

Pain Relief and Mobility Post-Total Knee Arthroplasty: Insights from Medial Parapatellar and Low Midvastus Surgical Techniques

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Abstract

This is Total Knee Arthroplasty (TKA); one of the most commonly performed orthopedic procedures to relieve pain and restore mobility in patients with advanced degenerative degeneration of the knee joint, most commonly due to osteoarthritis or trauma. Surgical technique has a big role in the success of TKA with the medial parapatellar and low midvastus approaches being the two most commonly used techniques. For years, the medial parapatellar approach to the knee has been considered the gold standard, offering excellent surgical exposure guaranteeing accurate prosthetic positioning. Unfortunately, this is a far more invasive technique associated with more post-operative pain, muscle disruption and a slower recovery time for patients. However, the low midvastus approach is less traumatizing to the surrounding tissues and therefore is considered more muscle sparing. While there appears to be slightly less joint exposure compared to the medial parapatellar technique, this results in reduced postoperative discomfort and faster early recovery. The goal of the present study was to compare these two approaches in terms of their impact on postoperative outcomes including pain levels, recovery time, and improvement in overall functional improvement. Then, evidence from several clinical studies was analyzed in order to give a full picture of the pros and cons of both approaches. The results help the surgeon decide which surgical technique to select for any given patient's needs, and also to improve overall longterm results.

Keywords: Arthroplasty, Knee joint degeneration, Low Midvastus, Medial Parapatellar, Total Knee Arthroplasty (TKA).

Introduction

Due to a global aging population in conjunction with an increased prevalence of knee joint degenerative diseases, including osteoarthritis, Total Knee Arthroplasty (TKA) is one of the most commonly performed orthopedic surgeries worldwide. Approximately 700,000 TKAs are performed each year in the United States alone and this number will only continue to grow in the coming decades as the aging Baby Boomer generation only grows. With the demand for knee replacements expected to increase by almost 700 percent by 2030, according to the American Academy of Orthopaedic Surgeons (AAOS), this procedure has become a much sought after procedure. The same trends are followed in developed nations around the world where the number of knee replacement surgeries is rising because of it, increase in life expectancy, sedentary lifestyles, and an increase in obesity which are all

responsible for knee joint degeneration and arthritis. The main purpose of TKA is to relieve debilitating pain and improve the range of motion for patients suffering from end stage knee arthritis, so that they can return to normal daily activities, to improve the quality of their lives and regain independence. TKA has been shown to be very successful at pain reduction and functional restoration, but the approach used during surgery is a crucial part of the recovery process. Two techniques for TKA, medial parapatellar and low midvastus (1), have differing effects on postoperative outcomes. Although invasiveness generally leads to more postoperative pain and slow recovery, the traditional method of the medial parapatellar approach gives the surgeon an excellent joint exposure for proper implant alignment. In turn, the low midvastus approach is a less invasive approach, as the muscles and soft

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tissues are spared, with this potentially benefiting from less pain and a faster recovery time. In order to optimize the routine benefits of TKA surgery with regard to pain relief and restoration of mobility, it is therefore crucial to understand the nuances of these techniques.

The Importance of Total Knee Arthroplasty (TKA)

Total Knee Arthroplasty (TKA) has become the gold standard of modern orthopedic care, giving patients with severe degeneration of the knee joint

a life-altering solution. Diseases like osteoarthritis, rheumatoid arthritis, and post-traumatic arthritis lead to chronic pain, joint deformities, and serious limitations in mobility. Such disabling effects can seriously impair a patient's ability to perform everyday activities, thereby ultimately reducing their quality of life. These people can be guided toward pain relief and functional restoration through TKA, which in turn will help them regain independence and participate more fully in their personal and professional lives.

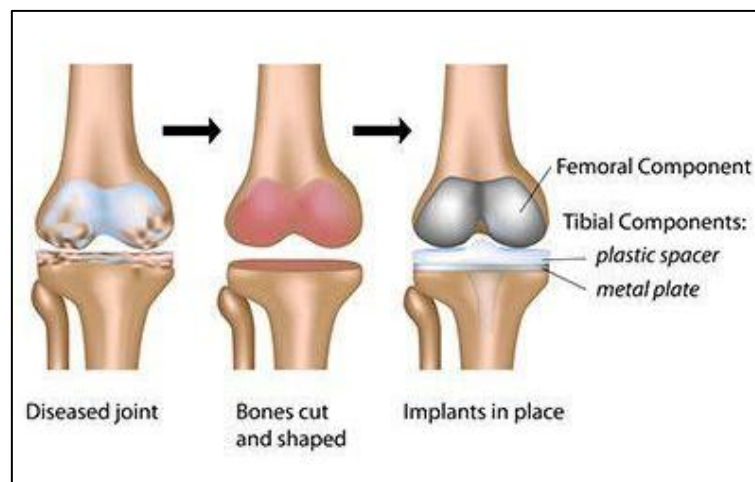


Figure 1: Total Knee Arthroplasty

Total Knee Arthroplasty (TKA) is a process represented by Figure 1. The diseased knee joint, as is typical in conditions like osteoarthritis, is injured and the cartilage and bone is damaged, as shown on the first panel. In the second panel, we cut and shape the bones in preparation for the implantation of the artificial parts. The final panel shows the implants in place: On the thigh bone the femoral component is placed, while the tibial components (a plastic spacer and metal plate) are positioned on the shinbone in order to create a functional, pain free joint. It's designed to ease pain and return your movement.

Reconstructive TKA aims to exchange the damaged and diseased portion of the knee joint with implants that are mimics of their natural counterparts to provide joint movements similar to their normal state. Through the evolution of prosthetic design and its materials, many improvements have led to the making of more reliable and durable results. This, of course, coincides with improvements in the surgical techniques, making TKA now a high success procedure because most of the patients who undergo surgery can now expect huge relief from

the pain and significant mobility improvements within weeks after surgery. It is one of the most commonly performed and highly successful orthopedic procedures globally.

Despite these advances, the success of TKA is not determined by the prosthetic device alone. The surgical approach chosen has a significant impact on both short-term and long-term success of the procedure. Surgical techniques differ in their invasiveness, tissue handling, and effects on surrounding structures, all of which affect postoperative pain, recovery time, and functional results. The approach chosen should be a compromise between ensuring that there is sufficient surgical exposure for accurate implant placement and the trauma to the soft tissues and muscles.

For decades, the parapatellar approach has served as a gold standard technique used in TKA: simplicity and exceptional visualization of the knee joint are considered major advantages. However, with all the destructive effects on the tendon within the quadriceps, it often leads to increased post-operative pain and slower recovery (2). The introduction of less invasive techniques has

opened new avenues for improving patient outcomes, including the low midvastus approach. By preserving muscle integrity, the low midvastus approach minimizes tissue trauma, potentially reducing pain and accelerating functional recovery.

Overview of Surgical Approaches in TKA

Success of TKA mainly depends on the surgical technique followed since it is one of the determining factors affecting the postoperative outcome in pain control, the speed of recovery, and ultimate functional ability. Two of the commonly used approaches include medial parapatellar and low midvastus techniques. These two methods vary in different benefits and limitations; hence the surgeon often relies on the type of surgical approach by understanding the individual's needs

and surgeon's preferences to achieve certain desired outcomes in postoperative periods.

The medial parapatellar approach has been considered the gold standard approach in TKA. In this approach, a vertical incision is made through the quadriceps tendon and medially around the patella to expose the knee joint. This creates excellent visibility that allows for accurate alignment and positioning of the prosthetic components, which is critical for the longevity and functionality of the implant. This level of exposure is particularly beneficial in patients with severe joint deformities, complex anatomy, or restricted range of motion. These are some of the valid reasons why the medial parapatellar approach is still the preferred procedure in challenging cases that call for better surgical access.

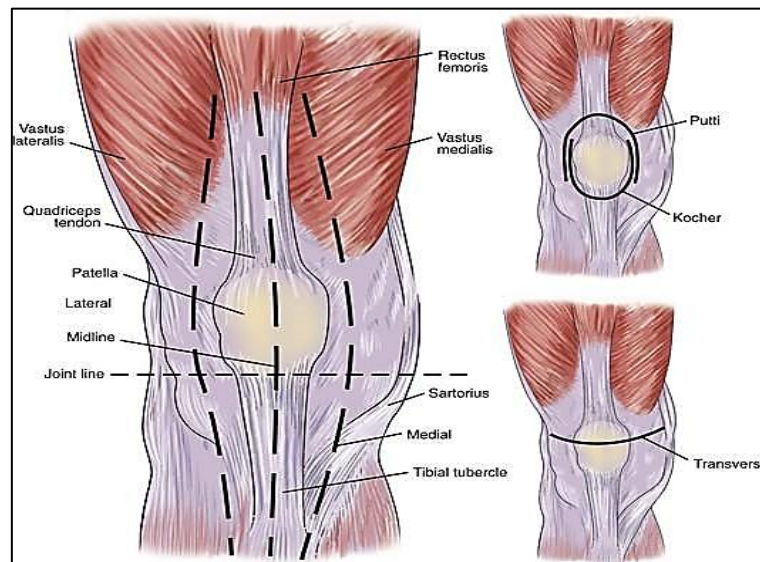


Figure 2: Surgical Approaches in Total Knee Arthroplasty

The image below shows the anatomy of the knee, including important muscles involved in knee surgery or rehabilitation. It shows the quadriceps tendon and the four muscles of the quadriceps group: all of which include vastus lateralis, vastus medialis, rectus femoris, and the sartorius (Figure 2). The patella (kneecap), tibial tubercle, and the joint line are all labeled on the image. It also includes anatomical landmarks like the lateral, medial, the cardinal middle region, transverse plane, etc. Distortions, associated with the relative motion of skin across the knee, obscure the structure of muscles and tendons, which are critical to understanding the anatomy prior to surgical approaches such as Total Knee Arthroplasty (TKA).

The medial parapatellar approach, however, is not without disadvantages. Being very invasive in nature, the approach involves the tearing of the quadriceps tendon and surrounding soft tissues, often with significant post-operative pain and inflammation. Such a disruption would deter early mobilization and would likely prolong recovery times, requiring intense physiotherapy to recover strength in muscles and flexibility in joints. Studies have also shown that patients who receive this treatment may have delayed attainment of full knee flexion and extensor strength, which are important components of functional recovery.

In contrast, the low midvastus approach has become increasingly popular in recent years as a less invasive alternative. Instead of cutting through

the quadriceps tendon, this technique splits the muscle fibers of the vastus medialis obliquus to access the knee joint. This preserves the extensor mechanism and minimizes soft tissue trauma, reducing the inflammatory response, thereby improving post-operative outcomes. Patients treated by this method tend to have fewer post-operative days with pain and allow for an earlier start of rehabilitation activities and the resumption of movement.

The muscle-sparing nature of the low midvastus approach also enables quicker restoration of quadriceps strength, which is important for functions such as walking, stair climbing, and stabilizing the joint. However, this technique does not come without its challenges. It demands higher surgical expertise in order to get adequate exposure without compromising the surrounding structures (3). Its use may also be limited in the case of patients with severe joint deformities or considerable soft tissue scarring, as more extensive visualization of the joint may be required.

Both techniques have their merits, and neither is universally superior. While the medial parapatellar approach excels in providing comprehensive joint exposure for complex cases, the low midvastus approach offers clear advantages in terms of reduced pain and faster recovery for less complicated scenarios. The choice between these techniques should be carefully made in relation to

the individual patient's pre-operative mobility, muscle strength, and overall health status. This way, the selected technique will best meet the needs of the patient, and the results of the TKA procedure will be maximized. Objectives of this study are, (a) to compare the medial parapatellar and low midvastus approaches in total knee arthroplasty (TKA) with respect to pain relief and mobility restoration, (b) to evaluate the clinical evidence on the advantages and limitations of each surgical approach, (c) to assess the impact of both techniques on patient recovery outcomes, including pain management and knee function, (d) to provide recommendations for tailoring surgical strategies to individual patient needs to optimize outcomes and enhance satisfaction.

Methodology

Surgical Techniques

Medial Parapatellar Approach: The medial parapatellar approach is commonly employed in TKA because it is versatile and because excellent surgical exposure can be easily achieved. It involves a vertical incision through the quadriceps tendon, extending medially around the patella (4). Access to the femoral and tibial surfaces for the meticulous implantation of the prosthesis is thereby accomplished by reflection of the patella laterally.

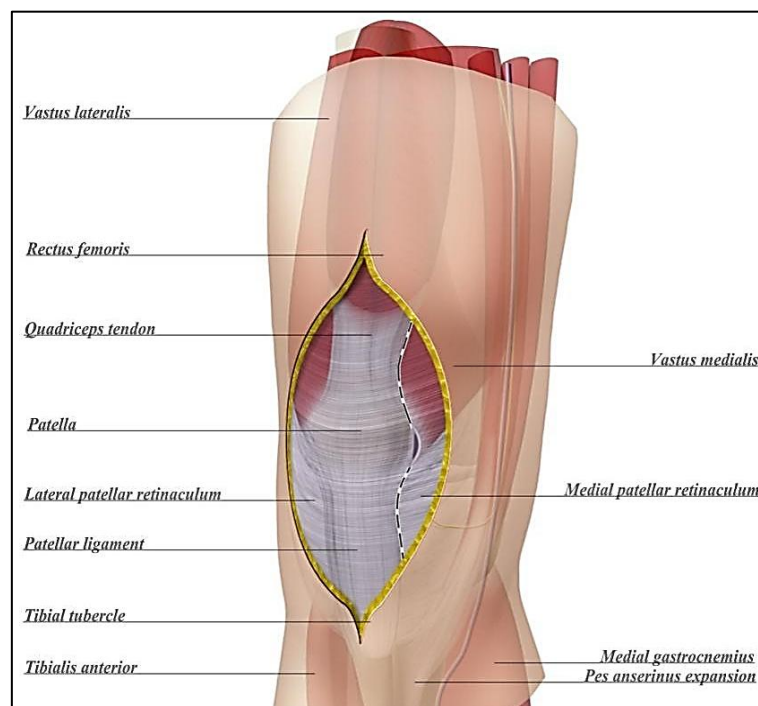


Figure 3: Knee Medial Parapatellar Approach

In Figure 3, there is a detailed anatomical illustration of the knee joint, looking at the muscles, tendons and ligaments around the patella. The vastus lateralis and vastus medialis muscles that make up the quadriceps group as well as rectus femoris, which also help to extend the knee, are all labeled. The quadriceps tendon attaches the muscles to the patella, while the patellar ligament attaches the patella to the tibial tubercle. The patella is also stabilized by the lateral and medial patellar retinaculum figuring in the figure. Furthermore, muscle and ligament interaction key to knee functioning and stability are labeled, namely, medial gastrocnemius, and pesanserinus expansion.

This technique offers simplicity, reliability, and appropriate suitability for severely deformed patients or those who have limited mobility of the

involved joint. Its major drawback, however, lies in its interruption of the extensor mechanism; this leads to increased postoperative pain and late functional recovery (5). The study demonstrates that the procedure requires more rehabilitation for patients after surgery, primarily because of strength and range of motion loss for the quadriceps in the first period after the surgery.

Low Midvastus Approach: The low midvastus approach is a muscle-sparing alternative to the more traditional medial parapatellar approach. It also involves a smaller incision that is made anterior to the quadriceps tendon without being transverse (6). This can split a portion of the vastus medialis obliquus fibers. This technique preserves the integrity of the extensor mechanism and minimizes disruption to surrounding tissues for more rapid recovery.

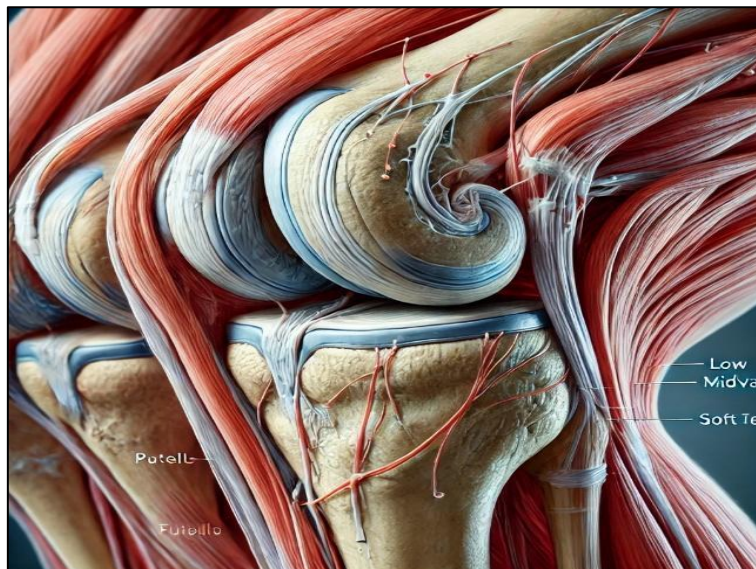


Figure 4: Low Midvastus Approach

The figure 4 shows the detailed extent of the anatomy of the knee joint from an overview of the structures surrounding the patella and tibia. It reveals the soft tissue structures of the knee — muscles, tendons, and ligaments — that help the knee work and stay stable. In front of the knee the patella (kneecap) is shown and the femur and tibia make up the joint. A surgical approach, or "Low Midvastus," is labeled as well as the anatomical area referred to as "Soft Tissue," the muscles and tendons surrounding the knee. It shows the finely interwoven tissues that give us knee movement and support.

Clinical studies showed that the midvastus approach resulted in significantly lower levels of post-operative pain and quicker return of

quadriceps function. But the technique, as with other techniques, presents challenges. Significant deformities are complicated by less exposure, while greater technical competence is required for proper alignment of the prosthesis.

Results and Discussion

Post-Operative Pain Relief

Pain management plays a crucial role in determining the patient's postoperative satisfaction and functional recovery following total knee arthroplasty (TKA). Effective pain control not only enables early mobilization but also reduces psychological stress related to postoperative discomfort (7). Among the surgical approaches for TKA, there has been increased interest in the

medial parapatellar and low midvastus techniques regarding their effect on postoperative pain and recovery curves.

The medial parapatellar approach, one of the most popular used techniques, allows for access into the knee by incision on the quadriceps tendon for adequate visualization and exposure during surgical procedures. Such a procedure results in ample visibility for better performance of a procedure but damages considerably the extensor mechanism together with other soft tissues. This approach is generally invasive, resulting in marked post-operative inflammation and pain, mainly in the first week of recovery (8). As such, patients receiving this technique often exhibit higher pain scores and more analgesic use within the first weeks following surgery.

The low midvastus approach has become an alternative that spares the quadriceps tendon and preserves the integrity of the extensor mechanism, thereby minimizing muscle disruption and soft tissue trauma, thus greatly reducing inflammation in the operative site. Clinical trials have consistently shown that patients who underwent the low midvastus approach had lower pain scores within the first six weeks post-surgery compared to those treated with the medial parapatellar approach. This reduced pain perception is due to decreased nerve irritation and faster resolution of surgical edema. Numerous studies related to pain relief in total knee arthroplasty (TKA) is described in Table 1.

Table 1: Studies Related to Post-Operative Pain Relief in Total Knee Arthroplasty (TKA)

Topic Covered	Research Study	Title	Reference
Post-operative pain relief in TKA: Comparison of approaches	Randomized, double-blinded study comparing mini-midvastus vs medial parapatellar approach	Mini-midvastus versus medial parapatellar approach in total knee arthroplasty: A prospective, randomized, double-blinded study	(9)
Enhanced recovery after surgery protocols in TKA via midvastus	Cohort study on enhanced recovery protocols in midvastus TKA	Enhanced recovery after surgery protocols in total knee arthroplasty via the midvastus approach: A prospective cohort study	(10)
Recovery outcomes in TKA with midvastus approach	Study on mid-vastus TKA and gait balance control recovery	Mid-vastus total knee arthroplasty for medial osteoarthritis recovers gait balance control in older individuals	(11)
Comparison of midvastus vs medial parapatellar in bilateral TKA	Randomized controlled trial on simultaneous bilateral TKA	Midvastus Versus Medial Parapatellar Approach in Simultaneous Bilateral Total Knee Arthroplasty: A Randomized Controlled Trial	(12)
Impact of mini-midvastus approach on recovery	Study on rapid recovery protocols in mini-midvastus TKA	Does mini-midvastus approach have an advantageous effect on rapid recovery protocols during total knee arthroplasty?	(13)

With its approach, lower midvastus minimizes disruption during transitions in postoperative rehabilitation. Muscle preservation thus ensures

restored early function about the knee-a feature that directly promotes faster average rehabilitation profiles. Rapid resumption of activities with

weights in place or patients returning relatively quicker to these loads, including significantly enhanced post-TKA motion in the affected knee, support quick restoration and more independence post-injury. In addition, lesser use of analgesics diminishes the likelihood of side effects in pain management such as gastrointestinal discomfort and sedation, making it even better for the patient.

Impact on Mobility and Functional Recovery

The choice of surgical approach in total knee arthroplasty (TKA) plays a significant role in determining both mobility and functional recovery in the post-operative phase. The medial parapatellar approach, a traditional and widely used method, provides excellent exposure to the knee joint, facilitating the surgeon's ability to address complex anatomical structures. The incision to be made, however, crosses the quadriceps tendon, causing destruction of the extensor mechanism. This further creates a larger level of muscle weakness postoperatively. Since early mobilization in the hospital requires stability in the knee joint for weight-bearing activities, the impairment occurs at an earlier stage during this process of rehabilitation. The patients who receive this treatment tend to have slower recovery in terms of knee ROM and muscle strength, especially in the first weeks after surgery (14). Loss of muscle strength of the quadriceps muscles further makes patients lose the power needed for movements that may prove basic to postoperative patients, including rising from sitting position and climbing upstairs, two basic requirements to prove their post-surgical functionality. Due to these problems, most patients undergo a strong course of physiotherapy and rehabilitation programs that may include maximum knee flexion and extension exercises for restoration of their strength of quadriceps. The early rehabilitation process, then, is likely to last longer and require more frequent physiotherapy sessions.

Conversely, the low midvastus technique is considered to be a more muscle-sparing technique and offers a different recovery course. This method preserves the quadriceps muscle, thus minimizing damage to the extensor mechanism. This leads to faster restoration of quadriceps function. The low midvastus technique results in less postoperative muscle weakness and allows for faster improvement in both knee flexion and extensor

strength. Clinical studies have shown that patients who received this approach gained greater knee flexion and more powerful extensor muscles within the first three months post-operatively compared to patients who received the medial parapatellar approach. This early advantage in functional recovery may allow a smoother and quicker transition to normal daily activities and physical rehabilitation. In particular, a better recovery in muscle tone and strength with preserved muscle integrity characterizes the recovery process of this low midvastus approach. The potential for earlier discharge and reduced lengths of stay arises from patients that are less complaining about their recoveries as not being too tiresome or uncomfortable as they quickly accomplish milestones like getting out of bed without the help of walkers, crutches, or wheel chairs and achieving prestroke levels of activity.

Despite these early benefits, long-term functional outcomes between the two techniques tend to become comparable; soon, both techniques result in similar outcomes regarding knee function, ROM, and muscle strength. Over a long period of time, the benefits of faster earlier recovery present with the low midvastus technique tend to dwindle and both groups of patients finally get to rehabilitation and the quadriceps muscle strength improve. By one year postoperatively, most patients have achieved the same level of function in regard to daily ambulation, strength, and stability regardless of whether an open or endoscopic technique is used (15). Consequently, whereas early functional recovery might be more optimal with the low midvastus approach, both approaches have similar long-term functional recovery outcomes, and hence the choice of surgical approach should not significantly influence the final status of recovery in the patient. However, the low midvastus approach presents a lower requirement for intense rehabilitation, and it goes along with early recovery without being as turbulent, making it more appealing for selected patient populations seeking faster recovery after surgery.

Key Findings

This study compared medial parapatellar approach and low midvastus surgical technique performed in Total Knee Arthroplasty (TKA) and shows how the amount of post-operative pain and mobility can differ greatly. Although the medial parapatellar approach offered excellent exposure

and precision of prosthetic placement, the approach was more invasive and was associated with higher levels of postoperative pain and slower recovery. Patients who had undergone this approach needed more pain management and longer rehabilitation periods. Additionally, the low midvastus approach was less invasive and more muscle sparing and as a result caused less soft tissue trauma, less pain and a faster early recovery. Patients in the mini-midvastus group regained mobility more quickly, and had more functional outcome earlier on postoperatively. Both techniques also ultimately resulted in improved pain relief and long-term mobility, but with the low midvastus approach having advantages in terms of post operative comfort and recovery time. Our findings indicate that both approaches are equally effective, but the low midvastus may be favored for quicker recovery with less pain at the expense of slightly more limited surgical exposure than the medial parapatellar approach.

Conclusion

In this study, both medial parapatellar and low midvastus surgical techniques play significant roles in the relief of post-total knee arthroplasty pain and mobility. The medial parapatellar approach provides an excellent exposure of the joint but is generally associated with more post-operative pain and slower recovery due to its invasive nature. In contrast, the low midvastus approach provides better muscle-sparing and faster relief of pain along with improved early mobility, thus giving patients a much quicker return to functional activities. Thus, the surgical technique must also be individualized based on patient-specific factors like knee deformity, muscle strength, and rehabilitation goals.

Future Scope

Several key areas for future research into pain relief and mobility post-Total Knee Arthroplasty (TKA) could be expanded by comparison of the medial parapatellar and low midvastus surgical techniques. Second, studies could be made to further study the long-term results of both techniques, especially how they affect prosthetic durability, joint stability and functional durability with time. Understanding how initial differences in recovery and pain management may translate into success, or microsurgery in general, in the long run would make also a clearer understanding.

Second, potentially patient specific factors associated with the success of each surgical approach—age, body mass index (BMI), comorbidities, and activity level—could be investigated. Matching which patient characteristics make one surgical approach more beneficial than the other might then help tailor surgical decisions and improve individualized patient care.

Improved surgical techniques and technology could also become extremely important in continuing to reduce the invasiveness of the procedures. Yet, incorporating robotic assisted surgery, enhanced imaging, and minimally invasive technology may enable more precise implant placement, and decrease postoperative pain, recovery time, and secondary treatment, even further. This could also be researched in combination with novel pain management strategies aimed at complementing these surgical techniques, including local anesthetics, nerve blocks, advanced rehabilitation protocols, etc., to further improve recovery outcomes. Important comparisons can be made not only between the medial parapatellar and the low midvastus techniques but also other emerging surgical approaches, such as subvastus or minimally invasive techniques, to understand how each approach affects patient outcomes. It would direct future TKA techniques to increase pain relief and movement, and aid in the refinement of clinical practices based on its outcomes.

Abbreviation

None.

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Author Contributions

All authors contribute equally.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Ethics Approval

Not applicable.

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