (TKA).[3] The number of total knee arthroplasties performed has significantly increased over the last decade, and by 2030, it is expected to reach 3.5 million procedures in the United States. Nonetheless, it has been noted that between 19% and 25% of patients express dissatisfaction with the use of manual jig-based tools for their primary KA. Component malalignment and instability are potential causes of dissatisfaction because even a 3° misalignment has been shown to cause pain and instability.[4] In comparison with conventional jig-based TKA, robotic TKA uses computer software to transform anatomical data into a virtual, patient-specific 3D reconstruction of the knee joint. It has been associated to increased accuracy in achieving the intended limb alignment, posterior tibial slope, joint line restoration, and femoral and tibial implant positioning.[5] By enhancing soft tissue balance, alignment, component size, and overall patient satisfaction, and also by giving the operating surgeon intraoperative assistance and

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facilitating objective evaluation at every stage of the treatment, robotic technology improves surgical accuracy and precision.[2,6]

In primary arthroplasty procedures, robotic-assisted systems have been demonstrated to increase reproducibility and preoperative planning accuracy.[7] Despite its growing popularity, the clinical and cost-effectiveness of robotic-assisted knee replacement is still under investigation. Although TKR improves pain and function for most people, approximately 15% - 20% experience chronic pain or are dissatisfied with their knee replacements.[8] lthough significant advancements in surgical methods for traditional total knee arthroscopy have been made, moderate-to-severe pain and stiffness after TKA have resulted in a significant patient dissatisfaction rate. As an alternative to traditional TKA, Robot assisted TKA emerged with the intention of increasing surgical accuracy, achieving better clinical results, well balanced knee and causing fewer postoperative problems.[7,9] The use of robotic-assisted technologies in TKA has significantly risen over the past century due to the exponential growth of computational power and robotic technology. Although these technologies are intended to increase accuracy, they may lengthen the duration of surgery.[10,11]

The purpose of this study was to compare the Oxford Knee Score in patients undergoing robotic knee replacement and conventional knee replacement surgeries.

2. Literature Review

2.1. Comparison of conventional and robotic assisted surgery outcomes

According to a meta-analysis which included data from 12 trails assessed the results of unicompartmental knee replacements and found that robotic-assisted surgery may enhance knee alignment and function when compared to conventional surgery. However, there were no significant differences between the two approaches in terms of discomfort, range of motion, health status, or joint awareness. Importantly, the robotic-assisted approach showed superior performance on the Oxford Knee Score, a metric evaluating knee function, with a mean difference (MD) of 3.03 (95% CI = 0.96-5.11).[11]

2.2. Clinical and functional outcomes of robotic-assisted TKA

In a multicentre study conducted Joo et al. it was found that RA-TKA significantly improved patient-reported outcomes (PROMs) over time, including the Forgotten Joint Score (FJS), Knee injury and osteoarthritis outcomes score (KOOS JR), and pain scores. The study discovered that the mean FJS increased from 17.5 preoperatively to 76.7 after a two-year follow-up, while KOOS JR scores improved from 51.6 to 87.9. These findings demonstrate the potential of RA-TKA to increase clinical outcomes and patient satisfaction by improving accuracy in implant alignment and gap balancing.[4]

2.3. Functional scores and clinical outcomes

In a systematic review and meta analysis indicated that, while manual total knee arthroplasty (M-TKA) was associated with shorter operating times and significant improvements in range of motion, it showed better outcomes in terms of the Knee Society Score (KSS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) compared to robotic-assisted TKA after more than six months of follow-up. However, despite its enhanced prosthesis alignment, robotic-assisted TKA did not consistently result in superior clinical outcome.[3]

2.4. Placement accuracy of prosthetic components

A systematic review and meta-analysis of randomised clinical trials study found that robot-assisted TKA resulted in fewer outliers in the hip-knee-ankle (HKA) angle ($p < 0.0001$), femoral component (coronal) angle ($p = 0.0006$), femoral component (sagittal) angle ($p = 0.009$), tibial component (coronal) angle ($p = 0.05$), and tibial component (sagittal) angle ($p = 0.01$) compared to conventional TKA. The postoperative HKA angle was significantly more neutral in the robot-assisted TKA group (mean difference, 20.77\; $p < 0.0001$). However, the complication rate was not significantly different between the two groups. As a result, robot-assisted TKA may deliver more accurate prosthetic component placement and joint alignment precision than conventional TKA, as seen by fewer outliers across multiple joint angles.[9]

3. Methodology

This study is a case comparison study conducted at Thunga group of hospitals, Mumbai between January 2024 to June 2024. A total of 50 participants were conveniently sampled from patients visiting the department during this period.

The Oxford Knee Score (OKS) a validated tool for assessing the knee function was used to compare the outcomes from robotic and non-robotic surgery. The OKS consisted of 12 questions, each with five responses scoring from 0 to 4. The total score ranges from 0 (worst outcome) to 48 (best outcomes). The questions were based on how they felt after hour weeks of surgery. Participants responses were collected via Google forms.

Data analysis was conducted using STATA v.14. Categorical variables such as gender, type of knee surgery and type of knee replacement surgery (robotic vs. non-robotic) were summarized as frequencies and percentages. Continuous variables such as age and OKS were summarised as Mean (SD). The association between types of knee replacement surgery i.e robotic or non-robotic and OKS was analyzed using independent t- test. A p- value of less than 0.05 was considered statistically significant.

3.1. Ethics statement

Ethical clearance was obtained from the appropriate institutional ethical committee. Patient consent was taken before the data was collected.

4. Results

Table 1: Gender

Variables	n	%
Male	7	14%
Female	43	86%

Table 1 shows that the mean age of the participants was 65.4 ± 9.56 years. A large number of participants (86%) were females.

Table 2: Type of replacement

Variable	n	%
Non robotic	22	44%
Robotic	28	56%

Table 2 shows that more than half of the participants (56%) had robotic knee replacement surgery

Table 3: Comparison of Type of Knee replacement surgery with mean OKS score

Variables	OKS	Test - value	p-value
	Mean ± SD		
Type of knee replacement surgery			
Non robotic surgery	11.09 ± 4.54	0.57	0.569
Robotic surgery	11.89 ± 5.17		

Table 3 shows that the overall mean OKS score was 11.54 ± 4.87. Participants who underwent non-robotic knee replacement surgery had a mean OKS score of 11.09 ± 4.54, while those who underwent robotic knee replacement surgery had a slightly higher mean score of 11.89 ± 5.17. This suggests a marginal improvement in knee function among patients who received robotic surgery.

5. Discussion

The OKS was used in this study to assess the functional results of knee replacement procedures performed with and without robotic assistance. Patients who had robotic-assisted surgery had a slightly higher mean OKS score (11.89 ± 5.17) than those who had non-robotic surgery (11.09 ± 4.54). However, the difference (p = 0.569) was not statistically significant.

The findings are consistent with existing literature, indicating that robotic-assisted knee surgeries increase precision and alignment, resulting in better functional outcomes. For example, a clinical and radiological study found that robotic-assisted UKA improved knee alignment and function compared to traditional treatments, with superior scores on the OKS[2] A similar study has been conducted in India to assess the final follow-up mean OKS of knees operated with manual and robotic-assisted TKA. In that study, the mean OKS for manual TKA was 39.76 (SD = 2.21), which was nearly identical to robotic TKA (40.42, SD = 1.85). The difference was not statistically significant (p = 0.085) (12). Despite better precision, the study from India and the current research show that there is little difference in OKS scores between robotic and manual procedures. Short-term clinical results, including pain alleviation, patient satisfaction, and functional recovery, may rely more on patient characteristics such as preoperative function, rehabilitation, and comorbidities than on surgical technique alone.[2] Systematic reviews and meta-analyses comparing robotic-assisted and conventional total knee arthroplasty (TKA) indicate that robotic-assisted TKA significantly reduces postoperative pain levels compared to conventional methods. However, the overall functional outcomes, including OKS, remain only marginally and insignificantly in favor of robotic-assisted TKA. This aligns with the current study's findings.[13]

In a review done by Mancino F et al, four studies (44%) 24, 26-28 reported revision rates. The overall revision rate was 1.7% in the Robotic arthroplasty (RA) group and 2.7% in the Conventional group. Yang et al, 27 reported an overall survivorship of 98.5% at 5 years in the Robotic A group and 97.6% in the Conventional manual (CM) group; 97.1%, and 92.3% respectively at 10 years (p=0.31). Cho et al, 28 reported an overall survivorship of 98.8% in the RA group and 98.5% in the CM (p=0.563), with no cases of aseptic loosening in the RA group compared to the two cases in the Conventional Manual group. This is in line with our findings that robotic has more precision and less complication for the patients although it is not statistically significant.[14]

A systemic review and meta-analysis done by Yi Ren et al included several studies, several scores were collected including the KSS, the HSS, the WOMAC, the Oxford Knee Score (OKS) and the Short Form-36 (SF-36) Health Survey. They reported a gradual improvement in both the HSS and WOMAC scores from 3 months postoperative to the final follow-up; however, none of the comparisons between the robotic and conventional approaches were shown to be significant. Hong et al also showed no difference in the HSS and WOMAC scores at the final follow-up. Our findings also show that there is a improvement but it is not statistically significant, we can attribute this to the longer surgical time taken, or the gaps in technological finesse of the first generation machines. At the end of it all, the machines are supposed to do quick and tidy work of the surgeries. More technological advancements in the robotic machines will have to be looked at for better outcomes.[15]

6. Conclusion

This study examined the functional outcomes of knee replacement surgeries conducted with and without robotic assistance, with the Oxford Knee Score (OKS) serving as the primary assessment measure. Robot-assisted procedures had slightly higher mean OKS scores (11.89 ± 5.17) than non-robotic surgeries (11.09 ± 4.54), but the difference was not statistically significant (p = 0.569). These findings are consistent with earlier research, which has shown that robotic-assisted operations enhance precision and alignment but not significantly improving overall functional outcomes. Preoperative function, rehabilitation, and comorbidities appear to have a larger impact on short-term clinical outcomes, such as pain alleviation and patient satisfaction.

7. Limitation of the study

A small sample size may limit the generalizability of the results and diminish statistical power to identify significant differences. The results were evaluated over a short period of time, which may have missed long-term functional benefits or issues associated with either surgical approach. Factors such as surgeon expertise, patient comorbidities, and recovery processes may have influenced outcomes, although they were not thoroughly controlled.

8. Scope of Future Work

Future research should include larger sample sizes, longer follow-up periods, as well as comprehensive evaluation of patient-reported outcomes to better understand the benefits and limitations of robotic-assisted knee replacement procedures.

9. Ethics Statement

Ethical clearance was obtained from the appropriate institutional ethical committee. Patient consent was taken before the data was collected.

10. Data Availability

Data is available on request from the authors.

11. Source of Funding

None.

12. Conflict of Interest

None.

13. Authors Contribution

All the authors, have contributed equally in conceptualisation, manuscript writing, data collection, analysis and article writing.

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