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COMPARATIVE ANALYSIS OF CLINICAL OUTCOMES: SUBVASTUS VERSUS MEDIAL PARAPATELLAR APPROACH IN PRIMARY TOTAL KNEE REPLACEMENT

Orthopaedics

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ABSTRACT

Background: Total knee arthroplasty (TKA) has evolved with various surgical approaches aimed at optimizing functional outcomes and recovery. The choice between subvastus and medial parapatellar approaches remains a subject of ongoing debate regarding their comparative effectiveness in primary knee replacement surgery. **Methodology:** This prospective comparative cross-sectional study was conducted at the Department of Orthopaedics, Mahatma Gandhi Medical College & Hospital, Jaipur, from April 2023 to September 2024. Sixty patients with primary knee osteoarthritis undergoing TKA were equally allocated to subvastus (n=30) and medial parapatellar (n=30) approach groups. Patients were assessed using the Knee Society Score (KSS), Visual Analogue Scale (VAS), range of motion measurements and time to achieve straight leg raise at postoperative Day 3, Week 3 and Month 3. Statistical analysis was performed using SPSS version 26. **Results:** Both groups were demographically comparable with mean ages of 60.27±5.28 years (subvastus) versus 60.73±6.55 years (medial parapatellar). The subvastus group demonstrated significantly lower intraoperative blood loss (275.00±50.43 mL vs. 311.67±52.00 mL; p=0.007) and faster quadriceps recovery with earlier straight leg raise achievement (2.43±0.50 days vs. 3.30±0.60 days; p<0.001). Postoperative pain scores were significantly lower in the subvastus group on Day 3 (4.77±1.45 vs. 5.58±1.33; p=0.047). While functional scores showed consistent trends favoring the subvastus approach in early recovery, both groups achieved comparable outcomes by Month 3. **Conclusion:** Both surgical approaches demonstrated safety and effectiveness for primary TKA. However, the subvastus approach offers distinct advantages including reduced blood loss, faster quadriceps recovery and superior early postoperative pain relief without increased complications. The subvastus approach may be considered preferable for enhanced early recovery in suitable patients.

KEYWORDS

Total knee arthroplasty, Subvastus approach, Medial parapatellar approach, Knee society score, Surgical outcomes, Quadriceps recovery

INTRODUCTION

Knee osteoarthritis (OA) is a progressive degenerative joint disease that significantly impacts mobility and quality of life, particularly in elderly individuals.[1] As one of the most prevalent causes of functional disability worldwide, knee OA is characterized by joint pain, stiffness and restricted movement.[2] The condition primarily results from cartilage degeneration and joint space narrowing, leading to increased friction and inflammation.[3] The rising prevalence of knee OA has been attributed to factors such as aging, obesity and sedentary lifestyles.[4] When conservative treatments including analgesics, physiotherapy and intra-articular injections fail to provide adequate symptom relief, total knee arthroplasty (TKA) becomes the preferred surgical intervention to restore knee function and improve patient well-being. Knee arthroplasty involves reconstructing the knee joint using artificial implants to relieve pain and improve function.[5] The primary goal is to achieve durable pain relief, restore joint mobility and improve functional outcomes, allowing patients to return to their daily activities with minimal discomfort.[6] Initially offered primarily to elderly, low-demand patients, TKA has evolved with improved surgical techniques and implant designs, leading to its increasing use in younger, active individuals across all age groups.

The procedure involves four key steps: preparation of the bone by removing damaged cartilage, positioning of metal implants to recreate the joint surface, optional resurfacing of the patella and insertion of a spacer to allow smooth movement.[7] The choice of surgical approach plays a crucial role in determining procedural success, influencing postoperative pain, recovery time and rehabilitation progress. Among widely used approaches, the medial parapatellar approach (MPA) and the subvastus approach (SVA) are the two most commonly employed techniques.[8] The medial parapatellar approach is the conventional and most commonly used technique, providing excellent surgical exposure for prosthesis implantation. However, it involves partial division of the quadriceps tendon, which may affect quadriceps strength and delay postoperative recovery. Conversely, the subvastus approach is a muscle-sparing technique that preserves quadriceps integrity by lifting the vastus medialis muscle instead of cutting through it. This approach is associated with reduced postoperative pain, faster quadriceps strength recovery and lower need for lateral release, though it may pose challenges in obese patients and those with previous knee surgeries due to limited joint exposure.[9] Other approaches include the midvastus approach, where the vastus medialis muscle is split along its fibers and the lateral parapatellar approach, primarily used in cases with significant valgus deformities.[10] Despite widespread use of both subvastus and medial parapatellar approaches, there remains no clear consensus on which technique offers superior functional outcomes.[11] Understanding the differences in postoperative pain levels, quadriceps strength, range of motion and long-term functional outcomes between these approaches is crucial for optimizing surgical techniques and improving patient care.

Methodology

This hospital-based observational study employed a comparative cross-sectional design to assess the clinical and functional outcomes of the subvastus and medial parapatellar approaches in total knee arthroplasty. The study was conducted in the Department of Orthopaedics, Mahatma Gandhi Medical College & Hospital (MGMC&H), Jaipur, a tertiary care center catering to a diverse patient population requiring total knee arthroplasty. The study period extended over 18 months, from April 2023 to September 2024, following necessary permissions obtained from the Institutional Ethics Committee (IEC) and the Research Review Board of MGMC&H, Jaipur, Rajasthan. A total of 60 patients were included using a non-randomized consecutive sampling method, with equal numbers allocated to two study groups: Group 1 (n=30) underwent TKA using the subvastus approach, while Group 2 (n=30) underwent TKA using the medial parapatellar approach. Eligible participants included patients aged 50 years or older with primary knee osteoarthritis confirmed by radiographic evidence, chronic knee pain not relieved by conservative management, Kellgren-Lawrence grading of ≥ Grade 3 and patients deemed fit for surgery based on preoperative evaluation. Exclusion criteria comprised patients aged below 50 years, those with severe comorbidities rendering them unfit for surgery, patients with known allergy to prosthetic implants, those with neurological deficits affecting lower limb function and patients with coexisting hip or spine pathology that may interfere with postoperative rehabilitation.

Preoperative Assessment And Surgical Procedures

Each participant underwent detailed history-taking and clinical examination, including demographic details, medical history encompassing duration of osteoarthritis, history of joint pain, functional limitations and previous knee surgeries, along with

medication history. Radiological evaluation included X-ray Knee (AP and Lateral views) to assess joint space narrowing, osteophytes and deformity, with classification of OA severity using the Kellgren-Lawrence grading system. Patients were assigned to one of the two surgical groups, with anesthesia administered either spinally or generally as per standard protocols. In the subvastus approach, the vastus medialis muscle was lifted off the intermuscular septum, preserving the quadriceps mechanism. The entire belly of the vastus medialis muscle was lifted anteriorly and an L-shaped arthrotomy was performed beginning medially through the vastus insertion on the medial patellar retinaculum and carrying it along the medial edge of the patella. The medial edge of the patellar tendon was partially released and the patella was everted laterally with the knee extended, importantly avoiding cutting the quadriceps tendon or patellar tendon to preserve structural integrity. In the medial parapatellar approach, a longitudinal skin incision was made extending from the upper pole of the patella to the tibial tuberosity, continuing through subcutaneous tissue and the anterior capsule of the knee joint. An incision was made along the medial border of the quadriceps tendon and the medial border of the patellar tendon, with partial cutting of the quadriceps and patellar tendons to provide better joint access. The patella was everted outwards, allowing full visualization of the femoral and tibial surfaces.

Postoperative Care And Follow-up

Postoperative care was uniform across both groups, including standardized rehabilitation and physiotherapy under supervision. Patients were mobilized under physiotherapy team supervision, with follow-up visits scheduled at postoperative Day 3, Week 3 and Month 3. Functional assessments included Knee Society Score (KSS) to evaluate pain, function and range of motion, along with quadriceps strength recovery and pain levels recorded at each follow-up.

Outcome Measures

Primary outcomes included comparison of intraoperative parameters such as operative time, blood loss and intraoperative complications between the two surgical approaches, assessment of functional recovery using KSS at Day 3, Week 3 and Month 3 postoperatively and comparison of quadriceps strength recovery and postoperative pain levels. Secondary outcomes encompassed incidence of postoperative complications including infection, cellulitis, wound healing issues and delayed rehabilitation, along with comparison of early versus late functional recovery between approaches.

Statistical Analysis

Data was entered into Microsoft Excel and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were expressed as proportions. Statistical significance was assessed using Chi-square test/Fisher's exact test for categorical variables, Student's t-test/Mann-Whitney U test for comparing means between groups and Pearson's correlation coefficient to assess relationships between quadriceps function recovery and pain levels. A p-value < 0.05 was considered statistically significant.

RESULTS

The study included 60 patients with primary osteoarthritis of the knee who underwent total knee arthroplasty with equal distribution between the subvastus (n=30) and medial parapatellar (n=30) groups. Analysis of demographic characteristics revealed comparable baseline parameters between groups, ensuring validity of outcome comparisons.

Table 1: Comprehensive Demographic Profile And Patient Characteristics

Parameter	Subvastus Group (n=30)	Medial Parapatellar Group (n=30)	P-value
Mean Age ± SD	60.27 ± 5.28 years	60.73 ± 6.55 years	0.625
Gender Distribution			0.292
Male, n (%)	14 (46.7%)	10 (33.3%)	
Female, n (%)	16 (53.3%)	20 (66.7%)	
Surgical Side (Laterality)			0.301
Right Knee, n (%)	12 (40.0%)	16 (53.3%)	
Left Knee, n (%)	18 (60.0%)	14 (46.7%)	
Anthropometric Parameters			
Weight (kg) ± SD	62.53 ± 8.56	62.70 ± 7.12	0.935
Height (cm) ± SD	162.40 ± 9.47	160.67 ± 8.90	0.468
BMI (kg/m²) ± SD	23.88 ± 3.89	24.28 ± 1.64	0.600

The study demonstrates excellent baseline homogeneity between the two surgical approach groups, with no statistically significant differences across all measured demographic parameters (all p-values > 0.05). Both groups exhibited identical age distributions within the 50-70 year range, with mean ages of approximately 60 years. This age profile is representative of the typical total knee arthroplasty candidate population, as primary knee osteoarthritis requiring surgical intervention predominantly affects individuals in their sixth and seventh decades of life. The balanced age distribution eliminates age-related confounding factors that could influence postoperative recovery trajectories. The study showed a female predominance in both groups (53.3% in subvastus vs. 66.7% in medial parapatellar), which aligns with established epidemiological patterns of primary knee osteoarthritis. Women are more commonly affected by knee osteoarthritis, particularly post-menopausally, due to hormonal changes, reduced bone density, and increased prevalence of joint degeneration. The comparable gender distribution between groups ensures that hormonal and gender-related factors do not bias the functional outcome comparisons. The distribution of operated knees showed balanced representation across both approaches, with no significant preference for right or left-sided procedures. This balanced laterality distribution minimizes potential confounding from limb dominance effects or surgical access variations that could influence recovery patterns or functional outcomes. The anthropometric parameters demonstrate remarkable similarity between groups, with both cohorts representing a relatively lean patient population (mean BMI approximately 24 kg/m²). This comparable baseline body habitus is particularly important for surgical approach comparison, as higher BMI can compromise visualization and surgical exposure, especially in the subvastus technique. The similar weight, height, and BMI distributions ensure that surgical difficulty, intraoperative exposure, and postoperative recovery are not confounded by significant differences in patient body habitus.

Table 2: Comparison Of Intraoperative Parameters Between Groups

Parameter	Subvastus	Medial Parapatellar	P-value
Duration of Surgery (min)	75.10 ± 6.50	74.97 ± 11.34	0.956
Intraoperative Blood Loss (mL)	275.00 ± 50.43	311.67 ± 52.00	0.007

The mean duration of surgery was nearly identical between the subvastus (75.10±6.50 minutes) and medial parapatellar (74.97±11.34 minutes) groups, indicating no statistically significant difference in operative time ($p = 0.956$). However, a significant difference was noted in intraoperative blood loss, which was lower in the subvastus group (275.00±50.43 mL) compared to the medial parapatellar group (311.67±52.00 mL; $p = 0.007$).

Table 3: Comparison Of Knee Score At Pre-op, Day 3, Week 3 And Month 3

Time Point	Subvastus	Medial Parapatellar	p-value
Pre-op	42.67 ± 9.30	41.97 ± 9.26	0.771
Day 3	56.40 ± 7.99	53.57 ± 7.82	0.171
Week 3	62.73 ± 8.00	63.20 ± 10.06	0.843
Month 3	79.33 ± 11.02	79.13 ± 11.18	0.945

The Knee Society Knee Scores (KSS-Knee) at all time points demonstrated progressive improvement in both groups, indicative of successful surgical intervention. Preoperatively, the mean score in the subvastus group was 42.67 ± 9.30, slightly higher than 41.97 ± 9.26 in the medial parapatellar group ($p = 0.771$). By postoperative Day 3, the subvastus group improved to 56.40 ± 7.99 compared to 53.57 ± 7.82 in the medial parapatellar group ($p = 0.171$). At Week 3, scores further improved to 62.73 ± 8.00 and 63.20 ± 10.06 respectively ($p = 0.843$). At Month 3, both groups achieved near-identical values (79.33 ± 11.02 in subvastus vs. 79.13 ± 11.18 in medial parapatellar; $p=0.945$). Although no significant intergroup differences were observed at any time point, both techniques demonstrated effective functional restoration with a trend toward slightly faster early gains in the subvastus group.

Table 4: Comparison Of Function Score At Pre-op, Day 3, Week 3,

And Month 3

Time Point	Subvastus	Medial Parapatellar	p-value
Pre-op	30.83 ± 8.12	30.40 ± 9.31	0.848
Day 3	45.00 ± 9.69	41.43 ± 8.87	0.143
Week 3	56.23 ± 8.65	55.17 ± 8.48	0.631
Month 3	76.63 ± 13.28	74.23 ± 14.10	0.500

Function scores, representing patients' ability to ambulate and climb stairs, improved consistently in both groups. At baseline, the subvastus group had a mean score of 30.83 ± 8.12, which was comparable to 30.40 ± 9.31 in the medial parapatellar group (p = 0.848). On Day 3 postoperatively, the subvastus group showed greater functional recovery (45.00 ± 9.69) compared to the medial parapatellar group (41.43 ± 8.87), although the difference was not statistically significant (p = 0.143). This trend continued at Week 3 (56.23 ± 8.65 vs. 55.17 ± 8.48; p = 0.631) and Month 3 (76.63 ± 13.28 vs. 74.23 ± 14.10; p = 0.500). These findings suggest that while both approaches lead to significant functional improvement.

Table 5: Comparison Of Quadriceps Recovery And Range Of Motion

Parameter	Time Point	Subvastus	Medial Parapatellar	P-value
Days to SLR	Mean	2.43 ± 0.50	3.30 ± 0.60	<0.001
	Day 2	17	2	
	Day 3	13	17	
	Day 4	0	11	
ROM (degrees)	Pre-op	100.27±10.73	99.93±10.48	0.904
	Day 3	107.43±10.57	104.13±10.20	0.223
	Week 3	122.37±13.34	117.10±9.69	0.086
	Month 3	132.50±11.91	131.50±13.66	0.764

SLR = Straight Leg Raise; ROM = Range of Motion

Early postoperative quadriceps function, as measured by straight leg raise ability was significantly superior in the subvastus group. This marked difference reflects the preserved integrity of the quadriceps mechanism in the subvastus approach, facilitating faster neuromuscular recovery. Both groups exhibited progressive improvement in knee range of motion postoperatively, with the subvastus group demonstrating a consistent trend toward greater early ROM recovery, although differences were not statistically significant.

Table 6: Comparison Of Pain Scores And Complications

Parameter	Time Point	Subvastus	Medial Parapatellar	P-value
VAS Pain Score	Pre-op	6.90±1.42	6.97±1.41	0.932
	Day 3	4.77±1.45	5.58±1.33	0.047
	Week 3	2.90±1.21	2.83±1.18	0.547
	Month 3	0.80±0.65	0.93±0.70	0.473
Complications	Superficial Infection	1	1	
	Cellulitis	0	1	
	Delayed Wound Healing	1	0	

Visual Analogue Scale scores for pain demonstrated significant improvement over time in both groups, with the subvastus group reporting significantly lower pain levels on Day 3, suggesting superior early postoperative comfort. This pain reduction benefit likely relates to less soft tissue and extensor mechanism disruption in the subvastus approach. The incidence of postoperative complications was low and comparable between groups, indicating both approaches are comparably safe.

Table 7: Distribution Of Final Functional Outcomes

Outcome Category	Subvastus	Medial Parapatellar	p-value
Excellent	17	11	0.126
Good	4	14	
Fair	8	5	
Poor	1	0	

Final outcomes based on the total Knee Society Score were categorized as excellent, good, fair, or poor. In the subvastus group, 17 patients (56.7%) achieved excellent outcomes, while 4 (13.3%) were classified as good, 8 (26.7%) as fair, and 1 (3.3%) as poor. In contrast, the medial parapatellar group had fewer patients with excellent results (n = 11; 36.7%) but more in the good category (n = 14; 46.7%). The distribution of fair and poor outcomes was 5 and 0 respectively. Although the differences did not reach statistical significance (p = 0.126), the trend indicates that the subvastus approach may be associated with a higher likelihood of achieving excellent functional results in the short term.

DISCUSSION

The demographic profile of our study cohort aligns consistently with existing literature on total knee arthroplasty populations. The mean age of patients in both groups (60.27±5.28 years for subvastus and 60.73±6.55 years for medial parapatellar) falls within the typical range reported by previous investigators. Kumar et al. (2012)[12] reported a similar mean age of 62 years in their subvastus group, while Bridgman et al. (2008)[13] and Emirhan and Yapici (2021)[14] reported comparable age distributions with participants predominantly in their sixth decade of life. Wu et al. (2018)[15], in their meta-analysis involving 1172 patients, highlighted that most included studies had patient cohorts with mean ages between 58 and 66 years, supporting the generalizability of our age-matched cohort to the broader TKA population.

The female predominance observed in our study (53.3% in subvastus and 66.7% in medial parapatellar groups) reflects the established epidemiological pattern of primary knee osteoarthritis. This gender distribution is consistent with findings from Kumar et al. (2012)[12] who observed 61.6% female representation, Mohammed et al. (2019)[16] with 56.7% females and Wu et al. (2018)[15] who documented 64% female subjects across 14 randomized controlled trials. The consistency in demographic characteristics across studies enhances the external validity of our findings and supports the representativeness of our patient cohort.

Our finding of significantly reduced intraoperative blood loss in the subvastus group (275.00±50.43 mL vs. 311.67±52.00 mL; p=0.007) corroborates previous research emphasizing the muscle-sparing benefits of this approach. Emirhan and Yapici (2021)[14] reported significantly lower mean blood loss in the subvastus group (p<0.001), while Wu et al. (2018)[15] found reduced intraoperative blood loss in their meta-analysis (p=0.004). Similarly, Nabil (2018)[17] reported significantly less blood loss with the subvastus technique, supporting the concept that this approach minimizes soft tissue trauma. The comparable operative times between groups (75.10±6.50 vs. 74.97±11.34 minutes; p=0.956) differ from some previous studies where longer durations were reported for the subvastus approach, possibly attributed to our uniform surgical expertise and patient selection excluding high-BMI or complex deformity cases.

The superior quadriceps recovery demonstrated by significantly earlier straight leg raise achievement in the subvastus group (2.43±0.50 vs. 3.30±0.60 days; p<0.001) represents a critical clinical advantage. This finding is strongly supported by Wu et al. (2018)[15] who reported significantly fewer days to SLR in patients undergoing the mini-subvastus approach (p=0.003) and Bourke et al. (2012)[18] who found earlier SLR performance in the subvastus group (p=0.044). Kumar et al. (2012)[12] reported an average SLR time of 3.2 days with the subvastus approach, consistent with our findings. Emirhan and Yapici (2021)[14] documented significantly earlier SLR in the subvastus group (p<0.001), attributing this to preservation of the quadriceps tendon. This enhanced quadriceps function recovery likely results from the muscle-sparing nature of the subvastus approach, which avoids division of the quadriceps mechanism.

The significantly lower pain scores observed in the subvastus group on postoperative Day 3 (4.77±1.45 vs. 5.58±1.33; p=0.047) align with the established benefits of quadriceps-preserving techniques. Bridgman et al. (2008)[13] reported lower KSS pain scores in the subvastus group at both early and late follow-up periods, while Stubnya et al. (2023)[19] noted that the mini-subvastus approach had the lowest pain scores on Days 1, 3 and 7 in their meta-analysis. Sood et al. (2018)[20] found significantly higher VAS scores in the medial parapatellar group during the third postoperative week, suggesting prolonged discomfort compared to subvastus. Tomek et al. (2014)[21] reported significantly lower pain at rest on Day 1 and during activity on Day 3 for quadriceps-sparing techniques, reinforcing our findings regarding the analgesic advantage of the subvastus approach in the early postoperative period.
While our study demonstrated progressive improvement in Knee Society Scores in both groups without statistically significant differences at most time points, the consistent trends favoring the subvastus approach during early recovery align with several previous

investigations. Teng et al. (2012)[22] found modest early advantages for the subvastus group in functional KSS at 4-6 weeks (WMD=5.09, p<0.01), while Bridgman et al. (2008)[13] reported significantly higher KSS pain and global scores for the subvastus group at one week and one year. Sood et al. (2018)[20] found lower KSS scores in the medial parapatellar group during early recovery phases (3 and 6 weeks), with convergence by six months. Wu et al. (2018)[15] reported significantly higher total KSS scores in the subvastus group (p=0.007), though the absolute differences were modest in long-term follow-up.

The range of motion improvements observed in both groups, with trends favoring the subvastus approach during early recovery, correspond to findings from multiple previous studies. Wu et al. (2018)[15] found superior ROM in the mini-subvastus group at 4-6 weeks (p=0.04), 3 months (p=0.007) and 6 months (p=0.02). Stubnya et al. (2023)[19] demonstrated that subvastus and mini-subvastus approaches significantly outperformed other methods in early ROM, especially on Days 3 and 4. However, our finding that ROM differences equalized by Month 3 is consistent with Emirhan and Yapici (2021)[14] who reported superior ROM in the subvastus group at one month but no difference by six months.

The low and comparable complication rates between groups in our study align with the safety profiles reported in previous literature. Teng et al. (2012)[22], Wu et al. (2018)[15] and Zhao et al. (2022)[23] all reported no significant differences in postoperative complications between surgical approaches, suggesting that both techniques are equally safe when performed by experienced surgeons. The higher proportion of "Excellent" outcomes in the subvastus group (56.7% vs. 36.7%) supports the functional benefits of this muscle-sparing approach, though the difference did not reach statistical significance, possibly due to the relatively short follow-up period and sample size limitations.

Our findings collectively support the growing body of evidence suggesting that the subvastus approach offers distinct advantages in early postoperative recovery while maintaining comparable long-term outcomes to the medial parapatellar approach. The preserved quadriceps mechanism, reduced soft tissue trauma and muscle-sparing nature of the subvastus technique contribute to faster functional recovery, reduced pain and improved early mobility without compromising surgical safety or long-term effectiveness.

CONCLUSION

The present study concludes that both the subvastus and medial parapatellar approaches are safe and effective for total knee arthroplasty, yielding comparable short-term functional outcomes. However, the subvastus approach demonstrates distinct advantages, including reduced intraoperative blood loss, faster quadriceps recovery, and lower immediate postoperative pain, without an associated increase in postoperative complications. Therefore, the subvastus approach may be considered the preferred technique for enhanced early recovery, particularly in patients suitable for muscle-sparing procedures. A key strength of this study lies in its comparative design, allowing direct evaluation of the two surgical approaches under similar conditions. However, the study is limited by a relatively small sample size and short-term follow-up, which may not fully capture long-term functional outcomes or delayed complications. Future studies should aim for larger cohorts and extended follow-up durations to validate these findings and better assess the durability and long-term benefits of each approach.

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