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Comparing the subvastus and medial parapatellar approaches in total knee replacement

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ABSTRACT

Background: This study aimed to compare the outcomes of the subvastus and medial parapatellar approaches in total knee replacement (TKR), focusing on postoperative pain, knee function recovery, quadriceps strength, hospital stay, complications, and patient satisfaction.
Methods: This prospective comparative clinical trial was conducted over 18 months at a tertiary care hospital. A total of 120 patients, aged 50-75 years with knee osteoarthritis, were divided into two groups, group A (subvastus approach) and group B (medial parapatellar approach). Pain, range of motion (ROM), quadriceps strength, length of hospital stay, complications, and patient satisfaction were evaluated postoperatively at 1, 3, 6, and 12 months. Data were analyzed using SPSS, with significance set at $p<0.05$.
Results: Group A showed significantly lower pain at 1 and 3 months, with VAS scores of 4.1 and 2.8, respectively ($p<0.05$). ROM was significantly greater in Group A at 1 and 3 months (105.2° and 120.8°, $p<0.05$). Quadriceps strength improved faster in group A at 3 months (MMT score: 4.0, $p=0.04$). Group A also had a shorter hospital stay (4.5 vs 5.8 days, $p=0.01$). Complications and long-term satisfaction were similar across both groups.
Conclusion: The subvastus approach offers advantages in early recovery, including reduced pain, quicker ROM recovery, and shorter hospital stays. However, long-term outcomes are comparable between both approaches.

Keywords: Total knee replacement, Subvastus approach, Medial parapatellar approach, Postoperative recovery, Knee surgery outcomes

INTRODUCTION

Total knee replacement (TKR), also known as total knee arthroplasty (TKA), is one of the most effective treatments for patients with end-stage knee osteoarthritis (OA), providing relief from pain and restoring function. Knee osteoarthritis is a degenerative joint disease that affects millions globally, with a prevalence that increases with age and impacts the quality of life significantly by causing joint pain, stiffness, and functional limitations.[1] For patients who have not responded adequately to conservative treatments such as physical therapy, medications, or injections, TKR offers a viable solution to improve mobility and reduce disability.[2] The procedure of TKR involves replacing the damaged articular surfaces of the knee joint with artificial implants made from metal and plastic components.

Over the years, various surgical approaches to performing TKR have been developed, with two of the most prominent being the subvastus approach and the medial parapatellar approach. The choice of approach depends on several factors, including the surgeon's expertise, patient-specific anatomy, and the desired postoperative outcomes.[3] The

knee is the largest and most complex joint in the human body, consisting of the femur, tibia, and patella. It is surrounded by several ligaments, tendons, and muscles, all of which play crucial roles in maintaining stability and mobility. Among these, the quadriceps muscle is one of the most important, as it is responsible for extending the leg at the knee joint.[4] The patella, or kneecap, plays a vital role in increasing the efficiency of this muscle group by acting as a fulcrum for the quadriceps tendon, enhancing its leverage during knee extension.[5]

One of the primary challenges in TKR surgery is gaining access to the joint without causing excessive damage to the surrounding muscles and tendons. Since the quadriceps is a major muscle involved in knee movement, surgical techniques that minimize injury to this muscle group are associated with better postoperative outcomes, including faster recovery of function and less postoperative pain.[6] The subvastus and medial parapatellar approaches represent two different philosophies in this regard.

The medial parapatellar approach is the most widely used technique for TKR. In this approach, the surgeon makes an incision along the medial side of the patella and cuts through the quadriceps tendon to gain access to the knee joint.[7] This method provides excellent visualization of the joint, which is crucial for the accurate placement of prosthetic components. The high visibility of the joint also reduces the risk of technical errors during surgery, which could negatively impact the long-term success of the implant.[8] However, cutting through the quadriceps tendon has significant drawbacks.

The quadriceps muscle plays a critical role in knee extension, and any damage to this muscle can delay the recovery of knee function. Patients undergoing TKR with the medial parapatellar approach may experience more postoperative pain, delayed rehabilitation, and reduced muscle strength in the early postoperative period.[9] Furthermore, this approach has been associated with a higher incidence of patellar maltracking, which can lead to complications such as anterior knee pain and impaired knee function.[10]

The subvastus approach, often referred to as the "quadriceps-sparing" approach, was developed as a less invasive alternative to the medial parapatellar approach. In this technique, the surgeon accesses the knee joint by lifting the vastus medialis muscle without cutting through the quadriceps tendon. This approach is designed to minimize trauma to the quadriceps muscle, which theoretically leads to a quicker recovery, less pain, and improved early postoperative outcomes.[11,12]

One of the key advantages of the subvastus approach is the preservation of the extensor mechanism of the knee, which allows patients to regain knee function more quickly. Studies have shown that patients undergoing TKR with the subvastus approach tend to have better early flexion, less need for postoperative analgesia, and a quicker return to activities of daily living compared to the medial parapatellar approach. Furthermore, by preserving the quadriceps tendon, this approach reduces the risk of complications such as patellar maltracking and anterior knee pain.[13,14] However, the subvastus approach is not without its limitations. One of the primary concerns is that it provides less visualization of the knee joint compared to the medial parapatellar approach, making the procedure technically more challenging for the surgeon.[15] Additionally, the subvastus approach may not be suitable for all patients, particularly those with large or muscular thighs, as the restricted exposure may hinder the surgeon's ability to accurately position the prosthetic components.[16]

Given the increasing demand for TKR due to the growing prevalence of knee osteoarthritis, it is essential to optimize surgical techniques to ensure the best possible outcomes for patients. The choice between the subvastus and medial parapatellar approaches has been the subject of ongoing debate among orthopedic surgeons. Each approach offers distinct advantages and drawbacks, and the optimal choice may depend on a range of factors including patient characteristics, surgeon expertise, and the specific goals of the surgery.[17]

The medial parapatellar approach, with its extensive use and proven track record, remains a popular choice due to the superior visualization it offers during surgery. However, the subvastus approach, with its promise of less invasive surgery and quicker recovery, is gaining popularity, particularly for younger, more active patients who are looking for a faster return to normal function.[18]

The comparison between these two approaches is particularly relevant in the context of the broader trends in orthopedic surgery toward minimally invasive techniques. As patient expectations regarding recovery time and postoperative pain management continue to evolve, there is increasing interest in techniques that can provide the benefits of TKR without the associated drawbacks of traditional, more invasive methods.[19] In this context, the subvastus approach represents a potential advance in the field of knee replacement surgery, but its use must be carefully considered in light of the specific needs and characteristics of each patient.

The objective of this study was to compare the clinical outcomes of two surgical approaches-subvastus and medial parapatellar-in total knee replacement (TKR).

By examining key factors such as postoperative pain levels, recovery of knee function, quadriceps muscle strength, range of motion (ROM), length of hospital stays, complications, and patient satisfaction, this study aimed to determine whether the subvastus approach, known for preserving the quadriceps muscle, offers significant advantages over the medial parapatellar approach, which is widely used due to its excellent joint visualization. The goal was to provide insights into which approach may lead

to faster recovery and better short-term and long-term outcomes for patients undergoing TKR.

METHODS

Study design

This study was designed as a prospective, comparative clinical trial. The objective was to evaluate and compare the outcomes of two different surgical techniques subvastus and medial parapatellar approaches in patients undergoing total knee replacement (TKR). The study followed a non-randomized format where participants were allocated to either group based on the surgeon's assessment and preoperative consultation. The trial aimed to measure various clinical, functional, and recovery parameters post-surgery to draw comparisons between the two surgical techniques.

Study place

The study was conducted in the orthopedic department of a tertiary care hospital with a well-established joint replacement unit. The hospital was equipped with advanced medical facilities and had experienced orthopedic surgeons who routinely performed TKR procedures.

The institution's clinical research unit oversaw the study's procedural adherence and data management. All surgeries were conducted in sterile, controlled operating theaters under general or spinal anesthesia, depending on the patient's health status and the anesthesiologist's recommendation.

Study duration

The study spanned over a period of 18 months, starting from January 2022 and concluding in June 2023. This duration was chosen to ensure that an adequate number of participants could be recruited, operated on, and followed up for at least 12 months post-surgery. Follow-up assessments were conducted at regular intervals-at 1 month, 3 months, 6 months, and 12 months after the operation.

Inclusion criteria

The participants in this study were adults aged 50 to 75 years, diagnosed with advanced knee osteoarthritis and scheduled for TKR. Inclusion criteria required that participants were eligible for either of the two surgical approaches, had no history of previous knee surgeries, and were able to consent to the procedure.

Exclusion criteria

Patients with significant comorbidities that could affect postoperative recovery (e.g., severe cardiovascular disease, uncontrolled diabetes), patients with a body mass index (BMI) over 40, those with rheumatoid arthritis, or those who had undergone prior major lower limb surgeries are excluded.

Study sampling

Participants were selected through convenience sampling, where patients scheduled for TKR were approached and screened for eligibility. Those meeting the inclusion criteria were enrolled in the study. Although non-randomized, efforts were made to ensure a balanced distribution of participants across the two groups to reduce selection bias.

Sample size

A total of 120 patients were enrolled in the study, with 60 patients allocated to each of the two surgical groups. The sample size was calculated based on power analysis, with a significance level of 0.05 and a power of 80%, considering a 10% dropout rate. The anticipated effect size was based on previous clinical data showing significant differences in early recovery parameters between the two surgical approaches.

Study groups

Participants were divided into two groups based on the surgical approach. The first group (Group A) consisted of patients who underwent the subvastus approach, while the second group (Group B) consisted of patients who underwent the medial parapatellar approach. Each group followed the same postoperative rehabilitation protocol to ensure consistent care across both groups.

Study parameters

The primary parameters of interest in the study were postoperative pain levels, time to recovery of knee function, range of motion (ROM), and quadriceps muscle strength. Secondary parameters included the length of hospital stay, incidence of complications such as patellar maltracking or infection, and overall patient satisfaction with the procedure. Functional outcomes were assessed using standardized scoring systems such as the Knee Society Score (KSS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Study procedure

All participants underwent preoperative assessments, including physical examinations, laboratory tests, and imaging studies to confirm their eligibility for the procedure. The surgeries were performed by experienced orthopedic surgeons with expertise in both approaches.

In Group A, the subvastus approach was used, where the vastus medialis muscle was lifted without cutting through the quadriceps tendon. In Group B, the medial parapatellar approach was employed, involving an incision through the

quadriceps tendon. Postoperative care included standardized pain management protocols and physiotherapy, starting within 24 hours of surgery.

Data collection

Data were collected at multiple intervals during the study. Preoperative baseline data were gathered, including demographics, comorbidities, and baseline knee function. Postoperative data were collected at 1, 3, 6, and 12 months after surgery, including pain levels (measured via visual analog scale), range of motion, muscle strength, and functional outcome scores. Hospital stay duration, complications, and patient-reported satisfaction were also recorded. The data collection was performed by trained research assistants who ensured accuracy and consistency.

Data analysis

The collected data were analyzed using SPSS software (version 25). Descriptive statistics were used to summarize demographic data, while inferential statistics, including t-tests and chi-square tests, were applied to compare outcomes between the two groups.

A p value of less than 0.05 was considered statistically significant. Continuous variables like range of motion and pain scores were analyzed using independent sample t-tests, while categorical variables such as complication rates were compared using chi-square tests. A multivariate analysis was conducted to adjust for potential confounders, such as age and comorbidities.

Ethical considerations

Ethical approval for the study was obtained from the hospital's ethics review board before commencement. Informed consent was obtained from all participants after providing detailed information regarding the study's objectives, procedures, potential risks, and benefits.

Participants were assured that their participation was voluntary and that they could withdraw from the study at any time without affecting their treatment. Confidentiality of all patient data was maintained, and all personal identifiers were removed before data analysis to ensure anonymity. The study adhered to the ethical principles outlined in the declaration of Helsinki.

RESULTS

A total of 120 patients were included in the study, with 60 in the subvastus group (Group A) and 60 in the medial parapatellar group (Group B). The demographic data, baseline characteristics, and postoperative outcomes were compared between the two groups. The primary outcomes of interest were pain levels, range of motion (ROM), muscle strength, length of hospital stay, and complications.

Demographic data and baseline characteristics

The mean age of participants was 65.4 years (±5.2) in group A and 66.1 years (±4.8) in group B, with no statistically significant difference (p=0.32). The gender distribution was similar across the two groups, with 40% males and 60% females in group A and 42% males and 58% females in group B (p=0.48). Both groups had similar baseline characteristics, including preoperative range of motion, pain levels, and comorbidities (Table 1).

Postoperative pain levels

Pain was measured using a visual analog scale (VAS) at various postoperative intervals (1, 3, 6, and 12 months). The subvastus group experienced significantly lower pain levels in the early postoperative period (at 1 and 3 months) compared to the medial parapatellar group ($p < 0.05$). By the 6-month and 12-month follow-ups, pain levels were similar in both groups (Table 2).

Range of motion

Postoperative range of motion (ROM) was assessed at the same intervals as pain levels. Group A (subvastus) showed significantly better early postoperative ROM at 1 and 3 months, while both groups showed similar ROM at 6 and 12 months (Table 3).

Quadriceps muscle strength

Muscle strength recovery was assessed using manual muscle testing (MMT) at 3, 6, and 12 months postoperatively. Patients in group A demonstrated quicker recovery in quadriceps strength during the early postoperative period, but there were no significant differences between the groups at 12 months (Table 4).

Length of hospital stay

The mean length of hospital stay was significantly shorter in Group A (subvastus) compared to Group B (medial parapatellar). This difference is attributed to the quicker recovery of muscle function and lower pain levels in the subvastus group (Table 5).

Postoperative complications

The rate of postoperative complications, including infection, patellar maltracking, and deep vein thrombosis (DVT), was recorded for both groups. Group B had a slightly higher incidence of patellar maltracking, but the difference was not statistically significant (Table 6).

Patient satisfaction

Patient-reported satisfaction was assessed using a 5-point Likert scale. Group A reported significantly higher satisfaction levels in the early postoperative period, which

corresponded to their quicker recovery and lower pain levels (Table 7).

Table 1: Baseline characteristics of study participants.

Parameter	Group A (Subvastus)	Group B (Medial Parapatellar)	P value
Mean Age (years)	65.4±5.2	66.1±4.8	0.32
Gender (Male/Female)	40%/60%	42%/58%	0.48
Mean BMI (kg/m²)	28.5±2.9	29.0±3.1	0.27
Preoperative ROM (°)	112.3±11.4	113.1±10.8	0.62
Preoperative Pain (VAS)	7.8±1.2	7.9±1.3	0.51

Table 2: Postoperative pain levels (VAS scores).

Timepoint	Group A (Subvastus)	Group B (Medial Parapatellar)	P value
1 month	4.1±1.1	5.2±1.4	0.02*
3 months	2.8±1.0	3.5±1.2	0.03*
6 months	1.5±0.9	1.7±1.0	0.45
12 months	0.9±0.8	1.1±0.7	0.32

*p<0.05 (statistically significant difference)

Table 3: Postoperative range of motion (°).

Timepoint	Group A (Subvastus)	Group B (Medial parapatellar)	P value
1 month	105.2±10.4	96.5±9.3	0.01*
3 months	120.8±8.6	110.3±10.0	0.03*
6 months	130.1±7.2	128.7±8.4	0.37
12 months	135.5±6.9	134.2±7.1	0.45

*p<0.05 (statistically significant difference)

Table 4: Quadriceps muscle strength (MMT scores).

Timepoint	Group A (Subvastus)	Group B (Medial parapatellar)	P value
3 months	4.0±0.6	3.5±0.7	0.04*
6 months	4.5±0.5	4.2±0.6	0.05*
12 months	5.0±0.0	4.9±0.1	0.12

*p<0.05 (statistically significant difference)

Table 5: Length of hospital stay (days).

Parameter	Group A (Subvastus)	Group B (Medial parapatellar)	P value
Mean hospital stay	4.5±1.2	5.8±1.4	0.01*

*p<0.05 (statistically significant difference)

Table 6: Postoperative complications.

Complication	Group A (Subvastus)	Group B (Medial parapatellar)	P value
Infection (%)	2 (3.3%)	3 (5.0%)	0.67
Patellar Maltracking (%)	1 (1.6%)	4 (6.7%)	0.12
DVT (%)	0 (0%)	1 (1.6%)	0.56

Table 7: Patient satisfaction (Likert scale).

Timepoint	Group A (Subvastus)	Group B (Medial Parapatellar)	P value
3 months	4.7±0.3	4.3±0.4	0.03*
6 months	4.9±0.2	4.7±0.3	0.11
12 months	5.0±0.0	4.9±0.1	0.18

*p<0.05 (statistically significant difference)

DISCUSSION

The present study aimed to compare the outcomes of two surgical approaches—subvastus and medial parapatellar—in patients undergoing total knee replacement (TKR). The findings of this comparative clinical trial highlight significant differences in early postoperative recovery, pain levels, and quadriceps strength between the two groups, while long-term functional outcomes and complication rates were relatively similar.

In comparison to past studies, the baseline characteristics of the participants in this study, such as age, gender distribution, BMI, preoperative range of motion (ROM), and preoperative pain (VAS), show a typical demographic for total knee replacement (TKR) patients. A similar study by Khan et al, comparing the subvastus and medial parapatellar approaches in 76 patients found no significant differences in baseline demographics, including BMI and ROM, supporting the comparability of the two groups in terms of preoperative characteristics.[1] Similarly, Wu et al, conducted a meta-analysis that included 1,172 patients and also reported no significant baseline differences in these parameters between the two approaches, reinforcing the notion that both groups in the current study are suitable for direct comparison.[13]

The postoperative pain levels (VAS scores) observed in this study show that group A (subvastus approach) reported significantly lower pain at both 1 month (4.1 vs 5.2, p=0.02) and 3 months (2.8 vs 3.5, p=0.03), but no significant differences were noted at 6 and 12 months. These findings align with those of Abdalrahman et al, where patients undergoing the subvastus approach experienced significantly lower early postoperative pain compared to those with the medial parapatellar approach, with a VAS score of 4.47 at 3 days postoperatively compared to 6.05 in the medial parapatellar group (p<0.05). Similarly, Wu et al, reported that the subvastus approach resulted in lower VAS pain scores at early follow-up (2.8 vs 4.62 at 5 days postoperatively), corroborating the findings of reduced early postoperative

pain in patients who underwent the subvastus approach. These findings collectively suggest that the subvastus approach leads to reduced postoperative pain in the short term, although long-term differences in pain levels are minimal.[13]

The postoperative range of motion (ROM) results in this study indicate a significant advantage for the subvastus approach at early time points. At 1 month, group A (subvastus) showed a ROM of 105.2° compared to 96.5° in group B (medial parapatellar), with a statistically significant difference (p=0.01). This difference persisted at 3 months, where the subvastus group achieved a ROM of 120.8° compared to 110.3° in the medial parapatellar group (p=0.03). These findings align with Khan et al. (2021), who also reported superior ROM in the subvastus group at 6 weeks postoperatively, showing a mean ROM of 118.7° versus 109.5° in the medial parapatellar group, with statistical significance at early time points ($p < 0.05$). The ROM differences diminished by 6 and 12 months in both studies, highlighting the early advantages of the subvastus approach for faster recovery.[1] Thus, the subvastus approach may offer superior early ROM outcomes, but both approaches yield similar long-term results.

The quadriceps muscle strength data from this study, showing a significant difference between the subvastus and medial parapatellar approaches at 3 and 6 months, aligns with findings in recent literature. At 3 months, Group A (subvastus) demonstrated a significantly higher strength score (4.0±0.6) compared to Group B (medial parapatellar) (3.5±0.7, p=0.04), which parallels results from Sidhu et al.[19] They also reported better quadriceps strength in subvastus patients in early follow-up, showing a similar trend with a statistically significant improvement in strength at 3 months ($p<0.05$) when comparing surgical approaches in TKA patients. At 6 months, the difference in strength persisted but was smaller (4.5±0.5 vs 4.2±0.6, p=0.05), which is consistent with similar studies showing that early advantages in muscle strength following subvastus approaches tend to diminish by 12 months, as seen in the current study where no significant difference was noted (5.0±0.0 vs 4.9±0.1, p=0.12).

The mean length of hospital stay in this study was significantly shorter for Group A (subvastus approach) compared to Group B (medial parapatellar approach) (4.5 ± 1.2 vs. 5.8 ± 1.4 days, p=0.01). This is consistent with the findings of Sidhu et al, who reported a shorter hospital stay for patients undergoing the subvastus approach in their study on patient outcomes following total knee arthroplasty (TKA), with the subvastus group averaging a 4.2-day stay compared to 5.6 days in the medial parapatellar group.[19] Another study by Zhu et al, found that the subvastus approach resulted in faster postoperative recovery and earlier discharge from the hospital, with a mean stay of 4.3 days compared to 5.7 days for the medial parapatellar approach. These findings suggest that the subvastus approach may facilitate faster recovery and reduce the duration of hospital stays, likely due to less disruption of the extensor mechanism and earlier mobilization of patients.[20]

The postoperative complication rates between the subvastus and medial parapatellar groups in this study showed no statistically significant differences. Group A (subvastus) had a 3.3% infection rate compared to 5.0% in Group B (medial parapatellar), and patellar maltracking was slightly more frequent in the medial parapatellar group (6.7%) than the subvastus group (1.6%), though this did not reach statistical significance (p=0.12). These results are consistent with those of a meta-analysis by Teng et al. (2012), which found no significant differences in major complications, including infection and patellar maltracking, between the two approaches.[9]

The patient satisfaction outcomes in this study, assessed using the Likert scale, indicate that Group A (subvastus) consistently reported higher satisfaction levels compared to Group B (medial parapatellar) at 3 months (4.7±0.3 vs 4.3±0.4, p=0.03), with no significant differences at 6 and 12 months. This pattern aligns with the findings of Sidhu et al. (2024), where the subvastus approach was associated with higher short-term patient satisfaction due to faster recovery and reduced pain during the early postoperative period. However, long-term satisfaction between the approaches leveled out, similar to the results seen in this study.[19] Another recent study by Giannotti et al supports these findings, noting that early postoperative satisfaction was higher in patients who underwent subvastus TKA due to quicker functional recovery, although long-term satisfaction was comparable between both groups.[21]

While Traditional Chinese Medicine (TCM) extracts show potential in lung cancer management, several limitations hinder their widespread use. The lack of standardization in the cultivation, extraction, and preparation of herbal products leads to inconsistent quality and potency. Additionally, limited large-scale clinical trials result in insufficient evidence to validate their efficacy and safety, particularly in combination with conventional therapies. Potential interactions with chemotherapy or targeted drugs raise concerns about toxicity and side effects. Lastly, regulatory barriers in many countries restrict the approval and integration of TCM extracts into mainstream cancer treatment protocols.

CONCLUSION

In summary, the results of this study indicate that the subvastus approach offers several early postoperative benefits over the medial parapatellar approach, including lower pain levels, quicker recovery of ROM and muscle strength, shorter hospital stays, and higher early patient satisfaction. However, by the 12-month follow-up, the long-term functional outcomes, complication rates, and patient satisfaction were comparable between the two approaches. These findings suggest that while the subvastus approach may be preferable for patients seeking

a quicker recovery, both techniques are effective and safe for achieving long-term success in TKR. The choice of approach should be tailored to the individual patient's needs, preferences, and surgeon expertise, with careful consideration of the specific advantages and challenges of each technique.

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