Research Square

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Influence of Extensile Medial Parapatellar Arthrotomy on Quadriceps Strength Recovery Following Primary Total Knee Arthroplasty: A Comparative Cohort Study

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Abstract

Introduction:

This study aimed to compare quadriceps strength, pain, functional outcomes, and range of motion between the standard medial parapatellar (SMP) and extensile medial parapatellar (EMP) approaches in patients undergoing primary total knee arthroplasty (TKA).

Materials and Methods

This retrospective comparative cohort study included 64 patients who underwent primary TKA between January 2024 and January 2025. Thirty-two patients underwent the EMP approach, and 32 underwent the SMP approach. Range of motion (ROM), Oxford Knee Score (OKS), Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS-JR), and quadriceps strength measurements obtained using a hand-held dynamometer were evaluated at postoperative week 6 and month 3. Peak torque values were calculated and compared between groups.

Results

The mean age of the study population was 65.14 ± 3.21 years, and 68.8% of the patients were female. No significant differences were observed between the groups regarding age, sex distribution, ROM, flexion, or extension measurements ($p > 0.05$). At postoperative week 6, OKS pain scores were significantly lower in the EMP group ($p = 0.041$); however, this difference was not observed at postoperative month 3 ($p = 0.957$). No significant between-group differences were identified in OKS function or KOOS-JR scores during follow-up (all $p > 0.05$). Peak torque measured at 90° knee flexion was significantly higher in the EMP group at postoperative month 3 (75.69 ± 14.28 Nm vs. 69.00 ± 9.78 Nm, $p = 0.032$). Furthermore, recovery in peak torque between postoperative week 6 and month 3 was significantly greater in the EMP group at both 90° and 30° knee flexion angles ($p = 0.002$ and $p = 0.015$, respectively).

Conclusion

The extensile medial parapatellar approach provided clinical and functional outcomes comparable to those of the standard medial parapatellar approach following primary TKA. In addition, patients treated with the extensile approach demonstrated greater recovery of quadriceps strength during the early postoperative period. These findings suggest that the extensile medial parapatellar approach is a safe and effective option when enhanced surgical exposure is required.

Introduction

Knee osteoarthritis (OA) is one of the leading causes of pain, disability, and reduced quality of life among older adults worldwide. As the prevalence of OA continues to increase with population aging and longer life expectancy, total knee arthroplasty (TKA) has become one of the most commonly performed and successful orthopedic procedures for relieving pain, correcting deformity, and restoring function in patients with end-stage disease [1–4]. Despite advances in implant design and perioperative management, optimization of surgical techniques remains an important factor influencing postoperative recovery and clinical outcomes [5].

Several surgical approaches have been described for TKA, including medial parapatellar, subvastus, midvastus, and quadriceps-sparing techniques [5–7]. Among these, the medial parapatellar approach remains the most frequently used because it provides excellent visualization of the knee joint, facilitates component positioning, and allows reliable soft-tissue balancing [6]. However, violation of the extensor mechanism during arthrotomy has raised concerns regarding postoperative pain, quadriceps weakness, and delayed functional recovery [8–10].

In complex primary TKA cases, such as severe varus deformity, restricted joint motion, obesity, or limited intraoperative visualization, extensile surgical exposure may be required. The extensile medial parapatellar (EMP) approach extends the standard arthrotomy proximally through the quadriceps tendon, providing wider exposure of the distal femur and tibiofemoral articulation [11]. Although this technique may improve surgical access and reduce excessive soft-tissue traction, its effects on extensor mechanism function and postoperative quadriceps strength remain insufficiently investigated. Furthermore, most previous studies have focused on comparisons between medial parapatellar, subvastus, and midvastus approaches, while evidence regarding EMP arthrotomy remains limited [6, 7, 12].

Therefore, the aim of this study was to compare quadriceps strength, pain, functional outcomes, and range of motion between the standard medial parapatellar (SMP) and extensile medial parapatellar (EMP) approaches in patients undergoing primary TKA. We hypothesized that the EMP approach would provide clinical and functional outcomes comparable to the SMP approach without adversely affecting postoperative quadriceps strength recovery.

Patients and Methods

This retrospective comparative cohort study was conducted at a tertiary referral center between January 2024 and January 2025. Patients who underwent primary TKA between January 2024 and January 2025 were screened for eligibility. Among 238 primary TKA procedures performed during the study period, patients aged between 60 and 70 years with varus knee osteoarthritis were identified.

Patients with a history of fracture around the knee, previous osteotomy around the knee, prior knee surgery, valgus knee osteoarthritis, patellar resurfacing, postoperative complications, or incomplete follow-up were excluded. To minimize surgical variability, only patients operated on by the same surgeon and without the use of a pneumatic tourniquet were included. After application of the exclusion criteria,

32 patients who underwent the EMP approach were identified. For comparison, 32 patients who underwent the SMP approach were randomly selected from eligible patients. Consequently, 64 patients were included in the final analysis.

Ethical Approval

The study protocol was approved by the Institutional Clinical Research Ethics Committee (Approval No. 187-2025). All procedures were performed in accordance with the ethical standards of the institutional and national research committee and with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to inclusion in the study.

Surgical Technique

All procedures were performed by the same senior surgeon using a standardized primary TKA technique. In the SMP group, the knee joint was exposed through a conventional medial parapatellar arthrotomy. In the EMP group, the standard medial parapatellar arthrotomy was extended proximally through the quadriceps tendon to improve surgical visualization and facilitate joint exposure. Patellar resurfacing was not performed in any patient, and a pneumatic tourniquet was not used during surgery (Figure. 1).

Figure 1. Schematic illustration of the EMP approach, demonstrating proximal extension of the SMP arthrotomy through the quadriceps tendon to improve surgical exposure

Clinical Assessment

Patients were evaluated at postoperative week 6 and month 3. Range of motion (ROM), flexion, and extension measurements were obtained using a standard goniometer. Functional outcomes were assessed using the Oxford Knee Score (OKS) and the Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS-JR). Changes in clinical outcomes between postoperative week 6 and month 3 were recorded and analyzed.

Muscle Strength Assessment

Quadriceps strength was evaluated using a hand-held dynamometer, as an isokinetic dynamometer was not available at our institution. Measurements were performed with the dynamometer positioned 5 cm proximal to the lateral malleolus. Patients were instructed to perform maximal knee extension against resistance at 90° and 30° of knee flexion. Each contraction was maintained for three seconds, followed by a one-minute rest interval, and repeated six times. The highest value obtained during testing was used for analysis.

Peak torque was calculated by multiplying the measured force by the lever arm distance from the lateral tibial plateau to the dynamometer position and was expressed in Newton-meters (Nm). The same protocol was applied to the contralateral non-operated extremity.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median (minimum–maximum), whereas categorical variables were presented as frequencies and percentages. The normality of data distribution was evaluated using the Shapiro-Wilk test and visual assessment of histograms. Comparisons between the EMP and SMP groups were performed using the independent samples t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Changes between postoperative week 6 and month 3 measurements within each group were analyzed using the paired samples t-test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. All statistical tests were two-sided, and a p value <0.05 was considered statistically significant.

Results

A total of 64 patients were included in the study, with 32 patients allocated to the EMP group and 32 to the SMP group. The mean age of the study population was 65.14±3.21 years, and 68.8% of the participants were female. No significant differences were observed between the groups regarding age, sex distribution, or baseline knee motion parameters, indicating comparable demographic and clinical characteristics (**Table 1**).

Table 1. Baseline demographic and clinical characteristics of the study groups

Variable	EMP (n=32)	SMP (n=32)	P value
Age (years)	64.78±2.39	65.50±3.87	0.331
Female, n (%)	23 (71.9)	21 (65.6)	0.590
Male, n (%)	9 (28.1)	11 (34.4)	0.590
ROM (°)	110.94±7.01	110.00±5.82	0.438
Flexion (°)	111.88±6.32	111.25±4.92	0.521
Extension (°)	-0.94±2.35	-1.25±2.20	0.403

EMP: Extensile medial parapatellar approach; SMP: Standard medial parapatellar approach; ROM: Range of motion.

Clinical outcomes are summarized in Table 2. Postoperative range of motion, flexion, and extension measurements were similar between the EMP and SMP groups. At postoperative week 6, OKS pain scores differed significantly between the groups, with lower scores observed in the EMP group (p=0.041). However, this difference was no longer evident at postoperative month 3 (p=0.957). No significant between-group differences were identified for OKS function or KOOS-JR scores at either follow-up assessment. Patient-reported outcome measures were generally higher at postoperative month 3 than at postoperative week 6 in both groups.

Table 2. Comparison of patient-reported outcomes between groups

Outcome Measure	EMP	SMP	P value
OKS Pain (Week 6)	76.31±6.84	79.99±7.47	0.041
OKS Pain (Month 3)	79.77±6.32	80.11±7.14	0.957
OKS Function (Week 6)	76.88±6.69	78.28±7.25	0.367
OKS Function (Month 3)	80.31±5.81	81.09±6.81	0.663
KOOS-JR (Week 6)	76.11±5.95	76.10±7.27	0.854
KOOS-JR (Month 3)	81.27±7.57	79.94±7.98	0.421

EMP: Extensile medial parapatellar approach; SMP: Standard medial parapatellar approach; OKS: Oxford Knee Score; KOOS-JR: Knee Injury and Osteoarthritis Outcome Score for Joint Replacement; SD: Standard deviation.

Quadriceps strength measurements are presented in Table 3. Peak torque measured at 90° knee flexion was comparable between groups at postoperative week 6 (p=0.298). However, at postoperative month 3, peak torque values were significantly higher in the EMP group (p=0.032). Furthermore, the increase in peak torque between postoperative week 6 and month 3 was significantly greater in the EMP group (p=0.002). Similarly, peak torque measurements obtained at 30° knee flexion were significantly higher in the EMP group at both postoperative assessments (both p<0.001), and the magnitude of recovery during follow-up was also greater in the EMP group (p=0.015). Although non-operated extremity peak torque values at 90° were comparable between groups (p=0.053), measurements at 30° were significantly higher in the EMP group (p<0.001).

Table 3. Comparison of quadriceps strength measurements between the study groups.

Variable	EMP	SMP	P value
Peak Torque 90° (Week 6)	68.30±14.05	64.25±10.72	0.298
Peak Torque 90° (Month 3)	75.69±14.28	69.00±9.78	*0.032*
Δ Peak Torque 90°	7.39±3.77	4.75±2.71	*0.002*
Peak Torque 30° (Week 6)	37.15±9.44	30.58±3.66	*<0.001*
Peak Torque 30° (Month 3)	40.71±9.96	32.85±3.23	*<0.001*
Δ Peak Torque 30°	3.56±2.23	2.28±1.85	*0.015*
Non-operated Peak Torque 90°	77.57±14.09	71.02±9.60	0.053
Non-operated Peak Torque 30°	41.63±10.06	34.08±3.09	*<0.001*

EMP: Extensile medial parapatellar approach; SMP: Standard medial parapatellar approach; Nm: Newton-meter.

Overall, both surgical approaches yielded comparable functional outcomes and knee motion parameters during the early postoperative period. Nevertheless, patients treated with the EMP approach demonstrated significantly greater recovery of quadriceps strength between postoperative week 6 and month 3, despite achieving similar patient-reported and functional outcomes.

Discussion

The principal finding of this study was that the extensile medial parapatellar approach provided clinical and functional outcomes comparable to those achieved with the standard medial parapatellar approach following primary total knee arthroplasty. While a significant difference in pain scores was observed at six weeks postoperatively, this difference disappeared by the third postoperative month. No significant between-group differences were identified in range of motion, OKS function, or KOOS-JR scores. In contrast, recovery of quadriceps strength was significantly greater in patients treated with the extensile approach, suggesting that the wider arthrotomy did not impair short-term functional recovery.

The medial parapatellar approach remains the most commonly used exposure in total knee arthroplasty because it provides excellent visualization of the joint and facilitates accurate component implantation and soft-tissue balancing [5,6]. Nevertheless, alternative surgical approaches have been developed to minimize soft-tissue trauma and improve early postoperative recovery. Previous comparative studies have suggested that less invasive approaches may preserve periarticular blood flow and extensor mechanism integrity more effectively than the conventional medial parapatellar arthrotomy [13-15]. Furthermore, improvements in early postoperative pain and functional recovery have been reported with selected muscle-sparing approaches, although long-term outcomes are generally comparable among different surgical techniques [16-18]. Therefore, the potential impact of surgical exposure on postoperative recovery remains an important topic of investigation.

In the present study, patient-reported outcomes were largely comparable between the two approaches. Although a significant difference in OKS pain scores was observed at postoperative week 6, this difference was no longer evident by postoperative month 3. Likewise, no significant differences were identified in OKS function or KOOS-JR scores during follow-up. These findings are consistent with previous studies reporting that differences between surgical approaches are most apparent during the early postoperative period and tend to diminish over time [16-19]. Lechner et al. found that the type of surgical approach may influence early recovery; however, clinically meaningful long-term differences are uncommon [17]. In agreement with these findings, Yang et al. reported improved short-term outcomes with minimally invasive techniques, while overall functional recovery remained comparable to conventional approaches during follow-up [19]. Collectively, these findings suggest that wider surgical exposure does not necessarily result in inferior patient-reported outcomes.

Recovery of quadriceps strength is a key determinant of postoperative function following total knee arthroplasty. In the present study, patients treated with the extensile approach demonstrated significantly greater improvements in peak torque measurements between postoperative week 6 and month 3. Moreover, peak torque measured at 90° knee flexion was significantly higher in the extensile group at postoperative month 3. These findings indicate that extending the arthrotomy proximally through the quadriceps tendon did not adversely affect extensor mechanism recovery. Previous investigations comparing different surgical exposures have often suggested that preservation of the quadriceps mechanism may contribute to improved early postoperative recovery [13-15,18]. However, evidence regarding the effect of extensile arthrotomy on postoperative muscle performance remains scarce. More recently, Sidhu et al. demonstrated comparable functional outcomes and knee kinematics between alternative surgical exposures and the medial parapatellar approach [20]. Similarly, Geng et al., Yang et al., Hu et al., and Fan et al. reported favorable early clinical outcomes with modified muscle-preserving approaches compared with conventional medial parapatellar arthrotomy [18,19,21,22]. In contrast to concerns that a more extensive arthrotomy may impair muscle recovery, our findings suggest that extensile exposure does not compromise quadriceps strength recovery and may facilitate postoperative restoration of extensor mechanism function.

From a clinical perspective, the findings of the present study support the use of the extensile medial parapatellar approach when enhanced surgical exposure is required during primary total knee arthroplasty. Although surgeons may be reluctant to extend the arthrotomy because of concerns regarding extensor mechanism dysfunction, our results indicate that wider exposure does not compromise short-term functional outcomes or quadriceps strength recovery. Therefore, the extensile approach may be considered a safe and effective option in selected patients requiring improved intraoperative visualization.

This study has several limitations. First, the retrospective design may have introduced selection bias despite the use of predefined inclusion and exclusion criteria. Second, the study was conducted at a single institution with a relatively small sample size, which may limit the generalizability of the findings. Third, follow-up was limited to three months and therefore does not provide information regarding mid- or long-term outcomes. Fourth, quadriceps strength was assessed using a hand-held dynamometer rather than an isokinetic dynamometer, which is considered the reference standard for muscle strength evaluation. Finally, preoperative quadriceps strength measurements were not available; therefore, postoperative recovery was evaluated based on follow-up assessments only. Future prospective studies with larger patient populations and longer follow-up periods are warranted to further clarify the effects of extensile arthrotomy on postoperative muscle recovery and functional outcomes.

Conclusion

In conclusion, the extensile medial parapatellar approach provided clinical and functional outcomes comparable to those of the standard medial parapatellar approach following primary total knee arthroplasty. Although a transient difference in pain scores was observed during the early postoperative

period, no significant differences were identified in range of motion, OKS function, or KOOS-JR scores at three months. Furthermore, patients treated with the extensile approach demonstrated greater recovery of quadriceps strength during follow-up. These findings suggest that the extensile medial parapatellar approach is a safe and effective option when enhanced surgical exposure is required during primary total knee arthroplasty.

Abbreviations

Standard Medial Parapatellar (SMP)

Extensile Medial Parapatellar (EMP)

Declarations

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

Ethics committee approval was obtained (Approval No. 187–2025).

Informed consent

Written informed consent was obtained from all participants.

Author Contribution

M.Y. and E.S.G. conceived and designed the study. E.S.G. collected the data. M.A. and E.S.G. analyzed the data. E.S.G. drafted the manuscript. M.A., K.A.C. and O.D. critically reviewed the manuscript and contributed to the revision process. All authors reviewed the final manuscript, approved the submitted version, and agree to be accountable for all aspects of the work.

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Not applicable.

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

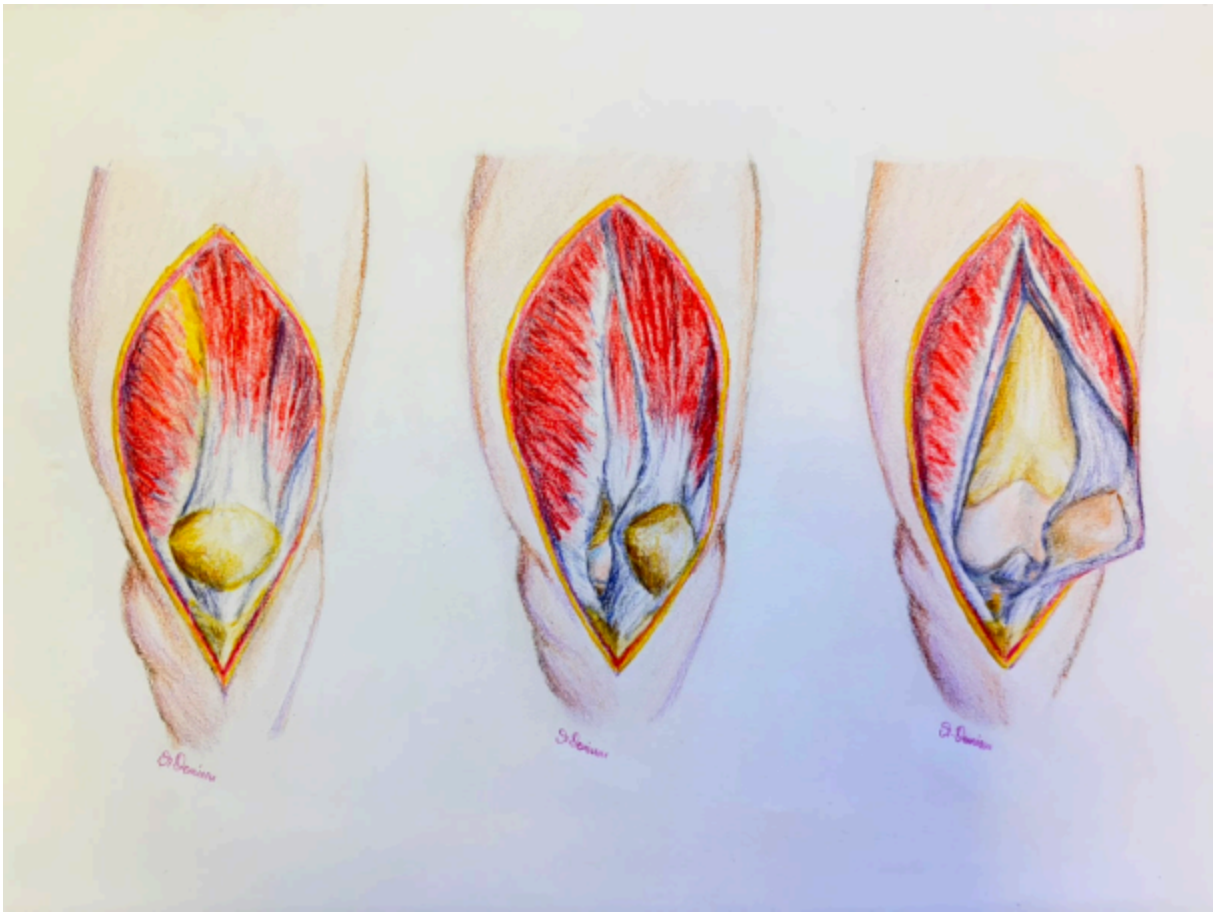


Figure 1

Schematic illustration of the EMP approach, demonstrating proximal extension of the SMP arthrotomy through the quadriceps tendon to improve surgical exposure