Original Article

Functional Outcome of Subvastus versus Medial Parapatellar Approaches for Total Knee Replacement in Patients with Knee Osteoarthritis: A Prospective Cohort Study

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Abstract

Background: Subvastus approach and medial parapatellar approach are two major approaches for total knee replacement (TKR). There is no global consensus on the superiority of either approach in terms of functional outcomes.

Objective: The present study aimed to evaluate the functional outcome of TKR through subvastus approach and medial parapatellar approach by using patient-reported scores at 3-, 6-, and 12-month post-operative follow-ups.

Methods: This prospective cohort follow-up study included patients with knee osteoarthritis who underwent elective primary TKR either through the subvastus or medial parapatellar approaches at King Abdullah Medical City, Makkah city, Kingdom of Saudi Arabia, from January 2019 to December 2022. Scores from the self-reported Oxford Knee Score (OKS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) were compared in the two groups of patients at 3-, 6-, and 12-month post-operative follow-ups.

Results: A total of 98 patients were included, of which 37 underwent TKR through the subvastus approach and 61 through the medial parapatellar approach. There was an overall significant change over time in both WOMAC and OKS scores ($P < 0.001$). Patients who underwent the subvastus approach had significantly higher mean of WOMAC and OKS than patients with the medial parapatellar approach at the 3- and 6-month follow-ups ($P < 0.05$), but not at the 12-month follow-up.

Conclusions: For TKR, the medial parapatellar approach results in better functional outcomes at the 3- and 6- month follow-up periods compared with the subvastus approach.

Keywords: Functional outcome, medial parapatellar, Oxford Knee Score, subvastus approach, total knee replacement, WOMAC knee scores

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INTRODUCTION

Knee joint osteoarthritis is a common public health problem that causes significant knee pain and functional disability. The global incidence of knee joint osteoarthritis is estimated to be 2.3% per year in individuals aged >20 years.[1] Total knee arthroplasty, also called total knee replacement (TKR), is the most successful surgical procedure for treating knee joint osteoarthritis. It is a safe procedure, in which the damaged joint surface is replaced with metals to reduce pain and improve knee function.[2] Although the medial parapatellar arthrotomy is the most common surgical approach for primary TKR, there are other approaches that prevent patellofemoral and quadriceps problems. In terms of patient-reported outcomes of the various surgical approaches, minimal clinical differences have been reported, with all resulting in good outcomes.[3]

These approaches have been evaluated based on the restoration speed of the quadriceps function after surgery. The subvastus approach, first described by Erkes in 1929 and popularized by Hoffman in 1991,[4] has the advantage of keeping the quadriceps muscle and tendon intact, which reduces post-operative knee pain and improves the strength of the quadriceps muscle to perform early rehabilitation.[5] The subvastus approach also preserves the vascularity of the patella, as the supreme, superior, and inferior medial genicular arteries are often preserved during the approach. In addition, this approach reduces the need for lateral release. Numerous studies using this method have shown improved patient satisfaction, less post-operative discomfort, and improved quadriceps function after TKR.[5] Many studies have compared the clinical outcomes between the subvastus approach and the standard parapatellar approach, with conflicting findings regarding the duration and significance of improvement in function.

Van Hemert *et al*.[6] compared the functional outcome between the subvastus and medial parapatellar approaches using multiple scoring systems, including the Knee Society Clinical Rating System and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and other objective assessments, and found no significant clinical differences in term of functional rehabilitation. However, the study had conducted a short-term analysis and did not focus on patient-reported outcomes. In contrast, another study compared the medial parapatellar and subvastus approach for TKR using the American Knee Society Score (AKSS) and the Oxford Knee Score (OKS) systems, and reported a greater improvement in the medial parapatellar group on AKSS at 12 and 18 months after surgery, suggesting that the subvastus approach provided an advantage in the short-term follow-up.[7] Therefore, there is need for further studies to consolidate evidence on which approach is most advantageous in terms of short- and long-term functional outcomes.

The current study aimed to compare the subvastus approach with the medial parapatellar approach for TKR in patients with osteoarthritis at a tertiary care center based on two validated patient-reported outcome scores (OKS and WOMAC). The two outcome scoring systems were chosen because they are the most common joint-specific validated short and reliable outcome scores and, based on the literature review, the use of a combination scoring system enhances the accuracy of predicting the knee function after TKR. The study evaluated the post-operative functional outcome and recovery time at 3, 6, and 12 months, which represent short- and long-term assessment.

METHODS

This prospective cohort follow-up study was conducted at King Abdullah Medical City from January 2019 to December 2022. It included a convenient sample of patients with knee osteoarthritis who underwent elective primary TKR with either the subvastus or medial parapatellar approaches between January 2019 and December 2021. The study was conducted after obtaining approval from the Ethics Review Board of King Abdullah Medical City.

The sample size was calculated using an online calculator from the University of California, San Francisco, using a 5% margin of error, 95% confidence interval and a power of 80%. For each group, the minimum number of participants were calculated as 32 ($N = 64$).

The patients were classified into two groups, depending on the surgical approach performed for TKR: Group A comprised patients who had undergone the medial parapatellar surgical approach, and Group B, the subvastus surgical approach. Patients with the following conditions were excluded: comorbidities that prevented participation in rehabilitation (e.g., severe obstructive pulmonary disease and hemiplegia after stroke); revision TKR; bilateral total knee arthroplasty; knee stiffness with <70° of flexion or flexion contracture >20°; valgus or varus deformity >20° preoperatively; and previous high tibial osteotomy or major arthrotomy on the operative knee. Participants were also excluded intraoperatively if they required an intervention outside the standardized surgical protocol, such as requiring a femoral nerve block or a lateral surgical release.

Data were collected from the hospital records and from patients by phone calls during office hours at 3, 6, and 12 months post-operatively. All patients provided informed consent for participation. The patients were informed that participation is voluntary, with no incentives being offered, and were assured of anonymity and confidentiality.

Surgical procedure and post-operative care

All surgical procedures were carried out by two senior subspecialized surgeons with a fellowship in arthroplasty and long experience in TKR using both approaches. The Smith & Nephew Genesis II Total Knee System was the implant used for all patients. The standard procedure and protocol were implemented, with identical techniques used in the two procedures except for the initial approach after the midline incision. For the subvastus approach, the knee was flexed for the incision of the skin and the inferior aspect of the capsule. The muscle belly of the vastus medialis is lifted off the intermuscular septum and dissected with the knee flexed or extended. The patella was not everted but rather subluxated laterally. For the medial parapatellar approach, the knee was flexed for incision, and the quadriceps tendon was incised vertically up to 3 cm above the patellae, dissecting between the vastus medialis and quadriceps tendon. The patella was not everted during the surgery.

The post-operative pain relief for all participants was identical, with the administration of intravenous patient-controlled analgesia for the first 48 hours and oral analgesia subsequently. The post-operative nursing care was similar in the two groups. The rehabilitation of all patients was standardized according to the hospital's clinical protocol for TKR.

Outcomes

The primary outcome measures were the OKS (range: 12–60/60 points) and WOMAC scores (overall range: 0–96/96 points; pain: 0–20, stiffness: 0–8, and physical function: 0–68). These scores have been extensively validated and used in various studies.[5-7] The scores are expected to decrease as the patient's function and pain improve. All data were collected using a paper-based questionnaire by blinded orthopedic doctors at 3, 6, and 12 months post-operatively.

Statistical methods

The patient's scores in both groups were compared using the SPSS version 25. Continuous variables were inspected for normality. A measure of association was used to identify the relationship between two or more variables. Mean ± SD was used to describe the numerical data. Percentages and frequencies were used to describe categorical variables. Student's *t*-test and Mann–Whitney test were used to compare the patients' scores in both groups at 3, 6, and 12 months in the post-operative period. The repeated measure analysis was used for both scores to determine if there was a significant change over time. A significance level of $P < 0.05$ was chosen for all analyses.

RESULTS

A total of 98 patients were included in the study: 61 in Group A and 37 in Group B. The majority of the participants were females (67.3%). About one-third (34.7%) of the patients were aged 50–60 years, 44.9% were aged 61–70 years, and 20.4% were aged 71–80 years. The mean (SD) BMI was 31.52 (±4.8). The proportion of female was higher in Group A (medial parapatellar) than Group B (subvastus groups) ($P = 0.043$). There was no significant difference in the BMI and age between the two groups [Table 1].

At 3 months, the WOMAC score was significantly higher (lower function) in Group B than in Group A (25.1 and 15.3, respectively; $P = 0.002$) and the OKS score was significantly higher in Group B than in Group A (27.6 and 20.5, respectively; $P = 0.001$). Similarly, at 6 months, the WOMAC score was significantly higher (lower function) in Group B than Group A (14.6 and 5.7, respectively; $P < 0.001$) and the OKS score was significantly higher in Group B than Group A (21.0 and 16.0, respectively; $P < 0.001$). However, at 12 months, there was no significant difference in the WOMAC and OKS scores between the two groups [Table 2].

Table 3 and Figure 1 show an overall significant change in both WOMAC and OKS over the three points of time ($P < 0.001$). No complications such as deep vein thrombosis, stiffness, and loosening were reported in either group.

DISCUSSION

This study compared the subvastus approach with the medial parapatellar approach for TKR in patients with

Table 1: Comparison of patients' demographic characteristics based on the type of operation

Variable	Total (*N*=98)	Medial parapatellar group (*n*=61)	Subvastus group (*n*=37)	*P*
Age (years), *n* (%)				
50–60	34 (34.7)	21 (34.4)	13 (35.1)	0.195
61–70	44 (44.9)	32 (52.5)	12 (32.4)	
71–80	20 (20.4)	8 (13.1)	12 (32.4)	
Gender, *n* (%)				
Male	32 (32.7)	17 (27.9)	15 (40.5)	0.043
Female	66 (67.3)	44 (72.1)	22 (59.5)	
BMI, mean±SD	31.52±4.8	32.02±4.59	30.69±5.18	0.190

BMI – Body mass index; SD – Standard deviation

knee osteoarthritis based on two validated patient-reported outcome scores (OKS and the WOMAC). OKS and WOMAC scores are widely used measures in TKR research, with evidence supporting their reliability, construct validity, and freedom from bias.[8-11] In general, compared with the medial parapatellar approach, the benefits of the subvastus approach include less pain, earlier restoration of quadriceps function, and potential reduction in the length of hospital stay and costs. However, this study found significantly better functional outcome in the medial parapatellar group than the subvastus group at 3 and 6 months, but no difference at 12 months.

Many studies have reported that the preservation of the quadriceps tendon would reduce post-operative pain for up to 1 month, which is the time required for the tendon to heal, with no difference between the two approaches at 3 months post-operatively.[12] Dutka *et al.* found that the subvastus approach resulted in better functional outcomes than the medial parapatellar approach in only the first 3 months.[13] The study clarified that these functional outcome scores might be less appropriate in an inpatient questionnaire and less useful in the early post-operative period due to variations in pain perception and patient response to pain medication affecting their rehabilitation and outcome function. Therefore, the results at 3 months were considered as a starting point in this study to assess the knee function outcome, as the sensitivity of these outcome scores improve over time.[9,10] The current study found better functional outcome in the medial parapatellar compared with the subvastus approach at 3 and 6 months, which is in contrast with the findings of previous studies that have reported that the subvastus approach has a significantly better functional outcome in the short term.[13,14] In fact, a meta-analysis of 19 randomized controlled trials also found that the outcomes in the subvastus approach were better than that of the parapatellar approach.[4] However, variations in follow-up periods and outcome-measuring tools are likely confounding factors and source of bias in the analysis.

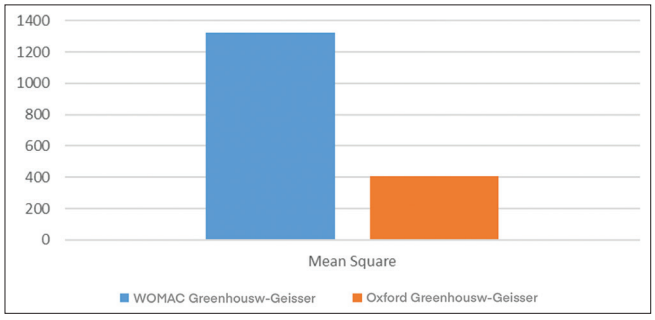

Figure 1: Repeated measure for WOMAC and Oxford Knee Score over time. WOMAC – Western Ontario and McMaster Universities Osteoarthritis Index

Table 2: Differences between the two approaches based on the two scoring systems at all timepoints

Time (months)	Score type	Mean±SD		*P*
		Medial parapatellar group	Subvastus group	
3	WOMAC	15.30±14.34	25.11±16.46	0.002*
	OKS	20.50±5.78	27.62±9.74	0.001*
6	WOMAC	5.74±7.53	14.63±13.45	<0.001*
	OKS	16.01±4.40	21.03±7.09	<0.001*
12	WOMAC	6.64±8.18	5.25±3.50	0.684
	OKS	15.94±4.72	15.50±3.31	0.848

SD – Standard deviation; WOMAC – The Western Ontario and McMaster Universities Osteoarthritis Index; OKS – Oxford Knee Score; *Significant difference at $P<0.05$

Fauré *et al.*[12] conducted a study on 20 patients who underwent one-stage bilateral knee arthroplasty, wherein one knee was operated on with the medial parapatellar approach and the other knee with the subvastus approach. The Knee Society Rating Scale was used to measure the functional outcomes at 1 week, 1 month, and 3 months. The results showed no significant difference between the two knees in the same patient. However, the occurrence of patellar maltracking was high in knees operated with the medial parapatellar approach, and this may later have a significant effect on the knee function. Similarly, a randomized controlled trial found better functional outcomes for the medial parapatellar approach at 12 and 18 months.[7]

A previous study found that the knee scores improved similarly in both groups, and quadriceps strength was greater in the subvastus group at postoperative week 6, but there was no significant difference between the groups at 3 and 6 months.[15] It was reported that preservation of the quadriceps tendon will reduce post-operative pain for up to 1 month. Within 1 month, the tendon heals and regains the quadriceps strength, and thus there is no difference between the two approaches at 3 months post-operatively.[2,4,6]

Table 3: Repeated measures for the WOMAC and OKS scores over time

Source	Mauchly's Test of Sphericity	df	Mean square	*F*	Significant	Partial eta squared
WOMAC	Greenhouse-Geisser	1.121	1324.45	15.28	<0.001	0.310
OKS	Greenhouse-Geisser	1.414	407.229	31.557	<0.001	0.481

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; OKS: Oxford Knee Score

Limitations

Previous studies have investigated the first 3 months of physiotherapy reports of knee function; however, this was not taken into account in the current study. Another limitation is that the current study did not compare the implant position or sizing fitness, which could affect the mid- and long-term functional outcomes. In the study, while the number of patients in the two groups were not equal, this is unlikely to impact the results. However, female patients were significantly higher in the medial parapatellar group, which may affect the outcomes. In the future, a multicenter, randomized controlled study with a larger sample size should be conducted to study the effects of the approaches on patellar tracking and the overall knee function.

CONCLUSIONS

This study found significant clinical improvement in functional outcome in the medial parapatellar group in comparison with the subvastus group at 3 and 6 months, but no difference at 12 months.

Ethical considerations

The study was approved by the Ethics Review Board (Ref. no: 22-964), King Abdullah Medical City, Makkah, Saudi Arabia. All study participants provided written consent before inclusion in the study. The study adhered to the principles of the Declaration of Helsinki, 2013.

Peer review

This article was peer-reviewed by two independent and anonymous reviewers.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions

Conceptualization: A.A.A, A.A.M, and A.S.A; Methodology: A.A.A, A.M.A, A.S.A, L.Z.A, and A.A.F; Data analysis: S.A.A and D.K.M; Writing–original draft preparation: A.A.A, T.A.A, and A.M.A; Writing – review and editing: A.A.A and S.A.A; Supervision: A.S.A.

All authors have read and agreed to the published version of the manuscript.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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