

Subvastus Approach for Total Knee Arthroplasty: Complete Quadriceps Sparing Technique

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Keywords: Subvastus approach, Quadriceps-sparing technique, Total knee arthroplasty (TKA), Minimally invasive surgery, Knee Society Score (KSS), Range of motion (ROM).

Abstract:

Background: Minimally invasive approaches are a more recent development, which aims at reducing damage to soft tissues. The subvastus or Southern approach to the knee had been described as early as 1929. This approach for primary total knee arthroplasty (TKA) preserves the integrity of the extensor mechanism and maintains the vascular supply to the patella. It provides excellent exposure of the knee joint with preservation of all peri-articular soft tissues. The benefits of the subvastus approach make it a valuable technique for primary TKA. This combination of advantages ensures rapid recovery, better knee range of motion and finally excellent patient satisfaction.

Aim of the study: The goal of this study is to compare the subvastus method to the usual medial parapatellar technique for total knee replacement in patients with osteoarthritis based on quadriceps function recovery in days after surgery.

Methods: We retrospectively reviewed case notes of 36 patients with osteoarthritis who had total knee replacements in satkhira medical college hospital and private clinics over the course of a period from August 2019 to August 2024. we evaluated all the cases regarding early postsurgical clinical outcomes (range of motion [ROM], pain on a visual analog scale, and Knee Society Score [KSS]). Preoperative quadriceps strength, BMI, and baseline demographics were all recorded from their initial pre-operative workup case notes. Starting on the first postoperative day, patients recorded first unassisted straight leg raise (SLR) was kept as the main determinant for muscle function. The data were evaluated to determine the quadriceps muscle function post TKR.

Result: When compared to the medial parapatellar approach, the quadriceps muscle function returns sooner with the subvastus technique. Patients in their sixties showed the highest improvement. Preoperative quadriceps strength has a major impact on muscle recovery after surgery.

Conclusion: The subvastus method to total knee replacement is linked to a faster recovery of quadriceps muscle strength, resulting in a shorter hospital stay and postoperative therapy.

Introduction:

Total knee replacement surgery begins with correct planning of both the incision and the exposure of the joint. Indeed, these are factors that are just as crucial to an optimal outcome as choosing the right implant, positioning the components, and balancing the ligaments. The best surgical approach in total knee replacement is still to be determined as none of the

existing approaches could prove its superiority in previous studies¹⁻³. First described in 1879 by von Langenbeck, the medial parapatellar approach on the inner side of the knee found early favor and it is regarded as the gold standard for which other approaches are compared¹⁻³. Hofmann reported on the quadriceps preserving subvastus approach in 1991². The subvastus approach to the knee joint has been

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described as an alternative to traditional approaches which involve a large incision with division of the quadriceps mechanism. The subvastus is a minimally invasive, muscle-sparing approach; it is truly “quadriceps-sparing.” Reported literature suggests that the utilization of this minimally invasive approach allows patients improved and quicker early recovery after total knee replacement surgery. Total knee arthroplasty³ is a successful operation for treating knee joint deterioration. Over the last three decades, this procedure has grown in popularity. Anterior midline incision with medial parapatellar arthrotomy is the most common skin incision for primary total knee arthroplasty. To gain access to the knee joint with patellar subluxation, a portion of the quadriceps tendon is incorporated in the arthrotomy. Alternative ways of exposure have been described to prevent patellofemoral problems and speed up the restoration of quadriceps function after surgery. In terms of subluxing the extensor mechanism laterally for knee exposure, the subvastus (“Southern”) technique varies from the medial parapatellar technique. Leave the extensor mechanism intact, according to proponents, results in faster restoration of quadriceps strength, retains greater vascularity in the patella, increases patient satisfaction while reducing postoperative pain, and reduces the need for lateral release. Hofman in 1991 popularized the subvastus approach for TKA, which first appeared in the German literature in 1929⁴. The goal of this study is to compare the subvastus technique to the usual medial parapatellar technique for total knee replacement based on quadriceps function recovery in days.

Materials and Methods:

This is a retrospective study carried out in Satkhira medical college hospital from January, 2019 to January, 2023. Data from patients who had complete knee replacements during that period was collected after clearance from the hospital. The study comprised patients of either gender between the ages of 50 and 70, with a BMI between 18.5 and 40 [measured as weight (kg)/height² (m²)], who were diagnosed with osteoarthritis and required a total knee replacement as a result. The sample size after applying the necessary criteria was 36 patients keeping an equal number of patients for standard

parapatellar and subvastus approach. Group A consisted of patients with subvastus approach and Group B included patients with medial parapatellar approach.

Inclusion Criteria

- Patients of either gender aged between 50 and 70 years.
- Patients with a body mass index (BMI) between 18.5 and 40, calculated as weight (kg)/height² (m²).
- Patients diagnosed with osteoarthritis requiring total knee replacement.
- Patients who underwent primary total knee replacement using either the medial parapatellar approach or the subvastus approach between January 2019 and January 2023 at Satkhira Medical College Hospital.

Exclusion Criteria

- Patients younger than 50 years or older than 70 years.
- Patients with BMI outside the range of 18.5–40.
- Patients with secondary causes of knee arthritis such as rheumatoid arthritis, post-traumatic arthritis, or infectious arthritis.
- Patients undergoing revision knee replacement or bilateral simultaneous total knee replacement.
- Patients with incomplete records or who could not be contacted during follow-up.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review board of Satkhira Medical College Hospital before commencing the study. All patients provided informed consent prior to participation. Patients were informed that participation was voluntary, no incentives would be provided, and they were assured of anonymity and confidentiality throughout the study.

Surgical Technique

A midline skin incision is performed, and full thickness skin flaps are elevated. Deep fascia is divided proximally and medially to mobilize the medial skin flap further to define the vastus medialis obliquus (VMO) muscle up to its attachment to the

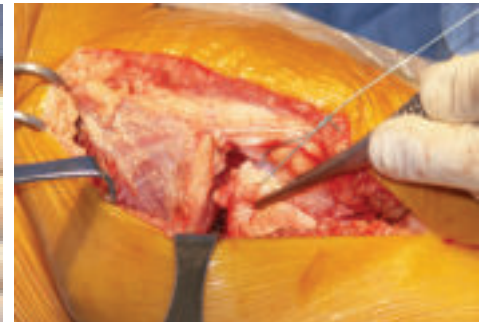
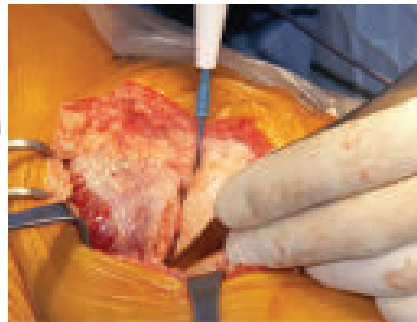
medial intermuscular septum. The arthrotomy is commenced at the attachment of the VMO to the medial intermuscular septum, dividing the capsular attachment and extended laterally to the supero-medial angle of the patella. Arthrotomy is then extended vertically and distally along the medial border of the patellar tendon terminating 1 to 2 cm medial to the tibial tuberosity. At this point, the VMO is reflected off the medial intermuscular septum up to the junction of middle third and distal third of the thigh. Care must be taken at this point to prevent inadvertent damage the femoral vascular structures. Following this, the infrapatellar fat pad and the lateral meniscus are incised; the proximal third of the patellar tendon is released off the proximal tibia. In the vast majority of cases, the above manoeuvres would be adequate to achieve a satisfactory exposure to carry out TKA.



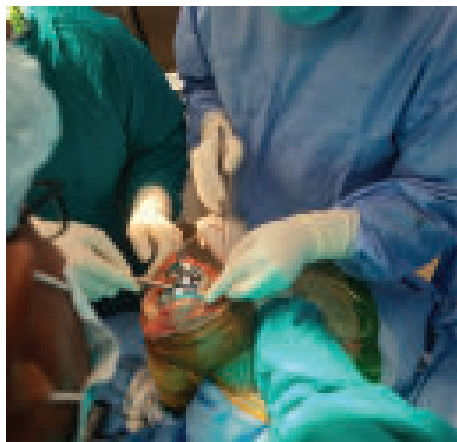
Total knee arthroplasty



Subvastus approach



Incision and Arthrotomy



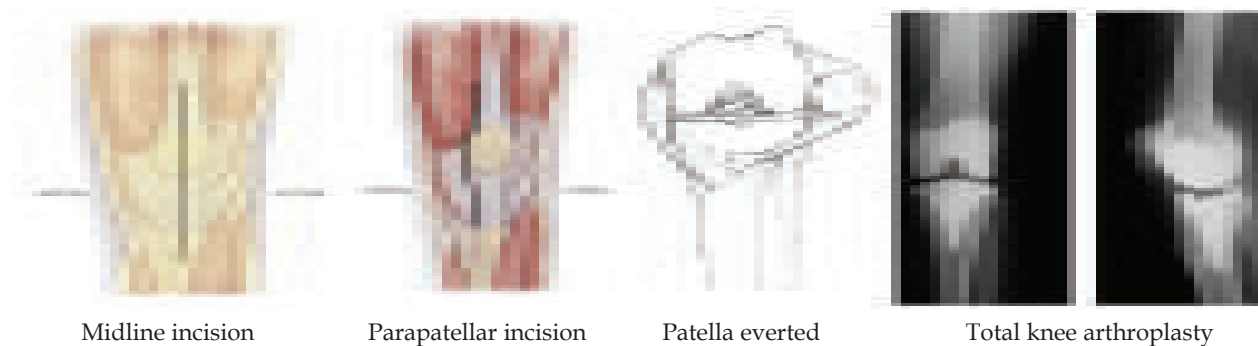
Implantation and cementation



Total knee replacement

Conventional median parapatellar approach:

1. standard anterior midline incision extending from a point 5 cm proximal to the apex of the patella to the tibial tubercle is made. 2. subcutaneous tissues are dissected 3. the capsule is entered through a medial parapatellar approach approximately 1 cm from the medial boarder of patella 4. Quadriceps mechanism is incised longitudinally to allow adequate patella eversion and sufficient knee flexion 5. Both femur and tibia are prepared for cementation 6. Implantation of both femur and tibia is completed 7. wound is closed with suture of the extensor mechanism.

**Data Collection Procedure**

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.

Statistical Analysis

The SPSS 16.0 statistical programmed was used to analyses the data. The results were provided as mean $\pm$ standard deviation for straight leg raise in days and gender frequency/ %. Using the t-test to compare means, a statistical comparison of quadriceps function in days is done between the two groups. A P-value of less than 0.05 was considered significant. Stratification was done in regards to age, gender, quadriceps strength and BMI to see the effect of these on outcomes.

Results:

Subvastus approach provided satisfactory exposure in all knees. Base line demographic data of the patient who has undergone total knee arthroplasty by either medial Parapatellar (group-1) or subvastus approach also called minimal invasive surgery (MIS group-2). Regarding operative time subvastus group had more operative time with mean duration of surgery of 98.56 minutes, range between 60-140 whereas; the mean operative time was 72.60 minutes, range between 45 – 127 in medial parapatellar approach. There was statistically significant difference. Regarding to Blood loss there was no statistically significant difference between the two groups in terms of blood loss and

blood transfusions ($p > 0.05$). Measurement was taken in gram per decilitre from pre-operative period following 24 hrs after postoperative period. Pain was less in group-2 (subvastus approach). Post operatively pain was measured on day 1, and day 3 using visual analogue score (VAS). On day 1 in the medial parapatellar group 42.5 percent of patients had score of 0. Whereas in subvastus approach 60.20 percent had score of 0 on day 1 but the mean score was 1.8 and 2.1 respectively. On day 3, Medial parapatellar group had 15.5 percent of patients experienced pain score of 0 and in the subvastus group 36.2 percent of patients experienced pain score of 0. Mean pain score was 2.8 and 3.9 respectively. So, on day one there was no significant difference of pain score between the two groups and pain score on day 3 was significantly less in subvastus group when compared to medial parapatellar group (p value < 0.01). Regarding to Duration of stay in hospital Subvastus group 7.65 days had shorter duration of stay in the hospital, range between 4- 13 days than medial parapatellar group 9.50 range between 5 to 15 days. There was no statistically significant difference between two groups in terms of duration of stay ($p > 0.05$) and post-operative. The quadriceps was required to be elevated from the anterior surface of the femur in 95 cases. We were able to achieve improvement in flexion on addressing all the etiological factors; however, pie crusting of the quadriceps was required in one case. The mean preoperative flexion was 72° (range 40° – 90°) with a total ROM of 64° (range 36° – 90°). Postoperatively, knee flexion improved mean 38° ($P < 0.05$) which was significant as assessed by Student's t-t.

Table I
Preoperative parameter

Preoperative data	Age (years)	Gender	Weight	Body mass index (kg/m ²)	Preoperative hemoglobin (g/dL)	Preoperative knee society score	Objective knee society score	Preoperative ROM	Functional knee society score	Preoperative knee deviation	Preoperative knee angle
MIS Group	68.02 (8.14)	14 M 36 F	79.30 (14.20)	30.97 (5.25)	14.11 (1.13)	82.44 (19.16)	35.28 (11.90)	47.16 (12.10)	93.70° (16.74)	45 VR 5 VL	173.5° (3.51)
Standard Group	70.64 (7.88)	13 M 37 F	78.13 (7.50)	30.62 (3.42)	13.75 (1.00)	89.08 (31.55)	47.96 (15.02)	41.12 (20.70)	99.29° (13.26)	45 VR 5 VL	174.1° (4.34)
Significance (p)	0.102	0.822	0.912	0.693*	0.064*	0.093	0.465	0.436*	—		

Table II
Postoperative pain and recovery analysis

Postoperative pain and early recovery	Patients consumed analgesic 24 hours	Patients consumed opioids 24 hours	Patients consumed analgesic 48 hours	Patients consumed opioids 48 hours	Milligrams metamyazol per kilogram per patient 24 hours	Milligrams metamyzol per kilogram per patient 48 hours	Walking start (days)	Hospital stay (days)
MIS Group	20	2	41	1	11.1 (10.2)	25.98 (18.9)	2.68 (0.62)	8.3 (3.33)
Standard Group	35	11	36	9	25.9 (17.4)	29.04 (19.5)	4.47 (1.37)	8.4 (2.05)
Significance (p)	0.002	0.007	0.307	0.007	0.002† 95% CI (5.71–23.9)	0.568†	< 0.001* 95% CI (1.36–2.21)	—

Table III
Knee Society score functional results

Postoperative Knee Society score	KSS 1 m	Objective score 1 month	Functional score 1 month	KSS 3 months	Objective score 3 months	Functional score 3 months	KSS 12 months	Objective score 12 months	Functional score 12 months	KSS 3 years	Objective score 3 years	Functional score 3 years
MIS Group	131.83 (23.23)	69.31 (11.43)	62.52 (15.18)	173.03 (16.67)	84.09 (7.88)	88.94 (10.97)	181.60 (10.99)	86.98 (6.17)	94.62 (7.18)	182.42 (11.43)	87.38 (4.57)	95.04 (6.97)
Standard Group	111.63 (28.53)	67.85 (11.01)	43.78 (20.44)	151.00 (24.89)	77.20 (9.80)	73.80 (20.31)	172.71 (20.28)	82.37 (6.34)	90.34 (16.54)	172.52 (15.99)	82.27 (6.24)	90.25 (10.65)
Significance (p)	< 0.001 95% CI (30.5–9.8)	0.517	< 0.001 95% CI (25.8–11.5)	<0.001 95% CI (13.6–30.4)	<0.001 95% CI (3.3–10.4)	<0.001 95% CI (8.6–21.6)	<0.001 95% CI (2.42–15.3)			—		

Table IV
Knee ROM

Postoperative ROM	ROM 1 month	ROM 3 months	ROM 12 months	ROM 3 years
MIS Group	95.5° (12.43)	110° (10.92)	114.4° (6.97)	113.7° (3.46)
Standard Group	89.7° (15.99)	99.9° (13.07)	102.4° (10.65)	102.7° (9.57)
Significance (p)	0.049 95% CI (0.1–11.4)	<0.001 95% CI (5.3–14.88)	< 0.001 95% CI (8–15.1)	< 0.001 95% CI (7.8–16.3)

Discussion:

Total knee replacement surgery begins with correct planning of both the incision and the exposure of the joint. Indeed, these are factors that are just as crucial to an optimal outcome as choosing the right implant, positioning the components, and balancing the ligaments. Many knee procedures, nowadays, are routinely performed via arthroscopic or arthroscopic-assisted methods. However, knowledge of open surgical access to the knee remains vital for knee arthroplasty and cases where arthroscopy is not possible or practical. Controversy currently surrounds the optimal surgical approach for total knee arthroplasty (TKA). The best surgical approach in total knee replacement is still to be determined as none of the existing approaches could prove its superiority in previous studies¹⁻³. Minimally invasive TKA has been developed during the last decade with hundreds of scientific works related to these techniques. Unfortunately, few well-designed trials exist capable of providing conclusions of high evidence about the real benefits and complications of minimally invasive TKA⁵. This study was performed to provide a higher level of evidence in comparison of MIS with a conventional approach in TKA. We found patients treated by MIS TKA had less pain early after surgery, achieved and sustained better ROM, but did not experience clinically important greater blood loss, component malpositioning, longer hospital stay, or incidence of complications. In our opinion, it is more reliable to evaluate pain by painkiller intake. Finally, the variable of walking start day is not a validated measurement but provides an idea of faster recovery in the MIS Group. Other authors like Healy et al.⁶ and Berger et al.⁷ used similar nonvalidated measurements to demonstrate faster recovery in subvastus approach. Whereas the transfusion requirements did not show notable differences, the greater fall in hemoglobin from preoperative to 6 hours postoperatively and the greater drainage in the MIS Group have led us to conclude that the perioperative bleeding could be slightly higher in the MIS Group. Our results are in agreement with Boerger and colleagues³ who detected 10% more bleeding with the minimally invasive subvastus approach. However, Zanasi⁸ found no differences. Probably, the higher bleeding could be explained by the difficulty of making a perfect hemostasis after the components have been definitively placed and by the accumulation of blood under the vastus medialis

muscle. In our opinion, although drainage may be greater, the most clinically relevant point is that no differences existed in the rate of transfusion. Nevertheless, there is a tendency toward more bleeding with MIS surgery. Based on analgesic consumption, lower postoperative pain was detected in patients operated on by the minimally invasive subvastus approach. In our opinion, the use of the pain VAS presents several problems because the score would change depending on the moment it was applied in relation to the analgesic intake. Using the VAS of pain, Boerger and colleagues³ found less pain in patients operated on using the MIS technique. Zanasi⁸ and Lombardini and colleagues³ also detected less postoperative pain in the MIS Group. In our study, the early recovery was faster in the MIS Group compared with the standard approach. This is demonstrated by the earlier walking start and the greater ROM of the knee in the patients operated on using the MIS subvastus approach. On the other hand, the hospital stay showed no major differences. Although this fact may be surprising, Boerger and colleagues³, Zanasi⁸ and Kolisek and colleagues¹⁰ also found substantial differences in early knee flexion but not in hospital stay. In contrast, Lombardini and colleagues⁹ and Schroer and colleagues¹¹ found earlier hospital discharge with the minimally invasive subvastus approach. The application of rapid recovery protocols may accelerate the recovery of these patients and reduce the hospital stay^{2,12,13}. However, one should not forget that Healy and colleagues⁶ showed how an aggressive rapid recovery protocol was capable of reducing hospital stay and cost of TKA performed by the conventional approach as well. Matsueda et al.¹⁴ compared a group of total knee arthroplasty (TKA) patients with parapatellar approach and subvastus approach retrospectively at 6 months. There were no significant differences for range of motion, Knee Society Score (KSS), knee function scores, and stair-climbing ability. No differences were found in surgical time. Our subjective opinion is the minimally invasive subvastus TKA consumes a little more time in the placement of the prosthesis, but this time is recovered during closure. Probably, the skin-to-skin time measurement has hidden this subjective difference. This impression has been confirmed by Boerger and colleagues³ and Zanasi⁸, both of whom have detected longer duration for the MIS procedure measuring the surgical time from skin to prosthesis placement. Component

orientation was similar in both groups with no differences in outliers or any angles measured. All studies which involve minimally subvastus approach have detected correct component orientation without differences compared with standard approach^{7,12,15,17}. No differences were found in complication rates and, again, no previous report exists in which the complication rate was higher in the MIS Group^{7,15}. Functional results, both KSS and ROM, were substantially better in the MIS Group and were maintained until 3 years of follow-up. Our results are in accordance with most prior studies^{7,12,15,18}. We assume this better result can be attributed to less scar formation resulting from less dissection, including the conservation of all vastus medialis attachments. In contrast, Kolisek and colleagues¹⁰ did not find differences in KSS at 3 and 12 weeks. Bonnutti et al.¹⁹ have used an MIS technique successfully on more than 420 knees. Laskin has reported good results using a limited midvastus approach¹⁸. Tria and Cook²⁰ have published data using the medial parapatellar limited subvastus approach known as the quad-sparing approach. The first articles published comparing the different techniques and surgical approaches show slight differences in terms of the clinical results and complications associated with the learning curve for each technique. Using repeated-measures analysis of variance, the KSS and ROM development were studied. Although no differences were found in the KSS development between the groups, the ROM analysis showed the minimally invasive subvastus approach is capable of achieving and sustaining better knee ROM. In conclusion, we found the minimally invasive subvastus approach can provide advantages over conventional surgery in terms of postoperative pain and recovery, but not in terms of perioperative bleeding. When compared with traditional exposure, the minimally invasive subvastus approach did not increase surgical time, risk of component malalignment, or complication rate. The early and late functional results were substantially better with the minimally invasive subvastus approach compared with the conventional approach.

Limitations of the study: This study has several limitations. Being retrospective in nature, it relied on hospital records and patient-reported follow-up, which may introduce recall bias and incomplete data. The small sample size and single-center setting limit

the generalizability of findings. Follow-up was restricted to one year, preventing assessment of long-term outcomes. Additionally, the exclusion of patients with incomplete records may have introduced selection bias, while objective functional and radiological outcomes were not comprehensively evaluated.

Conclusion:

Implementing the subvastus approach during TKR surgeries, with subsequent preservation of the patellar attachment of the vastus medialis oblique muscle, allows for better tracking of the patella over the femur during surgery, resulting in a reduction in the necessity of performing lateral retinaculum release intraoperatively. The subvastus approach can result in improved long-term Knee Society scores and range of motion of total knee arthroplasty without increased risk of component malalignment, surgical time, or complication rate.

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