

Vertical Incision Orientation Improves Midvastus Arthrotomy in Total Knee Arthroplasty: Superior Pain Relief, Minimal Blood Loss and Faster Recovery

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Abstract

Background: The midvastus arthrotomy technique is commonly utilized in Total Knee Arthroplasty (TKA) due to its potential to preserve quadriceps integrity and improve early postoperative outcomes. This retrospective cohort study evaluates the impact of incision orientation in the midvastus technique on pain, functional recovery and surgical outcomes.

Materials and methods: A total of 180 patients undergoing TKA were included, divided into three groups: standard midline, horizontally oriented and vertically oriented midvastus incisions. All patients received the same implant and standardized perioperative care. Outcomes such as pain (VAS), function (OKS), blood transfusion rates and numbness were assessed at 10 days, 1 month and 3 months.

Results: The vertical incision group demonstrated significantly lower VAS scores and faster functional recovery. Blood transfusion rates and numbness incidence were also lowest in this group. Results are supported by p-values and descriptive statistics.

Conclusion: Vertical incision orientation in the midvastus approach appears to offer benefits in early postoperative outcomes. However, due to the retrospective nature of this study and the variability in muscle anatomy, further prospective, anatomy-guided studies are necessary to confirm these findings.

Keywords: Total knee Arthroplasty; Midvastus; Arthrotomy; Vastus medialis muscle

Introduction

Total Knee Arthroplasty (TKA) has become a widely accepted surgical intervention for the treatment of end-stage osteoarthritis, rheumatoid arthritis and other degenerative joint diseases. Since initial successful implementations in 1970s, TKA has undergone significant advancements in surgical techniques, implant materials and perioperative management, greatly enhancing its efficacy and outcomes. The primary goal of TKA is to alleviate pain, restore joint function and improve overall quality of life, particularly in individuals whose symptoms persist despite conservative treatments [1]. Given the complex biomechanical nature of the knee joint, which bears considerable load during daily activities, achieving optimal alignment and soft tissue balance during TKA is crucial for long-term success and patient satisfaction.

The choice of arthrotomy technique in TKA plays a critical role in the overall surgical outcome, influencing both the intraoperative exposure and postoperative recovery. The most commonly used techniques include the medial parapatellar, subvastus and midvastus arthrotomies. Each of these methods offers distinct advantages and potential limitations and the selection of technique is often tailored to the anatomy of the patient, the preference of the surgeon and the specific demands of the procedure [2,3].

The medial parapatellar approach remains the gold standard for many surgeons, offering excellent exposure to the knee joint by displacing the patella laterally. However, this technique requires the transection of the quadriceps tendon, which can result in

postoperative quadriceps weakness, delayed rehabilitation and increased pain in the early postoperative period [4]. However, quadriceps muscle weakness can persist long after surgery, affecting the patient's functional recovery and satisfaction [5].

In an effort to mitigate the impact on the quadriceps mechanism, less invasive approaches such as the subvastus and midvastus techniques have gained popularity. The subvastus approach, which involves accessing the knee joint by retracting the vastus medialis muscle without cutting the quadriceps tendon, offers the advantage of preserving muscle integrity [6,7]. This technique has been associated with reduced postoperative pain and faster rehabilitation [8]. However, it is technically more challenging and may provide limited visualization of the joint, particularly in obese patients or those with complex deformities.

The midvastus approach, first introduced to combine the benefits of both the medial parapatellar and subvastus techniques, has emerged as a viable alternative in recent years. In this technique, the arthrotomy is performed through the fibers of the vastus medialis, preserving the quadriceps tendon while still providing sufficient exposure to the joint [9]. Clinical studies have demonstrated that the midvastus approach results in less

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postoperative pain, quicker recovery of quadriceps strength and improved early functional outcomes compared to the medial parapatellar approach. Furthermore, patients undergoing TKA with the midvastus technique have reported higher satisfaction levels due to a more rapid return to daily activities and a shorter rehabilitation period [10].

The preservation of the quadriceps mechanism is a key factor in postoperative recovery following TKA. The midvastus technique's ability to maintain quadriceps integrity while ensuring adequate surgical visualization makes it particularly suitable for patients who require a quicker return to function, such as those with active lifestyles or lower preoperative muscle strength. Moreover, studies have suggested that this approach may be especially advantageous in elderly patients, where muscle weakness and comorbidities complicate the recovery process.

According to the midvastus arthrotomy technique, the vastus medialis muscle is split from the midline into two segments. In this article we aim to seek for the optimal incision angle of this separating line. Our primary aim is to identify a modification that could enhance the efficacy of the midvastus approach, while our secondary objective is to determine the incision orientations at which the technique becomes less optimal.

Material and Methods

This retrospective study was approved by the institutional review board of (XXx) hospital and all data were collected from hospital records in accordance with ethical standards.

The first group (n=60) underwent TKA using the midline midvastus arthrotomy technique. In this group, the incision was made through the approximately midline fibers of the vastus medialis muscle, preserving the quadriceps tendon while allowing adequate visualization of the joint (Figure 1) (Table 1).



Figure 1. Midline incised midvastus arthrotomy.

Table 1: In the first group, the surgical approach involved an incision through the approximately midline fibers of the vastus medialis muscle.

Group	Age (mean ± SD)	Male (%)	BMI (mean ± SD)	Hypertension (%)	Diabetes (%)
Group 1	67.2 ± 6.1	40%	29.8 ± 3.5	45%	30%
Group 2	66.5 ± 5.9	42%	30.1 ± 3.7	48%	32%
Group 3	66.9 ± 6.3	39%	29.6 ± 3.3	44%	29%

The second group (n=60) underwent a horizontal midvastus incision, where the arthrotomy was made more medially along the muscle belly of the vastus medialis in a transverse direction. Although this incision ran more horizontally than the standard midline, it remained intramuscular and distinct from the true subvastus approach, which involves retraction of the muscle without incision (Figure 2) (Table 2).



Figure 2. Horizontally incised midvastus arthrotomy.

Table 2: The second group (n=60) underwent a horizontal midvastus incision, in which the arthrotomy was performed more medially along the muscle belly of the vastus medialis in a transverse direction.

Time Point	Group 1 (mean ± SD)	Group 2 (mean ± SD)	Group 3 (mean ± SD)
VAS 10d	4.8 ± 1.1	3.6 ± 1.0	2.8 ± 0.9
VAS 1m	3.9 ± 1.2	2.9 ± 1.1	2.1 ± 0.8
VAS 3m	2.7 ± 1.0	2.1 ± 0.9	1.5 ± 0.7
OKS 10d	28.3 ± 4.6	32.1 ± 5.0	34.5 ± 5.4
OKS 1m	34.2 ± 5.1	37.8 ± 5.3	39.1 ± 5.6
OKS 3m	38.9 ± 4.9	41.5 ± 5.2	43.0 ± 5.4

Lastly, the third group (n=60) underwent TKA using a more vertically oriented midvastus arthrotomy, where the incision was performed laterally at a steeper angle to allow for potentially improved access while still preserving the integrity of the quadriceps muscle (Figure 3) (Table 3).



Figure 3. Vertically incised midvastus arthrotomy.

Table 3: The third group (n = 60) underwent total knee arthroplasty (TKA) using a more vertically oriented midvastus arthrotomy.

Group	Blood Transfusion (%)	Reported Numbness (%)
Group 1	30%	18%
Group 2	22%	14%
Group 3	12%	8%

All surgeries were performed by the same surgical team, utilizing the same implant design and fixation method to reduce variability. In each case, the same type of cemented prosthesis was used and all patients received a posterior-stabilized knee design (Trausson, powered by Styker, USA). Standardized perioperative protocols, including anesthesia, postoperative pain management and rehabilitation, were applied to all patients to ensure consistency in care. Only difference were the angle of the arthrotomy incision (Figure 4).

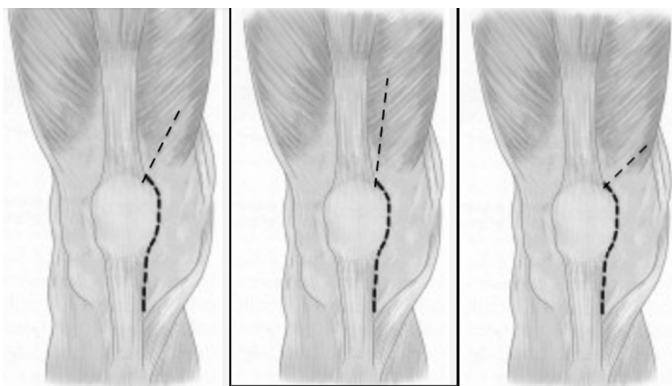


Figure 4. All 3 different incision angles demonstrated; midline, vertical and horizontal.

The primary outcomes of interest were postoperative pain, measured using the Visual Analog Scale (VAS) and functional recovery, assessed using the Oxford Knee Score (OKS) at regular intervals (10 days, 1 month and 3 months postoperatively). Additionally, secondary outcomes such as intraoperative blood loss, the requirement for blood transfusions and the incidence of wound complications were recorded.

The patients were followed for a minimum of 3 months postoperatively and data collection was carried out by independent assessors who were blinded to the surgical approach used in each case. Statistical analysis was conducted using analysis of variance (one-way ANOVA) to compare continuous variables between the three groups and post hoc Bonferroni correction test was applied for pairwise comparisons. A p-value of <0.05 was considered statistically significant.

Results

The overall structure of the data and the variables involved were analyzed to determine if there were significant differences among the postoperative outcomes of the three patient groups. Specifically, the study aimed to evaluate the differences in postoperative blood transfusion rates, Oxford Knee Scores (OKS) at 10 days, 1 month and 3 months, Visual Analog Scale

(VAS) scores at similar intervals and the incidence of numbness.

To compare the mean differences between the groups, we applied an analysis of variance (one-way ANOVA) test. If the one-way ANOVA test revealed statistical significance, post-hoc analyses were conducted to identify which groups differed from each other.

One-way ANOVA and chi-square tests were performed to assess significant differences among the groups in terms of postoperative blood transfusion rates, OKS scores (at 10 days, 1 month and 3 months), VAS scores (at 1 day, 3 days, 10 days, 1 month and 3 months) and the incidence of numbness. The results showed that postoperative blood transfusion rates had a p-value of 0.007, indicating a significant difference among the groups. The postoperative 10th day OKS scores yielded a p-value of 0.00021, while the postoperative first month OKS scores produced a p-value of 0.0165. At 3 months, the OKS scores showed a p-value of 0.012. For the VAS scores, the first postoperative day values resulted in a p-value of 0.105, while the 3-day scores had a p value of 0.00051. The 10th day VAS scores showed a p value of 0.00237. The first month postoperatively VAS scores presented a p value of 0.0149 and the 3rd month VAS scores had a p-value of 0.048. Chi-square analysis of numbness resulted in a p-value of 0.00166, indicating significant differences between the groups.

Further tests were performed to identify specific group differences where the one-way ANOVA tests revealed statistical significance. In terms of postoperative blood transfusion rates, first and second groups differed significantly with a mean difference of 0.50 (p-value 0.013) and between Group 1 and Group 3 with a mean difference of 0.58 (p-value 0.002). However, there was no significant difference between Group 2 and Group 3. The 10th day OKS scores showed significant differences between Group 1 and Group 2, (p-value 0.002) and between Group 1 and Group 3 (p-value 0.003). No significant difference was found between Group 2 and Group 3 in this parameter. For the 1st month OKS scores, there was a significant difference between Group 1 and Group 2 (p-value 0.005), but no significant differences were observed between other groups. Similarly, the 3rd month OKS scores showed a significant difference between Group 1 and Group 2 (p-value 0.003), but no significant differences between other group comparisons.

Regarding VAS scores, Group 1 and Group 2 showed a significant difference for the first day (p<0.005) and between Group 1 and Group 3 (p<0.005). No significant difference was found between Group 2 and Group 3. The third day VAS scores showed significant differences between Group 1 and Group 2 (p=0.002) and between Group 1 and Group 3 (p=0.001), but not between Group 2 and Group 3. For the 10th day VAS scores, significant differences were found between Group 1 and Group 2 (p=0.002) and between Group 1 and Group 3 (p=0.027), but no significant differences were found between Group 2 and Group 3. The postoperative first month VAS scores showed a significant difference between Group 1 and Group 2 (p=0.023), but no statistically significant differences between other groups. Finally, for the 3rd month VAS scores, Group 1 and Group 2 differed significantly (p=0.049), while no significant differences were found between other comparisons (p>0.05).

These results indicate that significant differences were observed between the groups for postoperative blood transfusion rates, OKS scores (at 10 days, 1 month and 3 months), VAS scores (at 1 day, 3 days, 10 days, 1 month and 3 months) and the incidence of numbness. Post-hoc analyses revealed specific group differences in the measured variables. These findings suggest that different treatment groups exhibited statistically significant variations in performance across various outcomes. Further detailed analysis of the variables with significant differences will help clarify the clinical relevance of these findings.

Discussion

The primary aim of this study was to evaluate the early postoperative outcomes of three different variants of the midvastus arthrotomy technique used in Total Knee Arthroplasty (TKA), specifically focusing on their impact on functional recovery, pain levels and blood transfusion requirements. The results demonstrated that there were significant differences between the groups, particularly in terms of postoperative pain, functional scores and blood transfusion rates. These findings align with previously published data while also providing new insights into the clinical advantages of less invasive techniques such as the midvastus approach [11,12].

One of the key findings in our study was the significant reduction in blood transfusion rates in the vertically oriented midvastus group compared to both the standard midvastus and the subvastus-like groups. Blood loss during TKA is an important concern. The preservation of the quadriceps mechanism in this technique likely contributes to reduced intraoperative trauma and, consequently, lower bleeding.

Midvastus approach for arthrotomy can cause more perioperative bleed relatively to the other conventional approaches. Muscles are well vascularised body parts [13]. Furthermore, muscles are more vascularised than tendons, especially in the lower extremity. In the medial parapatellar approach and subvastus approach the tendinous parts get incised. However the midvastus approach defines to cut the muscle into two parts from the middle of VMO muscle [14]. Our study showed statistically significant reduce in the postoperative blood transfusion rate amongst the group 3. The results imply that vertically oriented incisions, the perioperative bleed reduces. It is mainly due to vascularisation of medial superior genicular artery rising from the popliteal artery. Thus, more vertical incisions may anatomically distance the cut from major vascular structures, this may contribute to reduced perioperative blood transfusion rates [12]. Additionally, midline incisions often involve a larger volume of muscle disruption, on the other hand if the muscle cut angled vertically, the amount of muscle gets reduced [11]. Hence, vertical incision can help to laterally evert the patella easier, such as in the medial parapatellar approach. Therefore, in Group 3 the average incision is shorter than the others, especially rather than group 2.

In terms of postoperative pain, the group 3 consistently showed statistically significant lower VAS scores at various time points, particularly at 10 days and 1 month. These results corroborates findings from previous studies that have shown a correlation between less invasive arthrotomy techniques and reduced

postoperative pain. For example, Haas, et al. found that the midvastus approach results in less postoperative discomfort compared to the traditional medial parapatellar approach, likely due to the preservation of the extensor mechanism. However, in this study we did not compare midvastus approach with other arthrotomy techniques, because all 180 patients had an intact patellar tendon, the significant results in the group 3 may be conclusion of the decreased amount of the damaged muscle and the shortened arthrotomy incision length. Also in this study all the patellas were everted for better visualisation of the joint [15]. The vertically oriented midvastus technique in our study seems to further enhance these benefits, suggesting that the incision angle and preservation of muscle integrity play critical roles in pain management.

Functional recovery, assessed through the Oxford Knee Score (OKS), also demonstrated a faster improvement in the group 3, with statistically significant differences noted at 10th days, 1st month and 3rd months postoperatively. These outcomes support the growing body of evidence that muscle-sparing techniques, particularly those that avoid direct damage to the quadriceps tendon, promote quicker recovery of joint function. Previous studies demonstrated that midvastus techniques, offer superior early functional outcomes when compared to the traditional medial parapatellar technique. Our findings, specifically regarding the vertically oriented midvastus group, reinforce these conclusions and highlight the importance of incision orientation and technique refinement in optimizing early recovery [16,17].

It is also important to note the long-term implications of these early functional differences. While our study followed patients for only 3 months, studies with longer follow-up periods have demonstrated that early functional improvements often predict better long-term outcomes. Previous studies concluded that patients who experience faster recovery in the early postoperative period tend to maintain better overall function and satisfaction at 1 and 2 years postoperatively [18]. This suggests that the early benefits observed in the vertically oriented midvastus group in our study could translate into improved long-term results, although further research with extended follow-up is required to confirm this hypothesis because there are also many studies in literature that showed early better functional outcomes but similar results in the long period [19-22].

One of the secondary outcomes in our study was the incidence of numbness, which is often underreported but can significantly affect patient satisfaction following TKA. We found a statistically significant difference in the incidence of numbness among the groups, with the vertically oriented midvastus group having the lowest rates. Previous studies which noted reduced rates of sensory deficits in patients undergoing quadriceps-sparing TKA. The reduced incidence of numbness in our study further supports the potential advantages of refined midvastus techniques in preserving soft tissue integrity [14].

Despite the strengths of our study, including its retrospective design and standardized surgical and rehabilitation protocols, there are limitations that must be acknowledged. First, the relatively short follow-up period of 3 months limits our ability to assess long-term functional outcomes and complications

such as prosthetic loosening or wear. While early postoperative outcomes are critical for understanding the immediate benefits of different surgical techniques, future studies with longer follow-up are necessary to fully evaluate the durability of these results. Additionally, although the groups were stratified based on key variables such as age, sex and body mass index, the study's single-center design may limit the generalizability of the findings. Multicenter studies with larger sample sizes are warranted to confirm the reproducibility of these results across different patient populations and surgical teams.

Another important limitation is the inability to account for inter-individual anatomical variation in the orientation of Vastus Medialis Obliquus (VMO) fibers. Since no intraoperative imaging or mapping was performed, the exact degree of alignment between incision direction and muscle fibers could not be quantified. Moreover, functional assessments such as quadriceps strength and patellar tracking were not included. These could influence both recovery and patient-reported outcomes. Future prospective studies with imaging validation, standardized functional metrics and longer follow-up durations are essential to corroborate these findings.

Conclusion

In conclusion, this retrospective study provides insights into the comparative outcomes of three midvastus arthrotomy techniques in TKA. The vertically oriented modified incision was associated with reduced pain, lower transfusion rates and faster recovery. These findings support the potential value of tailoring incision angles based on anatomical fiber direction. Further prospective and anatomically guided studies are required to validate and refine these observations.

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