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Comparative Study Between Minimally Invasive Subvastus Approach Versus Conventional Approach For Improving The Results Of Total Knee Replacements

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Abstract

Background: Total Knee Arthroplasty (TKA) is the gold standard for end-stage knee osteoarthritis (OA), usually indicated for pain reduction and functional enhancement. As TKA demand expands worldwide, attempts are made to optimize surgical results and shorten recovery time. The traditional medial parapatellar (MPP) technique, although common, potentially compromises the extensor mechanism and vascularity. The minimally invasive subvastus (SV) technique hopes to avoid muscle disruption and postoperative morbidity.

Aims & Objective: To compare the advantages and disadvantages of minimally invasive subvastus approach and conventional approach in patients undergoing total knee replacement in terms of parameters like

1. Blood loss during surgery,
2. Post-operative pain,
3. Recovery
4. Hospital stay.

Methods: A prospective observational study was conducted from September 2020 to January 2022 at Srinivas Institute of Medical Sciences and Research Centre, Mangaluru, Karnataka. A total of 100 patients undergoing unilateral TKA for primary OA were randomized into two groups: Group M (subvastus, n=50) and Group C (conventional, n=50). Clinical and functional outcomes—including hemoglobin levels, analgesic/opioid use, range of motion (ROM), time to ambulation, hospital stay, and Knee Society Scores (KSS)—were compared between groups.

Results: Demographic profiles were similar among groups ($p>0.05$). Group M had significantly greater hemoglobin drop at 48 hours ($p=0.001$), but lower opioids used postoperatively ($p<0.05$). Early ambulation ($p<0.001$), ROM at 3 and 12 months, and KSS at all follow-ups were significantly improved in Group M ($p<0.05$). While Group M had higher drainage, rates of transfusion were not significantly different ($p=0.499$). Hospital stay was very little shorter in Group M, but not statistically significant.

Conclusion: The subvastus technique of TKA provides better early functional recovery, lower postoperative pain, and improved long-term results without adding operative complications. It is a safe and efficient option to the standard approach in appropriate candidates

Keywords: NIL

Introduction

Total Knee Arthroplasty (TKA) is a surgical procedure in which an artificial joint or prosthesis replaces a damaged knee joint and is considered as the most common treatment for end-stage knee osteoarthritis (OA).1 The primary indication for TKA is pain which also makes great sense for some other underlying indications, including inflammatory arthritis, fracture (post-traumatic OA and/or deformity), dysplasia, and malignancy.2 Nowadays, the global demand for TKA is increasing at a dramatic rate due to the growing prevalence of knee arthritis. The number of primary TKA procedures is projected to grow by 85% (1.26 million procedures) by 2030. The TKR reported in the IJR registry increased from 1019 in 2006 to 27,000 in 2019.3

Traditional TKA medial parapatellar approach, described by Von Langenbeck in 1879, performed on the inner side of the knee is used almost universally in total knee arthroplasty is regarded as the gold standard for the knee replacement. This method offers adequate surgical field exposure and relatively accurate positioning of the prosthesis.4 The conventional medial parapatellar arthrotomy splits the medial portion of the quadriceps tendon from the patella. The parapatellar incision is shown to interfere with the vascularity of the patella by dividing the peripatellar plexus of vessels. However, the relative avascularity produced may contribute to patellar fracture, button loosening, and anterior knee pain. The potential avascular problems are increased further if a lateral release is required. Parapatellar closure adds further problems relating to the repair, such as vastus medialis dehiscence and patellar maltracking secondary to a tight repair.5

The quest for quicker postoperative rehabilitation, shorter hospitalization, and fewer lifestyle disruptions has led to the development of new minimal incision surgical techniques and instruments with the aim to facilitate recognized surgical goals in total knee arthroplasty with less associated operative trauma.6 In these techniques the skin incision and surgical dissection have been modified to reduce the surgical morbidity associated with any procedure. The most commonly used MIS approaches in TKA are the subvastus (SV), midvastus (MV) and quadriceps sparing (QDS).7SV and QDS can be described as more “anatomic” techniques as they fully preserve the extensor mechanism and minimizes vascular damages to the knee compared to the traditional MPP approach. In minimally invasive techniques the skin incision is decreased but, in addition, the subvastus insertion is conserved, the patella is not everted, and the joint is not dislocated or hyperflexed until definitive placement of the tibial component. Less tissue injury with minimally invasive techniques has been demonstrated in other orthopaedic surgery fields through acute phase reactant analysis. This decrease could produce advantages in terms of less bleeding, and less postoperative pain, as well as shortened recovery time. The limited view/access in the surgical field and the increased operative difficulty level limits their popularity.8,9

The SV approach leaves the quadriceps intact and completely attached to the medial patellar border, which theoretically reduces the pain associated with violating the extensor mechanism and lessens the risk of blood supply damage to the patella and subsequent avascular necrosis and fractures of the patella.10 Such benefits may improve the range of movement and functional outcomes of patients after TKA surgery.11 This approach also helps in improved patellar tracking, expedited rehabilitation, and reduced postoperative pain resulting in shorter hospital stays.12 The advantages of minimally invasive techniques in TKA are still debated in all orthopaedic forums13. Despite the large number of existing papers, studies are very sparse from Indian demographics providing high levels of evidence between two approaches. Hence, this study was designed to compare the advantages and disadvantages of minimally invasive subvastus approach and conventional approach for total knee replacement in terms of blood loss during surgery, post-operative pain, hospital stay.

Aims & Objectives: To compare the advantages and disadvantages of minimally invasive subvastus approach and conventional approach in patients undergoing total knee replacement in terms of parameters like

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2. Post-operative pain,
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4. Hospital stay.

Study design:

A prospective observational study.

Study period:

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September 2020 to January 2022.

Study site:

Department of Orthopaedics, Srinivas Institute of Medical Sciences and Research Centre, Mangaluru, Karnataka.

Source of data:

Patients admitted/referred for total knee replacement in Srinivas Institute of Medical Sciences and Research Centre, Mangaluru, Karnataka and fulfilling below inclusion and exclusion criteria:

Inclusion Criteria:

1. Patients of either sex, age ≥ 18 years.
2. Patients with primary osteoarthritis of knee
3. Patient willing to participate in the study and with signed consent form.

Exclusion Criteria:

1. Patients with secondary osteoarthritis,
2. Patients posted for simultaneous B/L TKR.
3. Bmi > 40 kg/m2
4. Previously operated knee.
5. Patients with Patella baja.
6. Patients with knee contracture greater than 20o
7. Patients with knee Knee flexion <90 degree
8. Patients with Peripheral vascular disease

Patients with long term corticosteroid use.

Sample Size

The Sample size was calculated on the basis of following formula:

1. SS = Sample Size
2. Z-score = Critical value and a standard value for the corresponding level of confidence. (1.96 for confidence level 95%)
3. p= Expected prevalence.
4. e = Margin of error (margin of error of 10% is taken) SS = $(1.96)^2$ * 0.06 (1-0.06) / $(0.05)^2$
5. SS = 86.7.

Considering the drop-out rate of 10%; 86.7 + 8.7 = 95.4.

As per the above calculations and rounding off to nearest tens, study was carried out on 100 patients throughout the study period.

Methodology:

After admission, general condition of the patient was assessed with regards to associated orthopaedic or other systemic injuries. Patients undergoing TKR were randomized using computerized number generate method and patients were divided into two groups:

Group M (N=50): Patients underwent TKR by mid-vastus approach. Group C (N=50): Patients underwent TKR by conventional surgery. Preoperative Parameters

1. Age
2. Gender
3. Weight
4. BMI
5. Preopearative Knee Society Score

Perioperative Bleeding Parameters

1. Hb level at 8 hours
2. Hb level at 48 hours
3. PRBC transfused per patient
4. Drainage.

Postoperative Pain and Recovery Analysis Parameters

1. patient consumed analgesic in 24 hours and 48 hours
2. patient consumed opioids in 24 hours and 48 hours.
3. epidural topup
4. walking starts(days)
5. length of hospital stay
6. ROM at 48 hours
7. Knee Society Score calculated at 1 month, 3 month and 12 months.
8. Knee ROM checked at 1 month,3 month and 12months.

The person involved in the randomization was blinded about the study and its objectives. All procedures were performed by the same surgeon, who carries broad experience in both conventional and minimally invasive TKA. The criteria for blood transfusion were the same for both groups: hemoglobin levels lower than 8 mg/100 mL or lower than 10 mg/100 mL and signs or symptoms of heart insufficiency. In the evaluation of early recovery, the day the patient was able to walk 20 meters and climb two stairs (walking start day) and the ROM on the third day after surgery was collected. To measure the ROM, the same goniometer was used in all patients. Functional results between the groups were compared using the Knee

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Society score (KSS) assessed at 1 month, 3 months, and 12 months. Global KSS and its subparts, objective and functional, were analyzed. Finally, the ROM (measured by goniometer, JRVG) at 1 month, 3 months, and 12 months was evaluated independently for its particular relevance in knee function.

Data Analysis:

Data collection was on paper and later was compiled using an excel spreadsheet. The baseline patient characteristics are presented as frequencies for the categorical variables and as the means and standard deviations for continuous variables. After appropriate data filtration, the data sheet was transferred and analyzed using Graphpad Prism (vs. 9.2.0). For comparing categorical data, Chi square ($\chi 2$) test was performed. Comparison of quantitative variables between the study groups was done using Student t-test or One- way Analysis of Variance (ANOVA) test as applicable. Results were considered statistically significant at a P-value ≤ 0.05.

Results:

Table 1 shows the socio-demographic profile of the patients. The gender split was similar between groups (p=0.83) with 36% males in Group M and 38% in Group C. The age split had no significant difference (p=0.461) as most in both groups were ≤60 years. Side of the knee operated (left/right) was similar (p=0.685). Mean BMI was 28.6 ± 4.2 kg/m² in Group M and 29.1 ± 3.9 kg/m² in Group C. Mean body weight was 71.4 ± 8.5 kg and 72.7 ± 6.8 kg, respectively. None of these variables differed statistically.

Table 1. Socio-demographic profile

Variables	Sub-variable	Group M	Group C	P value
Gender	Male	18 (36%)	19 (38%)	0.83
	Female	32 (64%)	31 (62%)	
Age	>60yrs	9 (18%)	12 (24%)	0.461
	≤60yrs	41 (82%)	38 (76%)	
Side operated	Left	22 (44%)	20 (40%)	0.685
	Right	28 (56%)	30 (60%)	
BMI (kg/m2)		28.6±4.2	29.1±3.9	
Wt (kg)		71.4±8.5	72.7±6.8	

Table 2. The table presents clinical and functional results between Group M and Group C. Before the operation, both groups were similar in quadriceps strength, hemoglobin levels, knee scores, and range of motion. Hemoglobin decrease at 48 hours was significantly greater in Group M (p=0.001), with a little more drainage (p=0.051). Post-operatively, Group C used more opioids at 24 and 48 hours (p=0.029, p=0.0138). Group M started walking sooner (p<0.001) and had improved range of motion and Knee Society Scores at 3 and 12 months. These results indicate improved functional recovery and reduced post-surgical opioid needs in Group M.

Table 2. Clinical and functional outcomes between Group M and Group C

Variable	**Group M**	**Group C**	**P value**
Pre-operative quadriceps strength			
IV	**12 (24%)**	**14 (28%)**	

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V	**38 (76%)**	**36 (72%)**	
Pre-operative characteristics			
Hemoglobin	**12.9±2.3**	**13.3±2.7**	**0.427**
Knee society score	**81.7±18.6**	**88.1±21.4**	**0.1137**
Objective knee society score	**37.4±10.9**	**41.3±12.1**	**0.093**
Functional knee society score	**44.3±11.7**	**46.8±13.7**	**0.328**
Range of movements	**92.9±15.8**	**97.7±14.9**	**0.121**
Hemoglobin fall @ 8hrs	**3.2±1.1**	**2.9±0.9**	**0.138**
@48hrs	**4.8±1.4**	**3.8±1.1**	**0.001**
Drainage	**326.9±187.4**	**257.2±164.8**	**0.051**
Packed RBC transfused			
Yes	**12 (24%)**	**15 (30%)**	**0.499**
No	**38 (76%)**	**35 (70%)**	
Post-operative Need			
Analgesic @ 24hrs	**24 (48%)**	**31 (62%)**	**0.159**
Opioids @ 24hrs	**4 (8%)**	**12 (24%)**	**0.029**
Analgesic @ 24hrs	**39 (78%)**	**42 (84%)**	**0.444**
Opioids @ 48hrs	**2 (4%)**	**10 (20%)**	**0.0138**
Epidural top-up	**6 (12%)**	**11 (22%)**	**0.183**
Walking start	**2.9±0.7**	**4.3±1.6**	**<0.001**
Length of stay	**7.7±2.9**	**8.6±2.4**	**0.0941**
Range of movements			
@ 1 month	**97.9±12.6**	**93.1±12.7**	**0.0613**
@ 3 months	**112.4±11.4**	**99.5±12.9**	**<0.001**
@ 12 months	**116.8±9.8**	**104.8±10.3**	**<0.001**

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Knee society score			
@ 1 month	**132.4±19.8**	**114.5±23.7**	**0.001**
@ 3 month	**172.7±21.4**	**156.2±26.1**	**0.008**
@ 12 months	**184.6±16.1**	**171.7±18.3**	**0.003**

Discussion:

Minimally invasive total knee arthroplasty (TKA) procedures, particularly the mini-subvastus approach, have gained increasing attention due to advantages such as faster rehabilitation, reduced postoperative pain, and shorter hospital stay. This prospective study compared the clinical outcomes of the mini-subvastus approach (Group M, n=50) with the conventional medial parapatellar approach (Group C, n=50). Both groups had similar demographic distributions with no significant differences in gender (P=0.8359), age (P=0.4614), BMI (P>0.05), or laterality of surgery (P=0.6853), consistent with findings by Ziyu L et al.14 and Boerger et al.15

Preoperative parameters including quadriceps strength, range of motion (ROM), and hemoglobin levels were comparable. However, hemoglobin fall at 48 hours was significantly higher in Group M (P=0.0001), aligning with Egocheaga et al.16 Postoperative drainage was also higher in Group M, though not statistically significant (P=0.0511), possibly due to difficulty achieving hemostasis. Despite this, transfusion rates were similar (P=0.4992), indicating limited clinical relevance.

Group M required fewer opioids at 24 and 48 hours (P=0.0290 and P=0.0138, respectively), supporting findings of lower pain in MIS approaches reported by Boerger et al.15 and Jain et al.17 Early mobilization was significantly better in Group M (P<0.0001), in agreement with Ziyu L et al.14 and Egocheaga et al.15 Though hospital stay was shorter in Group M, the difference was not significant (P=0.0941). ROM at 3 and 12 months and Knee Society Scores (KSS) at all follow-up points were significantly higher in Group M (P<0.05), corroborating studies by Ziyu L et al.14 and Egocheaga et al.15

Limitations: It include small sample size, single-center design, and use of analgesic consumption over VAS for pain assessment. Larger studies are needed to validate these findings.

Conclusion: Based on our findings, we conclude that patients who underwent surgery using the subvastus approach had faster recovery, less pain, early walking start with comparable length of stay. Compared to conventional approach, the minimally invasive subvastus approach did not increase surgery time. Also, with the minimally invasive subvastus approach, the early and long-term functional results (Knee Society scores and range of motion) were much better than with the conventional approach. This supports our hypothesis that the subvastus technique is better anatomic and facilitates faster postoperative recovery.

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