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Functional outcomes following total hip and knee arthroplasty

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ABSTRACT

Background: Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are effective treatments for advanced osteoarthritis (OA) and other joint disorders. Despite their efficacy, many patients experience residual functional limitations postoperatively. This study evaluates functional outcomes following unilateral THA and TKA, integrating patient-reported outcome measures (PROMs) and performance-based outcome measures (PBOMs) over 12 weeks.
Methods: This prospective observational study, conducted at B. P. Koirala Institute of Health Sciences, Nepal, included adults scheduled for unilateral THA or TKA. Participants completed preoperative questionnaires assessing demographics, health status, joint disabilities, and baseline functional tests, including the 30-second chair stand test (30-s CST) and the HOOS/KOOS. Postoperative follow-ups were conducted at 2, 6, and 12 weeks, assessing functional outcomes, satisfaction, pain, and quality of life (QoL). Paired t-tests and repeated measures ANOVA was used for data analysis in SPSS version 26.0.
Results: The study included 38 patients; 24 THA and 14 TKA, with both groups showing significant postoperative improvements in all outcomes (HOOS/KOOS, 30-s CST, pain, and QoL). TKA patients demonstrated better early improvements in pain, symptoms, and physical function at 2 weeks. In contrast, THA patients had greater improvements in sports and recreation scores by 12 weeks. Self-reported QoL showed significant improvements, with no significant differences in age or BMI affecting outcomes. Pain catastrophizing decreased significantly in both groups. Gender differences were found in the THA group, where men improved better in most functional measures.
Conclusions: Both THA and TKA result in significant improvements in pain, physical function, and QoL, with PROMs and PBOMs playing complementary roles in tracking recovery highlighting the importance of integrating subjective and objective measures for holistic post-surgical evaluations and personalised rehabilitation strategies.

Keywords: Functional orthopaedic surgery outcomes, Patient-reported outcome measures, Performance-based outcome measures, Total hip arthroplasty, Total knee arthroplasty

INTRODUCTION

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are highly effective and widely utilized surgical interventions for addressing advanced osteoarthritis (OA) and other joint disorders such as inflammatory arthritis, osteonecrosis, trauma, and failed reconstructions.[1,2] OA is one of the most prevalent musculoskeletal conditions in the elderly, significantly impairing their functional mobility and quality of life (QoL).[1] While THA and TKA have been proven to alleviate pain and improve function, a notable proportion of patients continue to experience residual functional limitations postoperatively.[3]

Historically, implant durability served as the principal metric for evaluating the success of joint replacement

procedures like THA and TKA. However, in recent decades, attention has shifted toward patient-reported outcome measures (PROMs), which capture patients' subjective experiences related to pain, functional capacity, and overall QoL.[4,5] PROMs such as the Western Ontario and McMaster University osteoarthritis index (WOMAC), Harris hip score (HHS), and hip disability and osteoarthritis outcome score (HOOS)/knee injury and osteoarthritis outcome score (KOOS) have gained prominence.[6,7] The HOOS and KOOS, extensions of the WOMAC index, offer valuable insights into outcomes for younger or more active patients by addressing activities like sports and recreation.[8,9]

While PROMs provide valuable insights, they are inherently subjective and rely on patients' perceptions, which can be disproportionately affected by factors such as pain reduction. For example, pain relief following arthroplasty may lead patients to overestimate their functional recovery, thereby limiting the accuracy of PROMs as standalone metrics.[10,11] To address these limitations, performance-based outcome measures (PBOMs) have emerged as objective tools for evaluating physical function. Functional performance tests- such as the 30-second chair stand test (30-s CST), walking tests, and stair-climbing tests- along with activity tracking devices, quantify recovery through real-world simulations of everyday activities.[12,13] Despite their potential to complement PROMs, the interplay between PROMs and PBOMs remains poorly understood. There is limited evidence regarding the optimal combination of metrics to guide clinical decision-making.[14,15]

The present study aimed to bridge these gaps by comprehensively evaluating recovery following unilateral THA and TKA using both PROMs and PBOMs. The primary objective is to track functional outcomes based on self-reported and objectively measured metrics over the initial 12 weeks post-surgery. Secondary objectives include identifying clinical factors that predict successful outcomes, assessing discrepancies between PROMs and PBOMs, and exploring psychological predictors of postoperative pain. By integrating subjective and objective measures, this study aims to provide a more nuanced understanding of recovery trajectories, identify patients at risk for suboptimal outcomes, and inform personalized rehabilitation strategies.[16,17] The findings will offer critical insights into optimizing perioperative and postoperative care to maximize the benefits of THA and TKA.

METHODS

Study Design: This prospective observational study was conducted in the department of orthopaedics at B. P. Koirala Institute of Health Sciences, Nepal, in compliance with the strengthening the reporting of observational studies in epidemiology (STROBE) guidelines. Ethical approval was granted by the institutional review committee (IRC/2358/022), and the study adhered to the principles of the Declaration of Helsinki.[13,14]

Sample and sampling

Participants were recruited over a six-month period from July to December 2022. Adults aged >18 years, scheduled for unilateral total hip arthroplasty (THA) or total knee arthroplasty (TKA), were eligible to participate. Written informed consent was obtained from all participants after they were provided with a detailed information sheet outlining the study's objectives, risks, and benefits. Exclusion criteria included revision THA or TKA, use of custom or mega prostheses, and psychomotor or cognitive impairments that could interfere with reliable participation.[9,13] The sample size was calculated based on the 30-second chair stand test (CST) scores from the study by Mark-Christensen et al.[3] For TKA, the CST scores were 13±1.6, and for THA, 12.1±2.9. Using a 95% confidence interval ($Z = 1.96$), 80% power, and the formula $n=Z^2\times SD^2/d^2$, the estimated sample sizes were 10 for TKA and 9 for THA. However, to enhance robustness, all eligible participants who met the inclusion criteria were enrolled.

Recruitment and data collection

Participants were recruited preoperatively during informative group sessions on THA and TKA. Preoperative data collected through questionnaires included demographics, health status, joint disabilities, analgesic use, surgical expectations, and the 30-second CST. Additionally, the HOOS (hip disability and osteoarthritis outcome score) for THA and the KOOS (knee injury and osteoarthritis outcome score) for TKA were administered.[9,11] Follow-up data were collected at 2, 6, and 12 weeks postoperatively, which included the HOOS/KOOS, patient satisfaction, and the Forgotten Joint Scale (FJS). Participants followed a standardized rehabilitation protocol that included physiotherapy during hospitalization, followed by twice-weekly outpatient sessions and daily home exercises for 4-8 weeks after discharge.

Statistical analysis

Data analyses were performed separately for THA and TKA patients using SPSS (version 26.0; IBM Corp.). To summarize demographic and clinical variables, descriptive statistics were used whereas t-tests were used to compare preoperative variables such as age, gender, BMI, 30-second CST, HOOS/KOOS subscales, expectations, satisfaction, PCS, and FJS. Preoperative and postoperative changes in HOOS, KOOS, PCS, expectations, satisfaction, and FJS scores were analysed using a general linear model for repeated measures, with post hoc t-tests and Bonferroni corrections for pairwise comparisons. Pearson correlation coefficients were computed to assess relationships between percentage change scores at baseline and follow-ups for the following pairs: (1) HOOS/KOOS physical function and 30-second CST, (2) HOOS/KOOS physical function and pain, and (3) 30-second CST and HOOS/KOOS pain. P values were considered significant

at α = 0.05, and correlations were classified as low (<0.3), moderate (0.3-0.5), or strong (>0.5).[5,6,18]

Ethical considerations

The study was approved by the institutional review committee (IRC/2358/022) at B. P. Koirala Institute of Health Sciences, Dharan, Nepal, and conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants, who were provided with a detailed information sheet outlining the study's objectives, risks, and benefits. Participants were given time to review the information and ask questions before signing the consent form. Confidentiality was strictly maintained, and participants had the right to withdraw from the study at any time without affecting their medical care. The study minimized risks and ensured participant safety through regular monitoring and follow-ups.

RESULTS

Table 1 shows the outcomes for total hip arthroplasty (THA) and total knee arthroplasty (TKA) groups across various measures at baseline, 2 weeks, 6 weeks, and 12 weeks postoperatively. Both groups exhibited significant improvements in functional and pain-related measures. In the 30-second chair stand test (CST), THA scores increased from 4.9 (3.6) at baseline to 11.0 (3.5) at 12 weeks, while TKA scores improved from 7.6 (3.0) to 12.5 (3.0) over the same period. The HOOS/KOOS scores, which assess hip and knee function, also showed notable improvements in both groups, with THA progressing from 38.0 (15.7) to 78.5 (6.3), and TKA from 41.5 (13.5) to 79.6 (5.1) by 12 weeks.

Symptoms, pain, physical function, and quality of life (QoL) scores similarly demonstrated marked progress, with THA and TKA improving consistently over time.

Table 1: Changes from baseline to follow-up [total hip arthroplasty (THA) and total knee arthroplasty (TKA)].

Outcome measure	Group	Baseline mean (SD)	2 weeks mean (SD)	6 weeks mean (SD)	12 weeks mean (SD)
30-s CST	THA	4.9 (3.6)	4.8 (2.1)	8.3 (3.1)	11.0 (3.5)
	TKA	7.6 (3.0)	7.2 (2.3)	10.4 (2.6)	12.5 (3.0)
HOOS/KOOS	THA	38.0 (15.7)	47.8 (15.6)	63.5 (12.1)	78.5 (6.3)
	TKA	41.5 (13.5)	58.4 (7.4)	68.8 (6.0)	79.6 (5.1)
Symptoms	THA	42.7 (15.0)	51.8 (16.7)	67.5 (14.2)	81.6 (7.7)
	TKA	54.4 (19.2)	65.1 (10.2)	74.6 (7.7)	84.7 (6.3)
Pain	THA	39.2 (14.7)	47.4 (16.0)	64.2 (12.0)	79.5 (7.7)
	TKA	44.3 (16.9)	60.4 (9.7)	68.8 (7.6)	82.9 (6.8)
Physical function	THA	40.6 (18.5)	49.2 (18.1)	65.3 (12.4)	79.4 (6.6)
	TKA	47.8 (21.9)	61.1 (11.3)	70.9 (7.6)	81.1 (7.4)
Sport and recreation	THA	28.5 (22.0)	40.8 (18.8)	57.0 (16.1)	73.0 (9.4)
	TKA	26.1 (12.9)	45.0 (8.8)	57.9 (8.0)	66.8 (9.1)
QoL	THA	29.4 (16.7)	44.1 (18.4)	56.8 (15.1)	74.5 (5.6)
	TKA	34.8 (13.3)	55.3 (7.6)	65.6 (6.9)	76.9 (5.9)
PCS[a]	THA	37.0 (8.6)	29.3 (7.3)	19.3 (6.9)	12.3 (5.4)
	TKA	29.1 (10.8)	23.6 (8.5)	15.3 (6.5)	8.8 (5.1)
Daily (%) analgesics					
Paracetamol	THA	20.8	16.7	75.0	33.3
	TKA	21.4	21.4	57.1	35.7
NSAIDS	THA	91.7	83.3	16.7	0.0
	TKA	85.7	85.7	35.7	7.1
Opioids	THA	8.3	4.2	0.0	0.0
	TKA	28.6	14.3	0.0	0.0
Neuropathic agent	THA	16.7	16.7	20.8	4.2
	TKA	7.1	7.1	7.1	0.0
Expectation/ satisfaction	THA	84.0 (8.6)	67.5 (9.5)	78.8 (5.9)	86.7 (6.5)
	TKA	73.4 (7.2)	74.5 (6.5)	81.2 (7.0)	88.4 (4.8)
FJS[c]	THA	-	51.5 (18.0)	68.7 (15.2)	83.7 (8.9)
	TKA	-	63.3 (5.9)	77.5 (4.6)	86.6 (4.7)

Table 2: Changes from baseline to 12 weeks follow-up [total hip arthroplasty (THA) and total knee arthroplasty (TKA)].

Outcome measure	Group	Baseline mean (SD)	12 weeks mean (SD)	Mean difference (95% CI)	P value
30-s CST	THA	4.9 (3.6)	11.0 (3.5)	6.1 (4.9, 7.3)	0.001
	TKA	7.6 (3.0)	12.5 (3.0)	4.9 (3.8, 5.9)	0.001
HOOS/KOOS	THA	38.0 (15.7)	78.5 (6.3)	40.4 (35.6, 45.3)	0.001
	TKA	41.5 (13.5)	79.6 (5.1)	38.1 (31.6, 44.6)	0.001
Symptoms	THA	42.7 (24)	81.6 (7.7)	38.9 (34.7, 43.1)	0.001
	TKA	54.4 (19.2)	84.7 (6.3)	30.4 (20.3, 40.5)	0.001
Pain	THA	39.2 (14.7)	79.5 (7.7)	40.3 (35.9, 44.6)	0.001
	TKA	44.3 (17.0)	82.9 (6.8)	38.6 (30.0, 47.1)	0.001
Physical function	THA	40.6 (18.5)	79.4 (6.6)	38.8 (32.5, 45.1)	0.001
	TKA	47.8 (21.9)	81.1 (7.4)	33.3 (23.4, 43.2)	0.001
Sport and recreation	THA	28.5 (21.9)	73.0 (9.4)	44.5 (38.8, 52.0)	0.001
	TKA	26.1 (12.9)	66.8 (9.1)	40.7 (31.7, 49.8)	0.001
QoL	THA	29.4 (16.7)	74.5 (5.6)	45.1 (38.8, 51.4)	0.001
	TKA	34.8 (13.3)	76.9 (5.9)	42.1 (33.0, 51.2)	0.001
PCS[a]	THA	37.0 (8.6)	12.3 (5.4)	24.7 (21.5, 28.0)	0.001
	TKA	29.1 (10.8)	8.8 (5.1)	20.4 (16.0, 24.7)	0.001

Table 3: Prospectively tabulated hip disability and osteoarthritis outcome score (HOOS)/knee injury and osteoarthritis outcome score (KOOS).

	N	THA mean (SD)	N	TKA mean (SD)	P value
Preoperatively	24	38.0 (15.7)	14	41.5 (13.5)	0.494
2 weeks post-op	24	47.8 (15.6)	14	58.4 (7.4)	0.008
6 weeks post-op	24	63.5 (12.1)	14	68.8 (6.0)	0.086
12 weeks post-op	24	78.5 (6.3)	14	79.6 (5.1)	0.570

Table 4: Prospectively tabulated performance-based function [30-second chair stand test (30-s CST)].

	N	THA mean (SD)	N	TKA mean (SD)	P value
Preoperatively	24	4.9 (3.6)	14	7.6 (3.0)	0.230
2 weeks post-op	24	4.8 (2.1)	14	7.2 (2.3)	0.002
6 weeks post-op	24	8.3 (3.1)	14	10.4 (2.6)	0.040
12 weeks post-op	24	11.0 (3.5)	14	12.5 (3.0)	0.196

Table 5: Correlations between hip disability and osteoarthritis outcome score (HOOS)/knee injury and osteoarthritis outcome score (KOOS) subscales and performance measures.

Particular	Scores	2 weeks	6 weeks	12 weeks
PF versus 30-s CST	HOOS	R=0.244 P=0.250	R=0.140 P=0.515	R=0.264 P=0.212
	KOOS	R=-0.036 P=0.902	R=-0.181 P=0.535	R=-0.290 P=0.314
Pain versus PF	HOOS	R=0.654 P=0.001	R=0.955 P=0.001	R=0.823 P=0.001
	KOOS	R=0.609 P=0.002	R=0.620 P=0.001	R=0.562 P=0.004
Pain versus 30-s CST	HOOS	R=-0.106 P=0.718	R=0.090 P=0.675	R=0.149 P=0.486
	KOOS	R=-0.043 P=0.883	R=0.187 P=0.523	R=-0.293 P=0.309

The pain scores improved in both groups, with THA increasing from 39.2 (14.7) at baseline to 79.5 (7.7) at 12 weeks, and TKA rising from 44.3 (16.9) to 82.9 (6.8). This improvement was accompanied by a decrease in daily analgesic use, particularly in the use of NSAIDs, opioids, and neuropathic agents, which dropped significantly by 12 weeks. Additionally, the patients' expectations and satisfaction scores showed steady improvement, with THA scores rising from 84.0 (8.6) at baseline to 86.7 (6.5), and TKA from 73.4 (7.2) to 88.4 (4.8). The FJS (function joint score) also reflected significant progress, with THA improving from 51.5 (18.0) at 2 weeks to 83.7 (8.9) at 12 weeks, and TKA from 63.3 (5.9) to 86.6 (4.7). These findings highlight the substantial gains in both functional

recovery and patient satisfaction following hip and knee arthroplasties, with reductions in pain and analgesic use contributing to improved overall outcomes.

Table 2 shows both total hip arthroplasty (THA) and total knee arthroplasty (TKA) groups demonstrated significant improvements across all measured outcomes from baseline to 12 weeks. In the 30-second chair stand test (CST), the THA group showed a mean increase of 6.1 repetitions (95% CI: 4.9-7.3), while the TKA group improved by 4.9 repetitions (95% CI: 3.8-5.9). The HOOS/KOOS scores indicated substantial overall functional improvements, with mean increases of 40.4 (95% CI: 35.6-45.3) for THA and 38.1 (95% CI: 31.6-44.6) for TKA. Symptom scores improved significantly, with gains of 38.9 (95% CI: 34.7-43.1) for THA and 30.4 (95% CI: 20.3-40.5) for TKA. Pain scores also reflected marked reductions, with improvements of 40.3 (95% CI: 35.9-44.6) in THA and 38.6 (95% CI: 30.0-47.1) in TKA. Physical function scores increased by 38.8 (95% CI: 32.5-45.1) in THA and 33.3 (95% CI: 23.4-43.2) in TKA.

Table 3 shows preoperative and postoperative mean scores for the THA (total hip arthroplasty) and TKA (total knee arthroplasty) groups were compared at various time points. Preoperatively, there was no significant difference between the groups (THA: 38.0±15.7 versus TKA: 41.5±13.5, p=0.494). At 2 weeks postoperatively, the TKA group showed significantly higher mean scores compared to the THA group (THA: 47.8±15.6 versus TKA: 58.4±7.4, p=0.008). By 6 weeks postoperatively, the difference between groups narrowed and was not statistically significant (THA: 63.5±12.1 versus TKA: 68.8±6.0, p=0.086). At 12 weeks postoperatively, both groups demonstrated comparable scores (THA: 78.5±6.3 versus TKA: 79.6±5.1, p=0.570).

Table 4 shows the 30-second chair stand test (CST) performance for the THA (total hip arthroplasty) and TKA (total knee arthroplasty) groups was evaluated preoperatively and at multiple postoperative time points. Preoperatively, the groups were similar, with no significant difference in mean scores (THA: 4.9±3.6 versus TKA: 7.6±3.0, p=0.230). At 2 weeks postoperatively, the TKA group showed significantly better performance compared to the THA group (THA: 4.8±2.1 versus TKA: 7.2±2.3, p=0.002). By 6 weeks postoperatively, the TKA group maintained significantly higher scores (THA: 8.3±3.1 versus TKA: 10.4±2.6, p=0.040). However, by 12 weeks postoperatively, the difference between groups was no longer statistically significant (THA: 11.0±3.5 versus TKA: 12.5±3.0, p=0.196), indicating considerable improvement in both groups over time.

Table 5 shows the correlation analysis revealed distinct relationships between pain, physical function (PF), and 30-second chair stand test (CST) performance. There was no significant correlation between PF (measured by HOOS/KOOS scores) and CST performance at 2, 6, or 12 weeks postoperatively ($p>0.05$), indicating a weak association between perceived physical function and objective functional performance. Conversely, pain was strongly and positively correlated with PF at all time points, as shown by HOOS ($R=0.654$-0.955, $p<0.05$) and KOOS ($R=0.562$-0.620, $p<0.05$) scores, suggesting that reductions in pain were closely associated with improved physical function.

DISCUSSION

This study highlights the differential recovery trajectories following THA and TKA and underscores the significance of integrating self-reported and performance-based metrics for a comprehensive assessment. Although both groups showed notable gains in physical function, pain management, and quality of life, the limited connection between PROMs and PBOMs indicates that these measures capture different facets of recovery. Significant differences were found in early postoperative evaluations; PBOMs, like the 30-s CST, showed slower recovery, while PROMs showed significant gains in perceived physical function.

Recovery following THA and TKA is often assessed using self-reported tools such as HOOS and KOOS. However, self-report metrics can be influenced by patient perceptions and pain relief, which may lead to an overestimation of functional recovery.[2,10] In contrast, performance-based measures provide an objective assessment of functional capacity but fail to capture patient perceptions or experiences of recovery.[12] This study compared self-reported and performance-based outcomes longitudinally and found weak and statistically insignificant correlations between these measures during the postoperative period (2, 6, and 12 weeks).

In the early postoperative phase, conflicting recovery patterns were observed: HOOS/KOOS self-reported physical function scores improved significantly, while performance-based measures, such as the 30-second chair stand test (30-s CST), declined at 2 weeks. Although self-reported and performance-based metrics showed some alignment at 6 and 12 weeks, the correlations remained weak, highlighting the complementary nature of these tools.[3,13] These findings underscore the importance of using both self-report and performance-based assessments to provide a more holistic view of recovery after THA/TKA.

Discrepancies between self-reported outcomes and functional performance were further evident in the relationship between pain and function. Patients reported improvements in pain (HOOS/KOOS pain subscale) but did not demonstrate proportional gains in performance-based function, suggesting that early reductions in pain may influence perceived functional recovery more than actual functional capacity.[14,15] This aligns with previous research showing that self-reported measures of function

are often more strongly associated with pain than with objective performance measures.[9,11]

The findings add to the growing evidence that self-reported and performance-based tools assess different aspects of recovery, reinforcing the value of combining PROMs and PBOMs for postoperative assessments. While PROMs provide insights into patients' perceptions and satisfaction, PBOMs offer an objective evaluation of functional recovery.[16,17] Early postoperative care and rehabilitation should, therefore, consider both metrics to accurately guide recovery. This dual approach enables clinicians to identify discrepancies and tailor rehabilitation strategies to address both perceived and actual deficits. Future research should focus on long-term outcomes and explore strategies to enhance the alignment of PROMs and PBOMs, such as integrating activity monitoring technologies or patient education programs.

This study has several limitations that warrant consideration. First, the sample size was relatively small, although significant differences were still observed within this limited cohort. Second, the follow-up period was restricted to 12 weeks, limiting the ability to capture long-term recovery patterns. Lastly, the study was conducted at a single centre and involved multiple surgeons, suggesting a confounding effect due to the surgeons' influence.

Furthermore, while temporal variations in the relationship between HOOS subscales and performance-based measures were evident, particularly in the early postoperative period, these relationships showed improvement at 6 and 12 weeks, suggesting that correlations may strengthen with longer follow-ups. Lastly, functional performance measures, while objective and valuable, focus on specific tasks and may not fully reflect the broad range of daily activities a patient performs. In contrast, a patient's subjective perception of their day-to-day progress might provide a more comprehensive view of overall functionality, capturing aspects that isolated performance assessments may overlook.

CONCLUSION

The integration of patient-reported and performance-based outcomes provides a more comprehensive understanding of recovery following THA and TKA. While both tools highlight significant improvements in pain relief, physical function, and QoL, their weak correlation underscores the need for a dual approach to postoperative recovery assessment. Personalized rehabilitation strategies that address both perceived and actual functional deficits are essential for optimizing recovery. Future research should explore the influence of surgical techniques, rehabilitation programs, and long-term recovery trajectories and other innovative methods to align subjective and objective outcomes for enhanced patient care, including better recovery outcomes and improved patient satisfaction.

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