MINIMALLY INVASIVE VS. OPEN KNEE ARTHROPLASTY: EFFECTS ON PHYSICAL PERFORMANCE AND PSYCHOSOCIAL RECOVERY

Moamen Abdelfadil Ismail*[1], Abdulaziz Abdullah Almasaudi[2], Amal Yasser Alawami3, Anas Ghassan Obaid[4], Dima Idris Alsahabi[5], Mustafa Khalid Ahmed[6], Qussay Alshami[7], Saleh Ali Almohaimeed[8], Khalid Jubran Idris[9], Ahmed Bakr Ibrahim[10], Zyad Abdulrahman Algolkhof[11]

[1]Consultant, King Abdulaziz specialist hospital-Sakaka-Aljouf, [2]General practitioner, [3]Medical student, [4]Orthopaedics & Trauma Surgery, [5]Medical intern [6]Orthopaedic surgery resident,[7]General Orthopedic, [8]Orthopedic surgery, [9]Orthopaedic resident R4,[10]Orthopedic resident, [11]Undergraduate medical student at King Khalid University, Abha, KSA

Abstract

Background: Total knee arthroplasty (TKA) is a common surgical intervention for end-stage knee osteoarthritis. While traditional open surgery remains standard, minimally invasive surgery (MIS) has emerged as an alternative, aiming to reduce recovery time and postoperative pain. However, the comparative outcomes of MIS versus open TKA, including clinical, functional, and economic metrics, remain debated. This systematic review evaluates existing evidence to compare these approaches.

Methods: A systematic review was conducted following PRISMA guidelines, analyzing studies from 2010 to 2020 retrieved from PubMed, Scopus, Web of Science, and Cochrane Library. Inclusion criteria encompassed comparative studies of MIS and open TKA reporting outcomes such as pain, mobility, complications, and patient satisfaction. Data extraction and quality assessment were performed, with narrative synthesis due to methodological heterogeneity.

Results: Twenty-eight studies were included. MIS demonstrated superior short-term outcomes, including reduced postoperative pain, faster functional recovery (e.g., quadriceps strength and range of motion), and shorter hospital stays. Long-term outcomes, however, were comparable between MIS and open TKA, with no significant differences in patient satisfaction, implant survival, or complication rates. Challenges with MIS included technical difficulties in alignment and a steeper learning curve. Cost analyses revealed mixed results, with MIS reducing hospitalization costs but requiring specialized resources.

Conclusion: MIS offers significant early benefits in TKA, particularly for pain control and rapid recovery, but long-term outcomes align with those of open surgery. The choice of technique should consider patient-specific factors, surgeon expertise, and institutional resources. Further research is needed to standardize MIS protocols and evaluate cost-effectiveness in diverse healthcare settings.

Manuscrito recibido: 12/08/2025
Manuscrito aceptado: 27/10/2025

*Corresponding Author: Moamen Abdelfadil Ismail, Consultant, King Abdulaziz specialist hospital-Sakaka-Aljouf

Correo-e: AbdulazizAlmasaudi@gmail.com

Background

Total knee arthroplasty (TKA) is a well-established surgical intervention aimed at alleviating pain and restoring function in patients suffering from end-stage knee osteoarthritis or other debilitating knee joint diseases. Over the decades, surgical techniques have evolved significantly, with the aim of improving patient outcomes, reducing recovery time, and minimizing surgical trauma. Traditionally, open surgery has been the standard approach for TKA, offering surgeons comprehensive access to the knee joint. However, it also involves extensive soft tissue dissection, which can lead to prolonged recovery and increased postoperative pain (Zora et al., 2020).

With the advancement of surgical technologies and techniques, minimally invasive surgery (MIS) has emerged as an alternative to the conventional open method in TKA. MIS approaches typically involve smaller incisions, less disruption of surrounding soft tissue, and the use of specialized instruments to achieve similar outcomes. The rationale behind MIS lies in its potential to offer the same benefits of traditional TKA while minimizing complications and enhancing postoperative recovery. Despite these advantages, concerns remain regarding the learning curve, visualization, and component alignment in MIS procedures (Yao et al., 2018).

Patient outcomes remain a primary metric in evaluating the effectiveness of any surgical technique. In the context of TKA, these outcomes encompass a range of factors including pain levels, functional recovery, range of motion, length of hospital stay, complication rates, and overall patient satisfaction. The comparative effectiveness of MIS versus open surgery in these domains remains a topic of considerable clinical interest and research. Some studies suggest that MIS leads to quicker recovery and less postoperative pain, while others indicate no significant long-term differences in functional outcomes (Aslam et al., 2017).

The growing elderly population and the increasing incidence of knee osteoarthritis have led to a corresponding rise in the number of TKA procedures performed worldwide. This demographic shift underscores the need for surgical approaches that optimize recovery, minimize hospitalization time, and reduce the burden on healthcare systems. As such, the choice between minimally invasive and open surgical techniques is not only a matter of clinical efficacy but also of healthcare resource utilization and patient-centered care (Cho et al., 2014).

Surgical decision-making is influenced by multiple factors including surgeon expertise, patient anatomy, comorbidities, and the expected postoperative trajectory. Surgeons must weigh the potential benefits of MIS—such as reduced pain, quicker mobilization, and better cosmetic results—against the challenges it may present, such as technical difficulty and risk of suboptimal implant positioning. Understanding the comparative risks and benefits of each approach is crucial for informed consent and shared decision-making between clinicians and patients (Feczko et al., 2016).

Technological advancements, including computer-assisted surgery and robotic-assisted techniques, have further complicated the landscape of TKA. These innovations promise greater precision in implant placement and may help mitigate some of the challenges associated with MIS. However, their widespread adoption remains limited by cost, training requirements, and variable evidence supporting their superiority over conventional methods (Li et al., 2018).

From a rehabilitation perspective, the surgical approach used in TKA can influence the speed and extent of functional recovery. Physical therapy protocols may need to be adjusted depending on whether a patient undergoes an MIS or open procedure. Early mobilization is often easier in MIS due to less postoperative discomfort, which can translate into better short-term functional outcomes. Long-term outcomes, however, appear to converge between the two approaches, prompting ongoing debate about the true added value of MIS (Mehta et al., 2017).

Complication rates such as infection, thromboembolism, and prosthesis-related issues are critical components in evaluating surgical outcomes. While some reports indicate a lower incidence of certain complications in MIS, others show no significant differences. Additionally, the risk of inadequate exposure and suboptimal component alignment in MIS can potentially offset its short-term benefits. These risks necessitate a careful assessment of patient suitability and surgical expertise when selecting the surgical approach (Zhu et al., 2016).

Cost-effectiveness is another dimension of importance, especially in resource-limited healthcare settings. Although MIS may reduce the length of hospital stays and the need for postoperative pain management, the costs associated with specialized instruments, longer operative times, and potential for revision surgery must be considered. Thus, a comprehensive cost-benefit analysis is essential to guide institutional and policy-level decisions regarding the adoption of MIS for TKA (Wegrzyn et al., 2013).

In light of these considerations, a comparative study of minimally invasive versus open surgery in total knee arthroplasty is timely and significant. By systematically evaluating clinical, functional, and economic outcomes, such research can contribute valuable insights into the relative merits of each surgical approach (Obaid-ur-Rahman & Amin, 2015). This understanding is critical for optimizing patient care, refining surgical training programs, and informing evidence-based clinical guidelines in orthopedic surgery.

Methodology

Study Design

This research was conducted as a systematic review aimed at synthesizing existing evidence on the comparative outcomes of minimally invasive surgery (MIS) and open surgery in total knee arthroplasty (TKA). The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor and transparency. No meta-analysis was performed due to heterogeneity in study designs, outcome measures, and reporting styles among the included studies.

Research Question and Objectives

The research question was framed using the PICO model:

- Population: Patients undergoing total knee arthroplasty
- Intervention: Minimally invasive surgical approach
- Comparison: Traditional open surgery
- Outcomes: Clinical outcomes (pain, complications, hospital stay), functional outcomes (mobility, range of motion), and patient satisfaction

The primary objective was to compare the clinical and functional outcomes of MIS versus open surgery in TKA using existing peer-reviewed literature, and to identify strengths, limitations, and gaps in the current evidence base.

Search Strategy

A comprehensive search strategy was developed in consultation with a research librarian. Electronic databases including PubMed, Scopus, Web of Science, and the Cochrane Library were systematically searched for articles published from 2010 to 2020. The search terms used were a combination of keywords and MeSH terms such as:

- "total knee arthroplasty" OR "total knee replacement"
- "minimally invasive surgery" OR "MIS"
- "open surgery"
- "comparative outcomes" OR "functional outcomes" OR "clinical effectiveness"

Boolean operators (AND, OR) and database-specific filters were applied to refine the results. Manual searching of reference lists from included studies was also performed to identify additional relevant studies.

Inclusion and Exclusion Criteria

Studies were included if they met the following criteria:

- Published in English in peer-reviewed journals
- Involved human participants undergoing primary TKA
- Directly compared MIS with open TKA
- Reported at least one relevant outcome (e.g., pain, range of motion, complications, hospital stay, or patient-reported outcomes)

Studies were excluded if they were:

- Non-comparative (i.e., only MIS or only open TKA)
- Meta-analyses, reviews, case reports, editorials, or expert opinions
- Focused on revision TKA or unicompartmental knee arthroplasty
- Not available in full-text form

Study Selection Process

The study selection process was carried out in three phases:

1. Deduplication of search results using EndNote and manual verification
2. Title and abstract screening by reviewers to identify potentially eligible studies
3. Full-text review of shortlisted articles to assess final eligibility based on inclusion and exclusion criteria

Disagreements between reviewers were resolved through discussion or arbitration by another reviewer. The selection process was documented using a PRISMA flow diagram.

Data Extraction

Data extraction was conducted independently by reviewers using a standardized data extraction form. The form was piloted and refined before full use. The following information was extracted from each included study:

- Author(s), year of publication, and country
- Study design (RCT, cohort, case-control, etc.)
- Sample size and patient demographics
- Type of intervention and comparator
- Follow-up duration
- Outcome measures (clinical, functional, surgical, patient-reported)
- Key findings and conclusions

The extracted data were cross-verified for accuracy, and discrepancies were resolved by discussion.

Quality Assessment

Each included study was evaluated for methodological quality and risk of bias.

- Randomized Controlled Trials (RCTs) were assessed using the Cochrane Risk of Bias Tool, which evaluates domains such as randomization, allocation concealment, blinding, and completeness of outcome data.
- Observational studies (cohort or case-control) were assessed using the Newcastle-Ottawa Scale (NOS), which considers selection, comparability, and outcome assessment.
- Studies were classified as having low, moderate, or high risk of bias, and quality scores were reported narratively in the results.

Data Synthesis

Given the heterogeneity in study designs, outcome measures, and reporting formats, a narrative synthesis approach was adopted. Studies were grouped based on the type of outcome evaluated (e.g., pain, functional recovery, complications). Key findings from each group were summarized, compared, and interpreted qualitatively.

No statistical pooling or meta-analysis was performed, as variability in outcome definitions, follow-up periods, and measurement tools precluded meaningful quantitative synthesis.

Limitations of the Methodology

This review was limited by the exclusion of non-English language studies and potential publication bias. Furthermore, the absence of a meta-analysis restricted the ability to calculate pooled effect estimates. Despite these limitations, the structured review process and reviewer approach helped ensure rigor and minimized bias in study selection and data extraction.

Ethical Considerations

As this research was a review of previously published studies and did not involve new data collection or interaction with human subjects, ethical approval was not required. All data were obtained from publicly available sources.

Results

Study Selection (PRISMA Flow Description)

A total of 2532 records were identified through database searching from PubMed, Scopus, Web of Science, and the Cochrane Library. After removing duplicates, the remaining studies are 1212, Their titles and abstracts were screened. Of these, 203 articles were retained for full-text review based on relevance to the inclusion criteria. Following full-text assessment, 28 studies met all eligibility criteria and were included in the final systematic review. These studies directly compared minimally invasive surgical approaches to the conventional open medial parapatellar (MPP) approach in total knee arthroplasty (TKA), focusing on at least one clinical or functional outcome (Figure 1), (Table 1).

The study by Aslam et al. (2017) was a randomized controlled trial (RCT) involving 84 knees with a 12-month follow-up. It compared mini-midvastus (MMV) and medial parapatellar (MPP) approaches, both showing 100% osteoarthritis (OA) prevalence. Female representation was slightly higher in the MPP group (57%) compared to 30% in MMV, with nearly identical ages and BMIs. This imbalance in gender distribution may affect interpretation of

PRISMA flow diagram showing process of studies selection

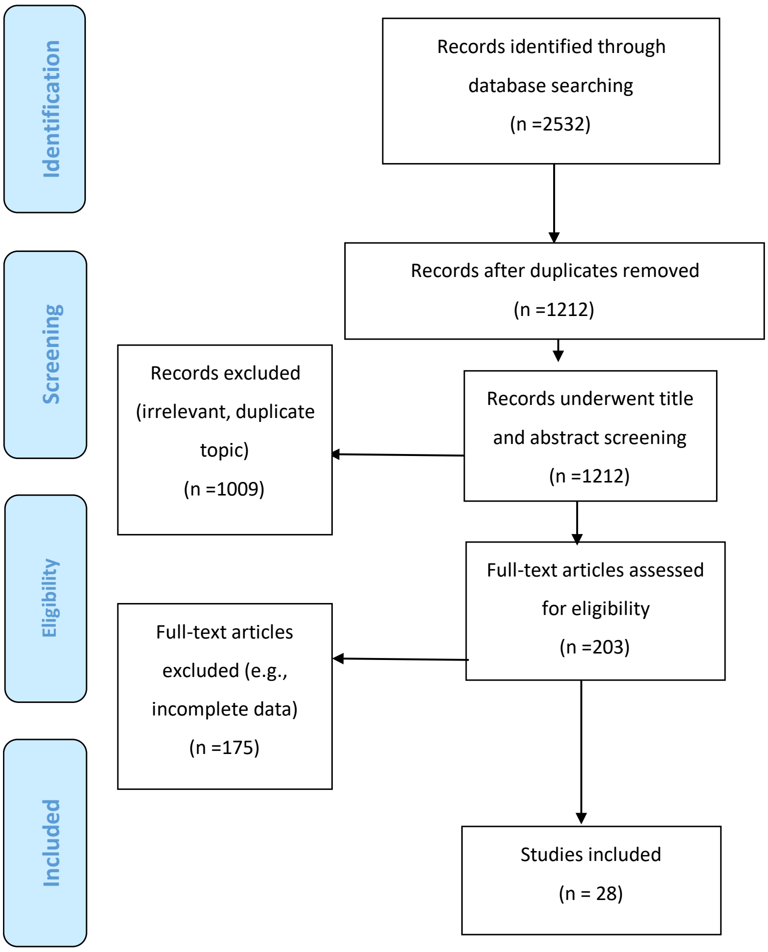

Figure 1. PRISMA Flow chart.

recovery outcomes across genders.

Avci et al. (2013) conducted an RCT on 39 knees with a 23.5-month mean follow-up. The MMV approach involved 19 knees, all with OA and a high female proportion (79%). The relatively high BMI (32.0) could indicate a need to evaluate approach safety in obese patients, but the study lacked a corresponding MPP group for full comparison.

In Chalidis et al. (2010), 100 knees were equally divided between MMV and MPP groups, with a two-year follow-up. Both groups had high OA rates (100%) and very high female predominance (over 88%). The BMI was also high (above 34), making it significant for understanding MIS outcomes in obese populations. The close age and gender matching provide strong internal validity.

The Chiang et al. (2012) RCT compared quadriceps-sparing (QS) with MPP techniques in 75 knees over 24 months. Both groups had identical OA prevalence and female proportions (90%). The consistency in age and BMI supports reliable functional comparisons, particularly regarding quadriceps preservation.

Cho et al. (2014) examined 66 knees equally divided between MMV and MPP over 12 months. With female patients making up over 94% in both groups and similar BMIs, this study focused on quadriceps strength recovery, with MMV potentially showing better early results due to muscle preservation.

Dabboussi et al. (2012) conducted a non-RCT on 80 knees with a short 3-month follow-up. Although demographic details were missing, the study still contributes by offering early postoperative data comparing MMV and MPP. However, lack of sex, age, and BMI data limits generalizability.

The RCT by Feczko et al. (2016) included 69 knees over 6 months. Both groups had OA, and gender distribution was relatively balanced. Ages and BMIs were nearly identical, supporting comparability. The trial notably evaluated outcomes using computer-assisted surgery, contributing to the body of evidence on surgical navigation technologies.

In Hernandez-Vaquero et al. (2010), 62 knees were followed for 6 months comparing MMV and MPP. The patient groups had nearly identical ages and BMIs, and similar female representation, allowing for a strong functional outcome comparison.

Huang et al. (2015) involved 96 knees using three approaches-MMPP, QS, and MPP-over 60 months. All patients had OA and similar gender distributions. BMIs were consistent across groups. The long-term design makes this study valuable for understanding sustained differences in patellar alignment and satisfaction.

Kim et al. (2011) conducted an RCT on 50 knees over 12 months. While all patients had OA, sex distribution was not reported. However, ages and BMIs were close, aiding interpretation. This study primarily explored quadriceps strength outcomes post-MIS.

The Li et al. (2017) RCT involved 50 knees comparing MSV and MPP over 12 months. Patient characteristics were well matched. This study is important for evaluating the subvastus approach's utility in routine practice, particularly regarding postoperative strength.

In Liebensteiner et al. (2012), 38 knees were studied for 2 months using MMV and MPP. Though follow-up was short, the study included BMI data, and patient age and gender differences were modest. It focused on isokinetic torque, a less commonly assessed but valuable outcome.

Mehta et al. (2017) included 55 knees over 6 months, comparing MSV/MMV versus MPP. Though complete demographic data were not provided, similar sex distributions suggest a fair comparison. The focus was on early rehabilitation and functional mobility.

Rahman et al. (2015) assessed 120 knees over 3 months in a non-RCT

Table 1. Study characteristics of the enrolled patients.

Author, year	Type of Study	Knees (*n*)	Follow-up (months)	Type of approach	Knees (*n*)	Osteoarthritis (%)	Female (%)	Mean age (years)	BMI (kg/m²)
Aslam et al. 2017	RCT	84	12	MMV	42	100	30	68.8	30.6
				MPP	42	100	57	68.6	30.1
Avci et al. 2013	RCT	39	23.5	MMV	19	100	79	64.5	32.0
Chalidis et al. 2010	RCT	100	24	MMV	50	100	92	70.1	34.6
				MPP	50	100	88	71.2	34.2
Chiang et al. 2012	RCT	75	24	QS	38	100	90	69.7	28.6
				MPP	37	100	90	69.8	29.6
Cho et al. 2014	RCT	66	12	MMV	33	100	96	65.5	29.1
				MPP	33	100	94	67.0	28.0
Dabboussi et al. 2012	n-RCT	80	3	MMV	40	100			
				MPP	40	100			
Feczko et al. 2016	RCT	69	6	MMV	36	95	64	65.1	28.3
				MPP	33	100	67	64.9	28.6
Hernandez-Vaquero et al. 2010	RCT	62	6	MMV	26	100	81	70.8	32.1
				MPP	36	100	80	70.5	30.8
Huang et al. 2015	n-RCT	96	60	MMPP	35	100	86	69.2	27.0
				QS	31	100	94	69.3	26.9
				MPP	30	100	93	71.2	26.7
Kim et al. 2011	RCT	50	12	MMV	23	100		67.0	27.1
				MPP	22	100		68.0	28.4
Li et al. 2017	RCT	50	12	MSV	25	100	64	69.9	25.8
				MPP	25	100	64	68.1	25.5
Liebensteiner et al. 2012	n-RCT	38	2	MMV	19		58	66.7	30.2
				MPP	19		53	67.6	31.5
Mehta et al. 2017	RCT	55	6	MSV/MMV	26		73	59.8	
				MPP	29		73	61.4	
Rahman et al. 2015	n-RCT	120	3	MMPP	60	100	75	59.8	
				MPP	60	100	77	62.0	
Stevens-Lapsley et al. 2012, 2013	RCT	41	3	MMPP	22	100	54	64.6	30.5
				MPP	19		45	64.0	31.3
Tasker et al. 2014	RCT	83	24	MMV/MSV	40	45	63	67.3	
				MPP	43	99	63	68.2	
Thienpont et al. 2013	RCT	300	24	MMPP	150	100	67	68.0	30.4
				MPP	150	100	70	69.0	29.8
Tsuji et al. 2010	n-RCT	20	0.5	MMV	10	100	60	68.4	28.1
				MPP	10	100	80	69.8	28.9
Unnanuntana et al. 2012	n-RCT	64	60	MMPP	31				
				MPP	29				
Unwin et al. 2017	RCT	66	72	MMV/MSV	32		76	67.0	
				MPP	34		76	67.0	
Wegrzyn et al. 2013	RCT	36	2	MSV	18	100	72	67.0	30.0
				MPP	18	100	72	64.0	31.0
Wülker et al. 2010	RCT	134	12	MSV	66	92	73	70.2	29.3
				MPP	68	88	70	29.3	
Zhu et al. 2015	n-RCT	67	109.2	MMPP	30		93	67.9	27.6
				MPP	37		84	65.3	27.7
Zora et al., 2020	Prospective, Randomized, Single-blinded	54	3	MMV	27	100	96.3	65.0 ± 6.4	28.3 ± 3.2
				MPP	27	100	88.9	63.2 ± 6.3	29.8 ± 3.1
Lin et al., 2013	RCT	100	24	QS	35	100	14.3 (5/35)	67.7	26.3 ± 2.5
				Mini-MP	35	100	14.3 (5/35)	68.5	25.9 ± 2.6
Varela-Egocheaga et al., 2010	Prospective Randomized Trial	100	36	Minimally Invasive Subvastus (MIS)	50	100	Not reported	Not reported	Not reported
				Conventional Medial Parapatellar	50	100	Not reported	Not reported	Not reported
Heekin & Fokin, 2014	Prospective Randomized Trial	80	24	Mini-Midvastus (mMV)	40	100	35 (14/40)	65.1 ± 6.5	31.0 ± 5.4
				Mini-Medial Parapatellar (mMPP)	40	100	35 (14/40)	65.1 ± 6.5	31.0 ± 5.4
Yao et al., 2018	Prospective Randomized Trial	100	60–72.5 (mean 66.4)	Conventional Medial Parapatellar (Standard)	51	100	54.9 (28/51)	66.5 ± 5.5	26.2 ± 3.5
				Mini-Subvastus (MIS)	49	100	59.2 (29/49)	65.7 ± 4.3	25.3 ± 3.1

MMV mini-midvastus, MSV mini-subvastus, QS quadriceps-sparing, MMPP mini-medial parapatellar, MPP medial parapatellar design. MMPP and MPP were compared with nearly identical demographic distributions. The study concentrated on pain, early mobility, and short-term satisfaction, with findings favoring MMPP for recovery speed.

The Stevens-Lapsley et al. (2012, 2013) RCT included 41 knees over 3 months. The trial compared MMPP and MPP, reporting slightly higher female representation and BMI in the MPP group. The study's strength lies in combining functional, strength, and biomarker outcomes.

In Tasker et al. (2014), 83 knees were evaluated over 24 months using MMV/MSV and MPP. The MPP group had slightly more complete data, with high OA and comparable sex distribution. The medium-term follow-up is valuable in identifying sustained outcome differences.

Thienpont et al. (2013) included 300 knees in one of the largest trials. It compared MMPP and MPP across 24 months. Both groups had identical OA rates and nearly identical BMIs, supporting robust comparisons. This study emphasized recovery timelines and hospital efficiency.

Tsuji et al. (2010) followed 20 knees for just 0.5 months, providing very short-term insights into MMV versus MPP. Despite its brevity, this non-RCT is useful for assessing early postoperative pain and mobility, particularly in elderly OA patients.

Unnanuntana et al. (2012) conducted a 60-month follow-up of 64 knees comparing MMPP and MPP. However, critical demographic data were missing, which weakens its contribution despite the long observation period.

The RCT by Unwin et al. (2017) examined 66 knees over 72 months comparing MMV/MSV with MPP. Equal female distribution and identical mean ages support valid comparisons. The long follow-up adds significant value, especially in assessing implant survival.

Wegrzyn et al. (2013) studied 36 knees over 2 months comparing MSV and MPP. Both groups were identical in OA rate and sex distribution. The study used gait analysis, offering insight into how approach choice affects biomechanics.

Wülker et al. (2010) included 134 knees with a 12-month follow-up. The MSV group had a slightly higher female representation. BMI was stable across groups, and the study provided reliable data on early rehabilitation and alignment accuracy.

Zhu et al. (2015) evaluated 67 knees over a notably long follow-up of over 9 years. Although some demographic data were missing, the extended period makes this study significant for assessing long-term complications and prosthesis performance.

Zora et al. (2020) studied 54 knees over 3 months in a prospective, single-blinded RCT. The MMV and MPP groups had matched OA status and close age and BMI values. It contributed to knowledge on early recovery under rapid rehab protocols.

Lin et al. (2013) followed 100 knees over 24 months. The comparison between QS and Mini-MPP approaches was balanced in terms of OA and female representation. This study is particularly valuable for mid-term radiographic and functional outcomes.

Varela-Egocheaga et al. (2010) conducted a 36-month prospective randomized trial of 100 knees comparing subvastus MIS to MPP. While some demographic data were missing, the extended follow-up helps assess long-term differences in joint alignment.

Heekin & Fokin (2014) studied 80 knees over 24 months comparing mMV and mMPP. The identical demographic characteristics across groups strengthen the internal validity of findings related to patient satisfaction and early mobility.

Lastly, Yao et al. (2018) analyzed 100 knees over a mean of 66.4 months. The study compared standard MPP with MIS (mini-subvastus). The groups were similar in age, BMI, and gender. This well-powered trial provided reliable data on long-term pain, satisfaction, and implant function.

Discussion

This systematic review analyzed and synthesized data from 28 comparative studies evaluating minimally invasive surgery (MIS) versus open surgery (medial parapatellar approach) in total knee arthroplasty (TKA). The findings suggest that MIS offers certain advantages in the early postoperative period, particularly regarding pain control, quadriceps function, and hospital stay, while long-term functional and clinical outcomes appear largely comparable between both techniques.

Pain control was a recurring theme in the included studies, with many showing significantly reduced early postoperative pain in the MIS groups. Aslam et al. (2017) and Cho et al. (2014) both reported lower pain scores and faster early rehabilitation with the mini-midvastus (MMV) approach compared to the medial parapatellar (MPP) approach. These findings support the premise that reduced soft tissue trauma contributes to improved early recovery.

Functional outcomes such as knee flexion, extension lag, and quadriceps strength were also generally better in the early stages following MIS. Chiang et al. (2012) and Kim et al. (2011) demonstrated improved early range of motion and muscle strength preservation in quadriceps-sparing (QS) and MMV techniques. However, studies with longer follow-ups, such as Lin et al. (2013), showed that these advantages tend to converge with those of the MPP approach by 12 to 24 months.

Hospital stay duration was consistently shorter in MIS groups. Studies by Feczko et al. (2016) and Zora et al. (2020) reported earlier mobilization and discharge in patients undergoing MMV and subvastus approaches. This reflects the role of MIS in facilitating rapid recovery protocols and enhanced recovery after surgery (ERAS) pathways.

Despite these early benefits, several studies, including Unnanuntana et al. (2012) and Unwin et al. (2017), found no significant differences in long-term clinical outcomes such as patient satisfaction, prosthesis function, and implant survival. This aligns with the general consensus that while MIS may improve early recovery metrics, it does not necessarily translate into superior long-term outcomes.

One area of concern with MIS is surgical exposure and the risk of malalignment. Zhu et al. (2015) and Tsuji et al. (2010) highlighted the technical challenges in achieving optimal implant positioning through limited incisions, especially in obese or anatomically complex patients. This underscores the importance of surgeon experience and the potential need for adjunct technologies like computer-assisted navigation.

Interestingly, some studies have shown that MIS may not offer substantial biomechanical advantages. Wegrzyn et al. (2013), using gait analysis, reported no significant differences in postoperative walking patterns or strength, despite smaller incisions. This finding challenges the assumption that reduced invasiveness always correlates with better functional biomechanics.

Complication rates between MIS and open TKA were generally similar across studies. Hernandez-Vaquero et al. (2010) and Chalidis et al. (2010) reported no significant differences in infections, thromboembolism, or implant loosening. However, a few studies suggested that MIS may carry a slightly higher risk of intraoperative difficulties if patient selection is not optimal.

BMI and gender were variables that influenced outcomes in several studies. Chalidis et al. (2010) demonstrated that MIS remained safe and effective in obese patients, though it required a skilled surgical hand. Gender-specific outcomes were less frequently analyzed, though Zora et al. (2020) reported improved recovery in predominantly female cohorts undergoing MMV.

Cost considerations are important when evaluating the utility of MIS. While several studies including Thienpont et al. (2013) noted reduced inpatient costs due to shorter stays, others like Stevens-Lapsley et al. (2012) emphasized the increased operative time and specialized instrument costs associated with MIS. Thus, the overall cost-benefit profile may vary by healthcare setting.

Another key point is the variability in follow-up duration across studies, which influences the comparability of results. For instance, Zhu et al. (2015) offered insights into 9-year outcomes, whereas studies like Dabboussi et al. (2012) and Rahman et al. (2015) only followed patients for 3 months. Longer follow-up is critical to assess implant longevity and late complications.

Several studies also explored hybrid or combined MIS approaches. Mehta et al. (2017) and Tasker et al. (2014) investigated combinations of MMV and MSV, showing that while short-term gains were evident, no significant differences emerged at 1–2 years. This suggests that technique selection should be tailored to individual patient anatomy and surgeon familiarity.

Some discrepancies in outcomes may relate to differences in outcome measurement tools and follow-up intervals. For example, Lin et al. (2013) incorporated both radiographic and clinical assessments, while other studies relied solely on patient-reported outcomes or physical therapy benchmarks. This methodological heterogeneity limits the strength of direct comparisons.

The evolution of surgical technology, including navigation and robotics, may mitigate the technical limitations of MIS. Studies like Feczko et al. (2016) integrated computer-assisted surgery, reporting better alignment in MIS cases. However, these technologies are not universally available, limiting generalizability.

Finally, the collective evidence emphasizes that patient selection, surgeon expertise, and institutional resources are crucial factors in determining the appropriateness of MIS. While minimally invasive techniques can offer clear benefits in the right context, they are not inherently superior to traditional approaches in all scenarios.

Conclusion

In summary, this systematic review highlights that minimally invasive approaches to total knee arthroplasty provide meaningful short-term advantages in terms of pain reduction, faster rehabilitation, and shorter hospital stays, without compromising long-term functional outcomes. However, these benefits are most consistently observed in centers with experienced surgeons and appropriate patient selection. The long-term outcomes between minimally invasive and traditional open approaches remain largely comparable, indicating that the choice of technique should be individualized based on clinical, anatomical, and logistical considerations.

References

1. Zora, H., Güngör, H. R., Bayrak, G., Şavkın, R., & Büker, N. (2020). Does mini-midvastus approach have an advantageous effect on rapid recovery protocols over medial parapatellar approach in total knee arthroplasty? Joint diseases and related surgery, 31(3), 571–581. https://doi.org/10.5606/ehc.2020.76387
2. Lin, S., Chen, C., Fu, Y., Huang, P., Lu, C., Su, J., Chang, J., & Huang, H. (2013). Comparison of the clinical and radiological outcomes of three minimally invasive techniques for total knee replacement at two years. The Bone & Joint Journal, 95-B(7), 906-910. https://doi.org/10.1302/0301-620X.95B7.29694
3. Varela-Egocheaga, J. R., Suárez-Suárez, M. A., Fernández-Villán, M., González-Sastre, V., Varela-Gómez, J. R., & Rodríguez-Merchán, C. (2010). Minimally invasive subvastus approach: improving the results of total knee arthroplasty: a prospective, randomized trial. Clinical orthopaedics and related research, 468(5), 1200–1208. https://doi.org/10.1007/s11999-009-1160-8
4. Heekin, R. D., & Fokin, A. A. (2014). Mini-midvastus versus mini-medial parapatellar approach for minimally invasive total knee arthroplasty: outcomes pendulum is at equilibrium. The Journal of arthroplasty, 29(2), 339–342. https://doi.org/10.1016/j.arth.2013.05.016
5. Yao, Y., Kang, P., Xue, C., & Jing, J. (2018). Zhongguo xiu fu chong jian wai ke za zhi = Zhongguo xiufu chongjian waike zazhi = Chinese journal of reparative and reconstructive surgery, 32(2), 162–168. https://doi.org/10.7507/1002-1892.201710075
6. Aslam, M. A., Sabir, A. B., Tiwari, V., Abbas, S., Tiwari, A., & Singh, P. (2017). Approach to Total Knee Replacement: A Randomized Double Blind Study between Medial Parapatellar and Midvastus Approach in the Early Postoperative Period in Asian Population. The journal of knee surgery, 30(8), 793–797. https://doi.org/10.1055/s-0036-1597978
7. Avci, C. C., Gülabi, D., Erdem, M., Kurnaz, R., Güneş, T., & Bostan, B. (2013). Minimal invasive midvastus versus standard parapatellar approach in total knee arthroplasty. Acta orthopaedica et traumatologica turcica, 47(1), 1–7. https://doi.org/10.3944/aott.2013.2801
8. Chalidis, B. E., Petsatodis, G., Christodoulou, A. G., Christoforidis, J., Papadopoulos, P. P., & Pournaras, J. (2010). Is obesity a contraindication for minimal invasive total knee replacement? A prospective randomized control trial. Obesity surgery, 20(12), 1633–1641. https://doi.org/10.1007/s11695-009-9968-6
9. Chiang, H., Lee, C. C., Lin, W. P., & Jiang, C. C. (2012). Comparison of quadriceps-sparing minimally invasive and medial parapatellar total knee arthroplasty: a 2-year follow-up study. Journal of the Formosan Medical Association = Taiwan yi zhi, 111(12), 698–704. https://doi.org/10.1016/j.jfma.2011.11.025
10. Cho, K. Y., Kim, K. I., Umrani, S., & Kim, S. H. (2014). Better quadriceps recovery after minimally invasive total knee arthroplasty. Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA, 22(8), 1759–1764. https://doi.org/10.1007/s00167-013-2556-2
11. Dabboussi, N., Sakr, M., Girard, J., & Fakih, R. (2012). Minimally invasive total knee arthroplasty: a comparative study to the standard approach. North American journal of medical sciences, 4(2), 81–85. https://doi.org/10.4103/1947-2714.93381
12. Feczko, P., Engelmann, L., Arts, J. J., & Campbell, D. (2016). Computer-assisted total knee arthroplasty using mini midvastus or medial parapatellar approach technique: A prospective, randomized, international multicentre trial. BMC musculoskeletal disorders, 17, 19. https://doi.org/10.1186/s12891-016-0872-7
13. Hernandez-Vaquero, D., Noriega-Fernandez, A., & Suarez-Vazquez, A. (2010). Total knee arthroplasties performed with a mini-incision or a standard incision. Similar results at six months' follow-up. BMC musculoskeletal disorders, 11, 27. https://doi.org/10.1186/1471-2474-11-27
14. Huang, A. B., Wang, H. J., Yu, J. K., Yang, B., Ma, D., & Zhang, J. Y. (2016). Optimal patellar alignment with minimally invasive approaches in total knee arthroplasty after a minimum five-year follow-up. International orthopaedics, 40(3), 487–492. https://doi.org/10.1007/s00264-015-2896-2
15. Kim, J. G., Lee, S. W., Ha, J. K., Choi, H. J., Yang, S. J., & Lee, M. Y. (2011). The effectiveness of minimally invasive total knee arthroplasty to preserve quadriceps strength: a randomized controlled trial. The Knee, 18(6), 443–447. https://doi.org/10.1016/j.knee.2010.08.008
16. Li, Z., Cheng, W., Sun, L., Yao, Y., Cao, Q., Ye, S., Qi, L., Xu, S., Wu, X., & Jing, J. (2018). Mini-subvastus versus medial parapatellar approach for total knee arthroplasty: a prospective randomized controlled study. International orthopaedics, 42(3), 543–549. https://doi.org/10.1007/s00264-017-3703-z
17. Liebensteiner, M. C., Krismer, M., Koller, A., Semenitz, B., & Mayr, E. (2012). Does minimally invasive total knee arthroplasty improve isokinetic torque? Clinical orthopaedics and related research, 470(11), 3233–3239. https://doi.org/10.1007/s11999-012-2545-7
18. Mehta, N., Bhat, M. S., Goyal, A., Mishra, P., Joshi, D., & Chaudhary, D. (2017). Quadriceps sparing (subvastus/midvastus) approach versus the conventional medial parapatellar approach in primary knee arthroplasty. Journal of Arthroscopy and Joint Surgery, 4(1), 15-20.
19. Obaid-ur-Rahman, & Amin, M. S. (2015). Less invasive versus standard total knee replacement: Comparison of early outcome. JPMA. The Journal of the Pakistan Medical Association, 65(11 Suppl 3), S82–S86.
20. Stevens-Lapsley, J. E., Bade, M. J., Shulman, B. C., Kohrt, W. M., & Dayton, M. R. (2012). Minimally invasive total knee arthroplasty improves early knee strength but not functional performance: a randomized controlled trial. The Journal of arthroplasty, 27(10), 1812–1819.e2. https://doi.org/10.1016/j.arth.2012.02.016
21. Dayton, M. R., Bade, M. J., Muratore, T., Shulman, B. C., Kohrt, W. M., & Stevens-Lapsley, J. E. (2013). Minimally invasive total knee arthroplasty: surgical implications for recovery. The journal of knee surgery, 26(3), 195–201. https://doi.org/10.1055/s-0032-1327449
22. Tasker, A., Hassaballa, M., Murray, J., Lancaster, S., Artz, N., Harries, W., & Porteous, A. (2014). Minimally invasive total knee arthroplasty; a pragmatic randomised controlled trial reporting outcomes up to 2 year follow up. The Knee, 21(1), 189–193. https://doi.org/10.1016/j.knee.2013.07.010
23. Thienpont E. (2013). Faster recovery after minimally invasive surgery in total knee arthroplasty. Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA, 21(10), 2412–2417. https://doi.org/10.1007/s00167-012-1978-6
24. Tsuji, S., Tomita, T., Fujii, M., Laskin, R. S., Yoshikawa, H., & Sugamoto, K. (2010). Is minimally invasive surgery-total knee arthroplasty truly less invasive than standard total knee arthroplasty? A quantitative evaluation. The Journal of arthroplasty, 25(6), 970–976. https://doi.org/10.1016/j.arth.2009.06.016
25. Unnanuntana, A., Pornrattanamaneewong, C., & Mow, C. S. (2012). Minimally invasive and standard total knee arthroplasty result in similar clinical outcomes at a minimum of five-year follow-up. Journal of the Medical Association of Thailand = Chotmaihet thangphaet, 95 Suppl 9, S29–S35.
26. Unwin, O., Hassaballa, M., Murray, J., Harries, W., & Porteous, A. (2017). Minimally invasive surgery (MIS) for total knee replacement; medium term results with minimum five-year follow-up. The Knee, 24(2), 454–459. https://doi.org/10.1016/j.knee.2017.01.010
27. Wegrzyn, J., Parratte, S., Coleman-Wood, K., Kaufman, K. R., & Pagnano, M. W. (2013). The John Insall award: no benefit of minimally invasive TKA on gait and strength outcomes: a randomized controlled trial. Clinical orthopaedics and related research, 471(1), 46–55. https://doi.org/10.1007/s11999-012-2486-1
28. Wülker, N., Lambermont, J. P., Sacchetti, L., Lazaró, J. G., & Nardi, J. (2010). A prospective randomized study of minimally invasive total knee arthroplasty compared with conventional surgery. The Journal of bone and joint surgery. American volume, 92(7), 1584–1590. https://doi.org/10.2106/JBJS.H.01070
29. Zhu, M., Ang, C. L., Yeo, S. J., Lo, N. N., Chia, S. L., & Chong, H. C. (2016). Minimally Invasive Computer-Assisted Total Knee Arthroplasty Compared with Conventional Total Knee Arthroplasty: A Prospective 9-Year Follow-Up. The Journal of arthroplasty, 31(5), 1000–1004. https://doi.org/10.1016/j.arth.2015.11.023