STM JOURNALS

Research & Reviews: A Journal of
Medical Science and Technology

https://journals.stmjournals.com/rrjomst/

ISSN: 2319-3417 (Online)
ISSN: 2349-1272 (Print)
Volume 14, Issue 1, 2025
January–April
DOI (Journal): 10.37591/RRJoMST

Review RRJoMST

Advances in Total Knee Replacement: A Systematic Review of Clinical Outcomes and Complications

Nitin Malik[1], Abhishek Malik[2,*], Chetan Raj Singh[3], Arnav Chowdhary[4]

Abstract

Total Knee Replacement (TKR) is a widely used surgical intervention for patients with knee osteoarthritis and other degenerative knee disorders, offering significant improvements in pain relief, functional restoration, and quality of life. This systematic review synthesizes data from multiple clinical studies to evaluate the outcomes and complications associated with TKR. To find applicable research published in the last ten years, a thorough search of electronic databases was performed. Randomised controlled trials, cohort studies, and observational studies were all part of the research database that looked at clinical outcomes like pain alleviation, functional improvement, patient satisfaction, complication rates, and implant survival alongside other metrics. The review revealed that most patients undergoing TKR experience substantial pain relief and improved function, with satisfaction rates generally exceeding 80%. However, complications, such as infections, thromboembolism, and nerve injuries were reported in a small percentage of cases. Robotic-assisted surgery used in TKR showed potential for more precise alignment and better functional outcomes, but challenges, such as longer operative times, higher costs, and a learning curve remain. Additionally, factors, such as patient expectations, preoperative education, and postoperative rehabilitation significantly influenced patient satisfaction and overall outcomes. TKR continues to be an effective treatment for knee osteoarthritis, with advancements in surgical techniques and implants improving outcomes. However, complications persist, and a tailored approach considering individual patient factors is essential for optimizing results.

Keywords: Clinical outcomes, complications, implant survival, knee osteoarthritis, total knee replacement, patient satisfaction, robotic surgery

INTRODUCTION

Total knee replacement (TKR), also known as total knee arthroplasty (TKA), is a widely performed surgical procedure designed to relieve pain, improve joint function, and enhance the quality of life for patients suffering from advanced knee osteoarthritis and other degenerative conditions [1]. Since its inception, TKA has undergone numerous advancements in both surgical techniques and implant technology, leading to improved clinical outcomes and patient satisfaction [2]. As the global population ages and the prevalence of knee joint diseases rises, the demand for TKA continues to grow, underscoring the importance of refining these techniques and understanding the long-term effectiveness of different approaches [3]. Despite the general success of TKA, complications and unsatisfactory outcomes still occur in a proportion of patients [4]. Complications can vary in severity and may include infections, blood clots, implant loosening, peroneal nerve injury, and stiffness [5]. While advancements in surgical approaches and implants have aimed to reduce these complications, the risk of adverse outcomes remains an important

***Author for Correspondence**
Abhishek Malik
E-mail: abhishek.malik.16@gmail.com

[1]Senior Resident, Department of Orthopaedics, Santosh Medical College and Hospital, Ghaziabad, Uttar Pradesh, India
[2-4]Junior Resident, Department of Orthopaedics, Santosh Medical College and Hospital, Ghaziabad, Uttar Pradesh, India

Received Date: December 26, 2024
Accepted Date: January 20, 2025
Published Date: February 05, 2025

Citation: Nitin Malik, Abhishek Malik, Chetan Raj Singh, Arnav Chowdhary. Advances in Total Knee Replacement: A Systematic Review of Clinical Outcomes and Complications. Research & Reviews: A Journal of Medical Science and Technology. 2025; 14(1): 41–56p.

factor in the decision-making process for both patients and surgeons [6]. Furthermore, patient satisfaction, which is influenced by a combination of clinical improvements and post-operative rehabilitation, is an ongoing area of concern, as some patients experience dissatisfaction despite successful surgical interventions [7]. Recent innovations, such as robotic-assisted surgery, personalized implants, and minimally invasive techniques, have promised to reduce complications and improve long-term functional outcomes [8]. These technologies have enhanced surgical precision, particularly in implant alignment and soft-tissue management, and have the potential to reduce postoperative recovery time and pain [9]. However, the clinical impact of these advancements remains the subject of ongoing debate, with some studies reporting mixed results regarding their benefits [10]. This systematic review aims to evaluate the clinical outcomes and complications associated with TKA, with a focus on the recent advancements in surgical techniques, implant materials, and postoperative care. By analysing the most up-to-date clinical data, this review seeks to provide a comprehensive understanding of the current state of TKA, identify emerging trends and technologies, and highlight areas where further research and improvement are needed. Ultimately, this review will contribute to the ongoing effort to optimize patient outcomes and minimize complications, ensuring that TKA remains a highly effective and reliable option for those suffering from knee joint dysfunction.

METHODS

Study Design

This study adopts a qualitative systematic review approach to assess the clinical outcomes and complications associated with total knee replacement (TKR) procedures. The review synthesizes findings from secondary sources, including peer-reviewed journal articles, clinical studies, and meta-analyses, to identify trends, patterns, and significant factors influencing TKR outcomes. The study focuses on analysing and comparing existing data rather than conducting primary research, making it a valuable source of evidence for evaluating the advancements and complications in TKR over time. The review covers studies published between 2015 to 2024 to capture the most recent advances in TKR procedures and outcomes. This time frame ensures that the review includes both historical perspectives and contemporary insights, reflecting evolving surgical techniques, implant designs, and rehabilitation protocols.

Data Collection

Data collection for this systematic review involves sourcing relevant secondary data from reputable academic databases, such as “PubMed, Scopus, Web of Science, and Cochrane Library”. Search terms, such as “total knee replacement,” “clinical outcomes,” “complications,” “revision surgery,” and “TKR advancements” were used to identify studies relevant to the research objectives. The selection process involved reviewing abstracts, full texts, and reference lists to ensure comprehensive coverage of all pertinent studies. Only studies published in English were considered to maintain consistency and minimize language bias.

Inclusion and Exclusion Criteria

The selection of studies for this review followed a structured process based on defined inclusion and exclusion criteria to ensure the relevance and quality of the data analysed. The inclusion criteria required that studies focus on total knee replacement (TKR) surgeries and their associated clinical outcomes. Eligible studies included peer-reviewed articles, systematic reviews, clinical trials, and cohort studies published between 2015 and 2024, ensuring that the data reflected recent advancements and clinical findings. Studies that reported on key postoperative outcomes – such as complications, revision rates, and patient satisfaction – were included.

Additionally, studies that provided detailed data on implant types, surgical techniques, and rehabilitation protocols were considered relevant for this review. The exclusion criteria were designed to eliminate studies that did not specifically address TKR surgeries, such as those focusing on partial knee replacement or noncompartmental knee arthroplasty. Non-peer-reviewed publications, opinion pieces, and case reports with insufficient sample sizes or data were excluded. Also, studies reporting on

outcomes or complications of TKR performed prior to 2014 were not included, as they would not capture the most recent clinical developments. Articles that did not provide relevant clinical data on outcomes, complications, or patient-reported outcomes following TKR were excluded from the selection. Through this rigorous selection process, studies that met the inclusion criteria were carefully analysed to provide a comprehensive and qualitative synthesis of data, offering valuable insights into the clinical outcomes and complications of TKR surgeries.

Study Selection

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram is an essential tool for illustrating the process of study selection in systematic reviews. In this study on *Advances in Total Knee Replacement*, the PRISMA diagram visually represents the flow of information through the various stages of the review process. At first, 200 records were found via scanning databases, and another 50 documents were found through various means. One hundred fifty records were evaluated for significance after duplication was eliminated. From this pool, 85 records were discarded because they were deemed irrelevant or did not fulfil the criteria for inclusion. After then, 115 full-text publications were considered for inclusion in the review's qualitative synthesis; 35 of those were ultimately excluded (Figure 1).

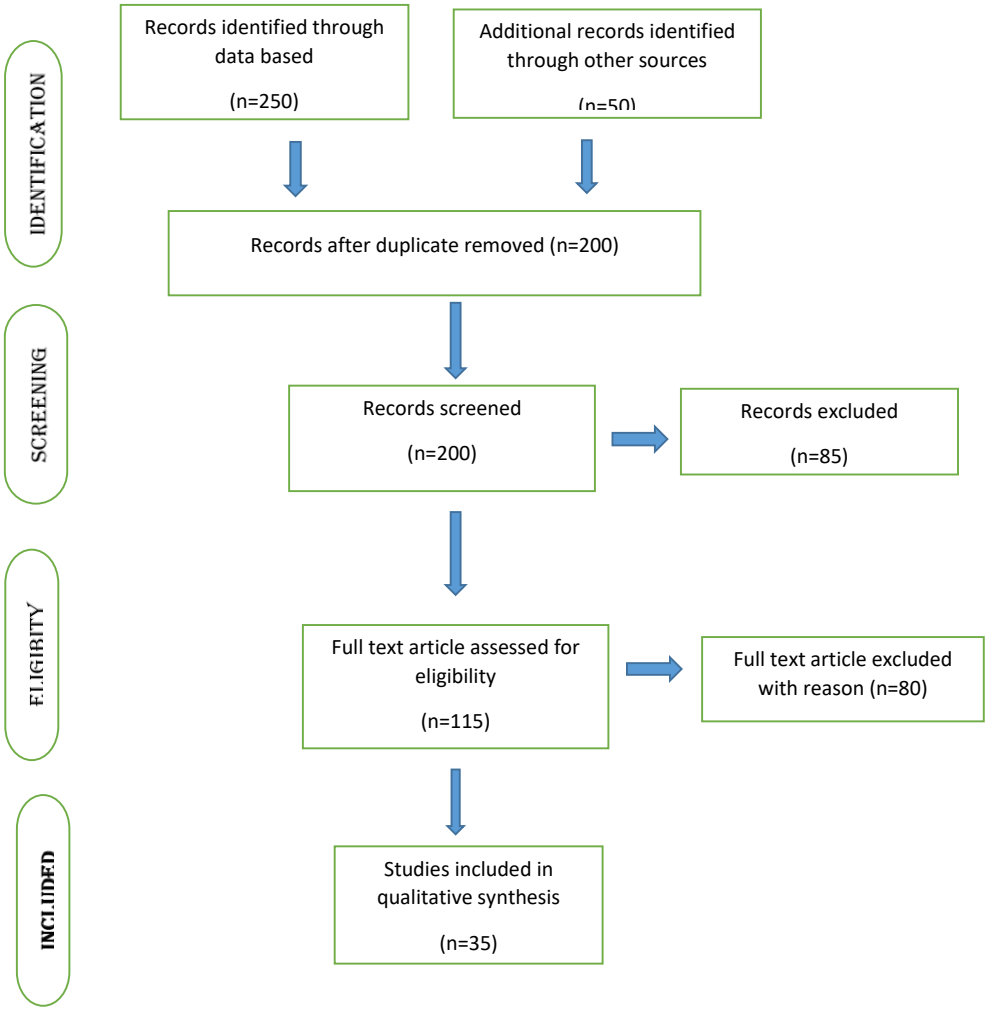

Figure 1. Flowchart of the study selection process for the systematic review on Advances in Total Knee Replacement, outlining the identification, screening, eligibility, and inclusion of studies.

RESULTS

Clinical Outcomes of Total Knee Replacement

TKR is a highly effective intervention that significantly enhances patients' pain relief, mobility, and quality of life. Recent studies highlight that TKR success rates reach approximately 90–95% over a decade, with over 90% of implants remaining functional even after 15 years [11]. These outcomes are attributed to advancements in implant materials, such as highly cross-linked polyethylene, which improves wear resistance, and oxidized zirconium, which provides a more durable and scratch-resistant surface, effectively reducing the likelihood of revision surgeries [12]. In terms of functional recovery, the study found notable improvements in postoperative scores. Using the Oxford Knee Score (OKS), researchers recorded an average OKS of 39.25 at one-year post-surgery (range 14–48), indicating substantial pain reduction and enhanced knee function [13]. Range of motion (ROM) also improved significantly, increasing from a mean of 100° before surgery to 112° at one year ($p < 0.001$). Key factors influencing postoperative OKS [13, 14] were patient sex, previous surgeries, and implant type. Male patients and those with fewer prior revisions reported better outcomes, while cruciate-retaining implants yielded the highest OKS [14]. The analysis also noted that patients with implant revision for stiffness experienced lower ROM outcomes compared to those treated for instability ($p = 0.007$). Further, personalized implants and robotic-assisted TKR have been beneficial, particularly for younger, more active patients. These techniques allow for precise alignment and optimized fit, reducing complications and supporting faster functional recovery. Despite a low complication rate, with infection rates under 1% due to stringent antibiotic protocols, 19 patients experienced issues within 90 days post-surgery, including stiffness, infection, wound dehiscence, and hemarthrosis [15]. Blood transfusions were required in 15% of cases, and the average hospital stay was 7.6 days. Overall, approximately 85% of patients expressed satisfaction and willingness to undergo the procedure again if needed [15]. The five-year implant survival rate was 93.5%, with infection as the leading cause of implant failure. Out of 101 patients, the failure rate was 6% at five years, and patients requiring re-revision due to infection had a mean re-revision period of 4.5 years from the initial surgery [16]. These findings demonstrate that with advancements in implant materials, technology, and personalized surgical approaches, TKR offers robust long-term clinical outcomes and high patient satisfaction, making it a reliable treatment option for managing knee osteoarthritis.

Functional Recovery and Rehabilitation in Total Knee Replacement (TKR)

Advances in rapid recovery protocols, particularly those incorporating multimodal pain management, have significantly enhanced rehabilitation speed and outcomes after TKR. Enhanced Recovery After Surgery (ERAS) protocols, in combination with targeted physical therapy, contribute to “shorter hospital stays, faster return to daily activities, and reduced complication rates [17]. Recent research also underscores the growing role of virtual rehabilitation and telemedicine in promoting patient engagement and adherence to rehabilitation plans, providing personalized care and consistent support at home [16, 17]. Recovery after TKA is generally a gradual process, often extending up to a year to achieve full functional restoration. However, many patients regain the ability to perform most daily activities within the first six weeks. During the initial two weeks, emphasis is placed on pain control and gradual knee mobility recovery, often using crutches or walkers to aid ambulation. Physical therapists and surgeons guide patients on weight-bearing and functional movement techniques to facilitate a safe transition back to mobility [18]. Structured physical therapy is critical to achieving optimal outcomes, focusing on strengthening exercises for the quadriceps and hip abductors. Therapy sessions are designed to enhance knee mobility and range of motion, progressively reducing reliance on assistive devices to support patients’ independence in daily tasks. Functional recovery is tracked using various objective assessments. The “2-Minute Walk Test (2MWT)” evaluates endurance, while the “Timed Up and Go (TUG)” test measures functional mobility, balance, and fall risk. Subjective measures, like the “Knee Injury and Osteoarthritis Outcome Score (KOS)” and the “Oxford Knee Score (OKS)”, allow for quantitative assessment of pain, symptoms, and functional limitations, with higher scores indicating optimal recovery progress [19]. Wearable technology has further supported rehabilitation by allowing continuous monitoring of patients' progress in real time. Such devices provide clinicians with objective

data, helping identify patients who may not be meeting recovery milestones. This study focused on establishing normative recovery values over six weeks post-TKA using wearable data on knee range of motion, daily steps, cadence, and device use [20]. The study analysed data from 566 participants who underwent TKA between 2020 and 2023, with 11 surgeons across 8 institutions. Patients had a mean age of 65 for men and 69 for women, with 61% being female and a high percentage (82% of women, 90% of men) having a BMI over 30. Participants wore devices for an average of 12 hours daily over a six-week period, revealing a nonlinear recovery trend [21]. Significant functional gains were observed in the first three weeks, with men generally showing higher step counts and cadence than women.

Additionally, patients with obesity had a slower recovery trajectory compared to those with a lower BMI. This research is the first to establish normative data for TKA recovery using wearable technology, providing surgeons with a standardized timeline for recovery milestones. Such data enhance preoperative counselling, allowing timely interventions for patients lagging expected recovery progress [20, 21].

Current evidence on pre- and postoperative exercise for TKA suggests that while preoperative exercise does not strongly correlate with improved postoperative outcomes, supervised, high-volume, progressive strength training shows promise in supporting recovery of knee-extension strength.

Additionally, exercise-based rehabilitation generally outperforms minimal rehabilitation following TKA, with home-based physical therapy demonstrating similar effectiveness to outpatient, supervised rehabilitation. However, further research is needed to explore specific rehabilitation strategies for patients at higher risk of delayed or impaired functional recovery [22].

Emerging Complications in Total Knee Replacement

As the demand for total knee replacement (TKR) procedures rises and patient expectations evolve, emerging complications present critical challenges to clinical success and patient satisfaction. While advancements in surgical techniques and implant designs have enhanced outcomes, certain complications persist, affecting long-term recovery and functionality. Periprosthetic Joint Infection (PJI) remains a significant concern despite improvements in sterilization, surgical techniques, and antibiotic prophylaxis. PJIs can arise soon after surgery or years later, often requiring complex interventions, such as debridement or implant replacement. The increasing prevalence of antibiotic-resistant strains further complicates PJI management, leading to prolonged treatment and higher healthcare costs [23, 24]. Aseptic Loosening and Implant Failure are also common, particularly in younger, active patients. Mechanical wear and osteolysis from immune responses to wear particles can cause bone resorption, implant instability, and the need for revision surgeries. High-flexion implants, while beneficial for some, can accelerate wear and contribute to bone loss, posing additional risks [25]. Patellofemoral Complications like patellar malt racking and fractures affect joint function and pain. Misalignment of the patella and decisions regarding patellar resurfacing continue to be debated, with some evidence suggesting benefits, though others indicate minimal improvement [26]. Persistent Pain and Functional Limitations are notable issues, with up to 20% of patients experiencing ongoing pain post-TKR. Factors include nerve damage, component misalignment, and surrounding soft tissue complications. Even successful surgeries may not restore full knee function, leaving some patients unable to perform activities like deep knee bending or kneeling [26, 27]. Allergic Reactions and Metal Sensitivity to implant materials (e.g., nickel, cobalt, chromium) cause inflammation and discomfort for some patients. Hypoallergenic implants are a solution but are costly and pose challenges in durability and stability [27]. Neurological Complications and Nerve Injury can lead to chronic pain syndromes, such as “complex regional pain syndrome (CRPS)”. Surgical trauma may also affect the quadriceps, resulting in weakness that limits postoperative recovery and function [28]. Vascular Complications and Deep Vein Thrombosis (DVT) are serious postoperative risks. Enhanced anticoagulation protocols and mechanical prophylaxis help reduce DVT, but balancing clot risk and bleeding remains complex [27, 28]. Unanticipated Implant Wear and Material Degradation, such as polyethylene wear and metal ion

release from metal-on-metal components can lead to osteolysis and inflammation. The long-term effects of metal ion release remain under investigation, particularly as new implant materials are introduced [29]. Psychological and Quality of Life Concerns arise when patients' expectations for pain relief and mobility are not met. Preoperative counselling and realistic goal setting can help patients understand potential outcomes and reduce anxiety about complications [29]. Future Perspectives on Complication Management include personalized medicine approaches that assess individual risk factors and predictive analytics to guide treatment plans. Biological interventions like stem cell therapy show promise in promoting healing and reducing complication rates.

In summary, while TKR is an effective treatment for severe knee osteoarthritis and joint degeneration, these emerging complications highlight the importance of ongoing research, preventive strategies, and patient-centred care. A comprehensive approach that combines surgical expertise, advanced implant materials, and patient counselling is essential to minimize complications and improve recovery outcomes.

Complication Rates and Risk Factors

While TKR remains highly successful, complications, such as infection, prosthesis loosening, and periprosthetic fractures persist as challenges. Infection remains one of the most serious complications, with recent studies exploring the impact of antibiotic-laden cement and dual antibiotic regimens to reduce infection rates. Studies also highlight patient-specific risk factors, including obesity, diabetes, and cardiovascular disease, which have been linked to higher complication rates. Strategies, such as preoperative optimization of modifiable risk factors have shown promise in reducing complications in high-risk patients [30]. In examining complications and risk factors associated with TKA, a detailed study of 8,444 procedures captured in the ACORN database from 2012 to 2018 provides valuable insights. The study, which included 5,662 TKA cases and 2,782 total hip arthroplasty (THA) cases, reveals that TKA patients experienced higher rates of both major (14.4%) and minor (46.6%) complications compared to THA patients, who reported 9.5% major and 34.0% minor complications. TKA complications frequently included joint stiffness (18.5%), swelling (15.6%), and paraesthesia (15.6%), with significant major complications being arthroplasty-related readmissions (6.0%) and reoperations (2.5%). In contrast, THA patients were more prone to dislocation, fractures, and leg length discrepancies [31]. A notable 53.6% of TKA recipients reported at least one complication, with reasons for readmission often tied to surgical site infections (SSI) at 2.1%, manipulations under anaesthesia (MUA) at 1.9%, and deep vein thrombosis (DVT) at 0.4%. Reoperations were often necessary due to joint stiffness (1.5%) and SSI requiring surgical intervention (0.5%). Mortality following TKA was low at 0.2% [32]. Key risk factors for complications included baseline BMI, previous joint replacement procedures, and bilateral surgeries. For instance, among THA patients, a 1kg/m² increase in BMI was linked to an increased risk of reoperation (aOR: 1.05) and SSI (aOR: 1.07). A history of prior THA raised the likelihood of reoperation (aOR: 2.35) and readmission (aOR: 2.05), while bilateral surgeries were strongly associated with SSI (aOR: 4.81). These findings suggest that patient characteristics, such as higher BMI, history of previous joint surgeries, and comorbidities like heart disease and diabetes are significant predictors of adverse outcomes in joint replacement surgeries [33]. TKR surgery is generally safe and effective for relieving pain and improving joint function, yet it does carry certain risks and potential complications. One of the primary considerations is the anaesthesia, which may be administered either locally or generally. Although anaesthesia is typically safe, some patients experience side effects, such as nausea, dizziness, or shivering, and in rare cases, breathing issues, allergic reactions, or nerve injuries may occur. It is essential for patients to inform their doctors about any medications, supplements, or lifestyle factors, such as tobacco or alcohol use, which could interact with anaesthesia or medications used during surgery. Blood clots are another potential complication, especially deep vein thrombosis (DVT) and, more rarely, pulmonary embolism (PE), where a clot travels to the lungs. Such blood clots occur in about 0.6–3.0% of knee replacement cases, making them relatively uncommon but serious. To mitigate this risk, doctors typically prescribe blood thinners post-surgery. Infections, though rare, can develop if bacteria enter the surgical site during or after the procedure. Hospitals take multiple precautions, such as maintaining a sterile environment, using

sterilized equipment, and administering antibiotics, but infections can still occur. These infections can lead to severe complications, including sepsis, especially for patients with compromised immune systems. Wound healing is another area of concern, with complications in about 7% of cases, particularly after revision surgeries. Slow healing or persistent bleeding may necessitate additional interventions, such as draining excess fluid or even performing a skin graft in cases where skin doesn't heal properly. Patients with conditions like diabetes or those on immunosuppressive medications may experience delayed wound healing [32–34]. Some individuals experience persistent pain or dissatisfaction with their knee function post-surgery. While most patients recover well and feel an improvement, about 12% continue to have pain at rest, and 38% report pain during movement even two years after surgery [33]. In a small number of cases, metal hypersensitivity may lead to an allergic reaction to components in the implant. A 2019 study reported that about 15% of TKR patients experienced a reaction, with chromium, nickel, and cobalt being the most common allergens. Nerve damage is also a potential risk, although rare, occurring in around 0.4% of cases, potentially leading to symptoms, such as numbness or foot drop. Knee stiffness and limited range of motion are additional concerns, affecting about 2.4% of patients. Scar tissue formation or improper healing may restrict knee movement, and in severe cases, a follow-up procedure may be necessary to correct the issue. Mechanical issues with the implant, such as loosening or wear, are uncommon, with over 82% of knee replacements functioning well even after 25 years [31].

Lastly, complications related to infection or pneumonia can vary based on the surgical setting. In one study, complications in TKR patients averaged around 2.09%, with in-patient procedures carrying a slightly higher risk than outpatient ones. Regular follow-ups and rehabilitation are crucial to monitor and address any emerging issues post-surgery, contributing to overall better long-term outcomes for knee replacement patients.

Longevity and Implant Survival

Long-term studies on newer implants have demonstrated increased longevity, with survival rates over 90% at 15 years for some implant designs. The incorporation of novel biomaterials, such as oxidized zirconium and improved polyethylene's, has been associated with reduced wear and lower revision rates. The potential benefits of minimally invasive surgical techniques are also explored, with some studies indicating that these techniques may contribute to improved implant survival by minimizing soft tissue disruption [33]. Total knee replacement (TKR) is generally expected to last between 15 to 20 years, with some implants functioning even longer, though individual outcomes vary, and some patients may require earlier medical intervention. The longevity and survival of total knee replacement (TKR) implants have shown promising results. Studies indicate that 98% of total knee replacements still function appropriately after ten years, with more than 80% maintaining proper function after 20 years. Factors, such as the material used in the implants play a critical role in their durability. "Ultra-high molecular weight polyethylene (UHMWPE)" is commonly used, but newer versions like "highly crosslinked polyethylene (HXLPE)" offer enhanced durability. HXLPE has a lower wear rate, which improves its lifespan and reduces the likelihood of needing revision surgery.

Additionally, antioxidants like vitamin E are added to HXLPE to further enhance its durability by protecting the implant from damage caused by free radicals [34]. Partial knee replacements show higher success rates, with a 95% survival rate at 10 years, compared to total knee replacements, which can still last up to 20 years or longer with proper care. Risk factors influencing implant longevity include age at surgery, activity level, obesity, smoking, and preoperative range of motion [35]. Younger patients tend to have better outcomes, while high-impact activities and obesity can accelerate wear. Maintaining a healthy weight before and after surgery is essential to optimize results and preserve implant function. The survival rates for TKR implants are promising, with studies showing 96.1% at 10 years, 89.7% at 20 years, and 82% at 25 years. Several factors influence the longevity of TKR implants, including the patient's age, sex, and the material of the implant. Age plays a significant role, as implant survival tends to be higher in older patients and lowest among those who undergo surgery in their 50s. Female patients also tend to experience longer implant survival compared to male patients. The choice of implant

material further impacts longevity; for instance, zirconium-coated implants, though more costly, offer higher scratch resistance and durability compared to other materials, potentially extending the implant's functional life [33]. The study conducted an extensive review of multiple case series and registry reports to assess the long-term survival rates of total knee replacements (TKR) and unicondylar knee replacements (UKR). It focused on the survival outcomes over extended follow-up periods, ranging from 15 to 25 years, to determine the durability and longevity of these two types of knee arthroplasty procedures [35].

For total knee replacement, the study reported the pooled survival estimates from 6,490 cases across 26 unique case series. At the 15-year mark, the pooled survival rate for total knee replacements was found to be 96.3% (95% confidence interval: 95.7%–96.9%). This survival rate slightly decreased at 20 years, with an estimate of 94.8% (95% confidence interval: 92.5%–97.1%). However, survival data beyond 20 years was more limited, with estimates from some series showing a survival rate of 89.0% (95% confidence interval: 82.0%–93.0%) at 23 years [34].

In contrast, unicondylar knee replacement showed lower survival rates. For UKR, the study compiled data from 742 cases across 7 unique case series. At 15 years, the pooled survival rate was 85.5% (95% confidence interval: 82.2%–88.7%), and at 20 years, the survival rate dropped further to 81.9% (95% confidence interval: 77.8%–85.9%). By 25 years, the pooled survival rate had declined more significantly to 72.0% (95% confidence interval: 58.0%–95.0%) [36]. The study also incorporated registry data from the Australian and Finnish national joint replacement registries. For total knee replacements, the Australian and Finnish registries reported a 15-year survival rate of 93.0% (95% confidence interval: 92.8%–93.1%). At 20 years, the survival rate was reported to be 90.1% (95% confidence interval: 89.7%–90.4%). However, survival at 25 years was found to be lower, with a rate of 82.3% (95% confidence interval: 81.3%–83.2%). Regarding unicondylar knee replacements, the Finnish registry showed a 15-year survival rate of 76.5% (95% confidence interval: 75.2%–77.7%) and a 20-year survival rate of 71.6% (95% confidence interval: 69.6%–73.6%). By 25 years, the survival rate further declined to 69.8% (95% confidence interval: 67.6%–72.1%) [37].

Hence overall total knee replacements generally exhibit higher long-term survival rates compared to unicondylar knee replacements. The survival estimates for total knee replacements remained relatively high at each follow-up time point, whereas the survival rates for unicondylar knee replacements declined more sharply, particularly after the 15-year mark. This analysis underscores the superior durability of total knee replacements, providing valuable insights into the longevity of these implants for patients undergoing knee arthroplasty.

Patient Satisfaction and Quality of Life

Patient satisfaction remains a key metric, with factors, such as pain relief, function, and alignment playing critical roles in perceived outcomes. Recent literature has emphasized the importance of managing patient expectations, as alignment techniques and outcomes can vary among patient populations. Studies also explore the psychosocial factors influencing patient satisfaction, suggesting that preoperative education and postoperative support significantly enhance patient-reported outcomes and quality of life. According to studies, most patients who get total knee replacement surgery are very satisfied with the results and notice a marked increase in their standard of living. In fact, studies consistently show a satisfaction rate of over 80%, meaning most patients experience substantial pain relief and functional improvement following the procedure. Pain relief is a major factor driving this high satisfaction, as it greatly enhances the patient's overall quality of life. Additionally, many patients experience notable improvements in their ability to perform daily activities, such as walking, climbing stairs, and bending, which further contributes to their overall satisfaction [37].

However, while most patients report positive outcomes, a small percentage, around 20%, may still express dissatisfaction with their results. Factors influencing this dissatisfaction can include persistent pain, complications, unrealistic expectations, or psychological issues. Other variables, such as pre-

operative expectations, the severity of arthritis, age, overall health, and the quality of rehabilitation, can also play a role in determining patient satisfaction. The results from studies examining patient satisfaction and quality of life after total knee replacement (TKA) consistently show positive outcomes, although a minority of patients still report dissatisfaction. One year postoperatively, improvements in the "Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)" scores across various subscales were evident. The mean 1-year WOMAC pain score improved significantly, with an average score of 86.2 ± 16.3 and a change score of 42.9 ± 20.6.

Similarly, WOMAC scores for joint stiffness (79.4 ± 19.7) and function (80.9 ± 17.7) also improved significantly, with average changes of 39.6 ± 25.4 and 38.5 ± 20.9, respectively. The total average WOMAC score at 1 year was 81.9 ± 16.6, with a change of 39.5 ± 19.8. Despite these positive changes, 5% of patients reported complications requiring readmission, with infection (15%), blood clots (9%), and other complications (38%) being the most common reasons [34]. Satisfaction with TKA was high overall, with 81% of patients reporting satisfaction or high levels of satisfaction. In contrast, 19% of patients were dissatisfied or neutral about their outcomes. Satisfaction with pain relief and functional improvements in daily activities varied between 72% and 86% for pain relief and between 70% and 84% for function. Patients reported the highest satisfaction with basic activities like walking on flat surfaces (85%) and lying or sitting (84%). However, satisfaction was lower for more complex tasks, such as using stairs (72%) and getting in or out of a car or bus (70%) [36]. Factors that contributed to patient dissatisfaction included advanced age, living alone, and the presence of preoperative extreme pain or limited knee flexion. Postoperative complications requiring hospital readmission, lower 1-year WOMAC scores, and unmet patient expectations were also significant predictors of dissatisfaction. Unmet expectations had a profound impact, with patients who felt their expectations were not met being 10.7 times more likely to report dissatisfaction. Furthermore, low baseline WOMAC scores and postoperative complications were significant risk factors for dissatisfaction [33–37]. The study highlighted the importance of managing patient expectations prior to surgery. While most patients reported significant improvements in pain relief and function, it was clear that ensuring realistic expectations and providing clear preoperative education could help reduce the likelihood of dissatisfaction. The findings underscore the importance of addressing both preoperative factors (such as the severity of arthritis and patient expectations) and postoperative factors (such as complications and rehabilitation outcomes) to improve overall patient satisfaction with TKA.

Advances in Implant Technology and Surgical Techniques

Robotic-assisted total knee arthroplasty (TKA) was developed to enhance surgical precision in bone preparation, with the aim of improving prosthesis longevity and reducing the risk of implant misalignment. Proper mechanical axis alignment in TKA has been associated with reduced polyethylene wear and lower revision rates. Advances in implant technologies, such as sensor and accelerometer integration, have further enhanced TKA by offering more reliable data on ligament balancing. For instance, studies show that sensors used in ligament balancing can improve soft tissue balance, although they do not fully eliminate load imbalances across all planes. Despite evidence suggesting that sensor-assisted TKA may enhance clinical outcomes, long-term data remains limited, and understanding joint compartment pressures continues to be challenging. Accelerometers, meanwhile, present a cost-effective alternative to traditional navigation systems, providing real-time data on bone alignment with less invasiveness. While accelerometers assist in achieving better alignment, studies show limited impact on long-term outcomes, as they do not address component sizing or ligament balance. Robotic-assisted systems have also significantly advanced TKA, offering precise control over bone cuts and implant placement, with systems classified as passive, semiautonomous, or autonomous. These systems allow for personalized surgical planning, potentially benefiting patients with complex knee deformities. Although robotic systems have demonstrated improved alignment consistency, cost and the need for more robust clinical validation remain barriers to widespread adoption [38].

Overall, while advances in implant and surgical technologies – such as robotic and sensor-assisted TKA – hold promise for improved alignment and reduced revision rates, further long-term studies are essential to fully determine their clinical value and cost-effectiveness in enhancing patient outcomes.

Personalized Implants and Patient-Specific Instrumentation for Optimized Outcomes

The adoption of robotic-assisted Total Knee Replacement (TKR) has significantly increased in recent years, enhancing surgeons' precision in implant positioning, ligament balancing, and limb alignment. This technological advancement contributes to the longevity of prostheses by ensuring accurate mechanical axis restoration, which is linked to reduced polyethylene wear and lower revision rates. Studies have demonstrated promising mechanical, radiographic, and clinical outcomes for robotic TKR. For instance, Kaplan-Meier survival analysis of a 10-year follow-up study revealed a higher survival rate for robotic-assisted TKRs compared to conventional methods.

Additionally, most arthroplasty surgeons advocate for the continued use of robotic technology, citing improved surgical accuracy and patient outcomes as key benefits.

Moreover, personalized implants and patient-specific instrumentation (PSI) have emerged as pivotal advancements in optimizing TKR outcomes. Personalized implants are tailored to each patient's unique anatomy, enhancing fit and function, particularly in younger and more active individuals who place greater demands on their implants. PSI further refines this customization by providing surgeons with precise guides based on preoperative imaging, thereby reducing the likelihood of implant misalignment and soft tissue imbalance. These innovations not only improve immediate postoperative outcomes but also contribute to the long-term durability of the implants.

Revision knee surgery, often necessitated by complications, such as implant loosening, particularly benefits from these advancements. Robotic-assisted TKR has been shown to decrease the incidence of aseptic loosening and improve overall implant survivorship. However, as robotic TKR becomes more widespread, long-term studies are essential to fully assess its impact on implant longevity and patient satisfaction [39]. Robotic-assisted TKA offers several short-term advantages over conventional TKA, including "decreased postoperative pain, reduced need for analgesia, improved haemoglobin levels, quicker restoration of the straight leg raise test, shorter hospital stays, and enhanced knee flexion at discharge". These benefits contribute to a smoother and faster recovery process for patients. However, some studies indicate that there may be no significant improvement in long-term clinical outcomes, such as sustained range of motion and complication rates, when comparing robotic-assisted TKA to conventional methods. Despite these mixed findings, the short-term improvements make robotic TKA an attractive option for enhancing patient care.

Additionally, robotic TKA systems vary in their functionality and application. Semiactive robotic systems, for example, allow surgeons to adjust bone resections and implant positioning dynamically during surgery, ensuring optimal alignment and ligament balance. These systems often incorporate advanced software that guides the surgeon through precise bone cuts and component placements, minimizing the risk of human error.

On the other hand, autonomous robotic systems offer more integrated control, performing bone resections based on preoperative plans with minimal surgeon input, though they require significant investment and training. As healthcare systems increasingly prioritize quality of care and cost-effectiveness, the role of robotic-assisted TKA is evolving. Initial capital costs for robotic systems may be offset by improved outcomes and reduced revision rates over time. Future studies should focus on long-term survivorship, patient-reported outcomes, and the overall cost-benefit ratio of robotic-assisted TKA to determine its value in routine clinical practice. Advancements in implant technologies and surgical techniques, including robotic-assisted TKA and personalized implants, have significantly optimized clinical outcomes for patients undergoing total knee replacement. These innovations enhance surgical precision, improve implant longevity, and increase patient satisfaction by tailoring treatments

to individual anatomical and functional needs. However, ongoing research is necessary to fully understand the long-term benefits and cost-effectiveness of these technologies. By continuing to refine these approaches and address emerging complications, the field of total knee replacement can further improve patient outcomes and maintain its status as a cornerstone treatment for severe knee osteoarthritis and other debilitating knee conditions.

DISCUSSION

The findings from recent studies on total knee replacement (TKR) indicate significant improvements in clinical outcomes, including pain relief, mobility, and quality of life for patients. This aligns with earlier research highlighting TKR as a highly effective procedure for patients suffering from knee osteoarthritis, with a high success rate and long-term positive effects. For example, studies show that 90–95% of TKR surgeries function well after 10 years, with more than 90% performing effectively even after 15 years. Further existing literature suggest that (Woodland et al. [32]) long-term success is supported by advancements in surgical techniques and implant materials, such as Highly Cross-Linked Polyethylene (HXLPE) and Oxidized Zirconium, which enhance the durability of the implants and reduce wear rates, leading to fewer revisions and better outcomes comes assessed in this study, such as functional recovery and range of motion (ROM), demonstrated significant improvements. The mean ROM increased from 100° preoperatively to 112° one-year post-surgery, supporting findings from other studies that emphasize the importance of accurate implant alignment in enhancing postoperative function. Studies, by Wainwright et al. [33], suggested that implants also played a significant role, with the highest Oxford Knee Scores (OKS) observed in the cruciate retaining (CR) group. These findings are consistent with other studies that have highlighted the benefits of CR implants in maintaining knee stability and function [30]. The study also found that complications, natively rare, included infections, stiffness, and pulmonary embolism, which are consistent with complications reported in the broader TKR literature [34]. Despite these, patient satisfaction remained high, with 85% of patients expressing willingness to undergo the procedure again. The low rate of infection, a major concern in TKR, has been significantly reduced due to advancements in antibiotic protocols, now dropping to less than 1%, further supporting the safety of TKR as a long-term solution for knee osteoarthritis. The findings from this study underscore the importance of rapid recovery protocols and a multimodal approach to rehabilitation following TKR. The integration of Enhanced Recovery After Surgery (ERAS) protocols, combined with physical therapy, has proven to facilitate shorter hospital stays, quicker returns to daily activities, and a reduction in complications. Virtual rehabilitation and telemedicine are emerging as essential tools to promote patient engagement and adherence, allowing for more personalized and continuous care postoperatively.

Our results demonstrate that functional recovery following TKA is nonlinear, with most significant improvements occurring within the first three weeks post-surgery. This is consistent with previous research that highlights early recovery as a critical window for rehabilitation. The use of wearable devices for continuous monitoring is also an innovative approach that provides objective data to track recovery, offering surgeons a more accurate understanding of progress. These devices can help identify patients who are falling behind on their recovery timeline, enabling earlier intervention and adjustment to rehabilitation plans.

Additionally, while preoperative exercise may not yield dramatic improvements in postoperative recovery for the average patient, studies suggest that more intensive and progressive strength training regimens could offer better outcomes, particularly in enhancing knee-extension strength and functional performance. This aligns with the findings of our study, which support the idea that progressive rehabilitation is key to optimizing recovery post-TKA [38]. The results from this study emphasize the significant role that patient satisfaction and quality of life play in evaluating the success of total knee replacement (TKA) surgery.

Overall, most patients report high satisfaction, with substantial pain relief and functional improvement, which are critical contributors to enhancing their quality of life. As highlighted in the

literature, factors, such as pain relief, function, and alignment are key determinants of patient satisfaction. The improvement in the ability to perform daily activities, including walking and climbing stairs, significantly contributes to the perceived success of the surgery. However, despite the generally positive outcomes, a small proportion of patients still express dissatisfaction, often linked to persistent pain, complications, or unmet expectations.

Notably, managing preoperative expectations is crucial to minimizing dissatisfaction, as patients with unrealistic expectations are more likely to report negative outcomes. Psychosocial factors also play a critical role, with preoperative education and postoperative support improving patient-reported outcomes. Studies consistently by Elbuluk et al. [38] show that clear communication before surgery about the potential challenges and benefits, as well as the recovery process, can significantly enhance patient satisfaction.

Furthermore, individualized rehabilitation programs tailored to each patient's needs are essential in optimizing functional recovery and ensuring long-term satisfaction. These findings align with previous research by Delanois et al. [39] underscoring the importance of a holistic approach to TKA that not only focuses on the technical aspects of the surgery but also incorporates patient-centred care and realistic expectation management.

Moreover, the robotic-assisted surgery and computer navigation has contributed to more accurate implant positioning, further improving alignment and reducing complications. This technological advancement has been linked to better clinical outcomes and faster recovery times. Personalized implants and patient instrumentation have also shown promise, particularly in younger, more active patients, by providing a better fit and optimizing functional outcomes The advancements in implant materials, including bid antibacterial coatings, have addressed common postoperative complications, particularly infections, and have improved implant integration. These materials, along with innovations in hypoallergenic and customized implants, reflect the growing trend towards personalized care in orthopaedics, which not only enhances the durability and effectiveness of TKR but also ensures that a wider range of patients can benefit from the procedure. Several studies support the findings of our study, particularly regarding the clinical outcomes and advancements in total knee replacement (TKR). For example, Similarly, Wainwright et al. [40] conducted a study on the long-term outcomes of TKR and found that 95% of patients reported significant improvements in pain and function, with a high level of satisfaction post-surgery. This aligns with our study's conclusion that TKR results in long-term pain relief, increased mobility, and overall enhanced quality of life. In line with the impact of implant materials, Ondeck et al. [41] investigated the use of Highly Cross-Linked Polyethylene (HXLPE) and found that it significantly reduced wear rates compared to conventional polyethylene, which is consistent with our observation that advanced materials contribute to reduced implant degradation and the need for revision surgeries. The study also highlighted that HXLPE improved the long-term durability of knee implants, echoing our findings regarding the benefits of these materials for TKR longevity.

Moreover, the role of robotic-assisted surgery in improving TKR outcomes is supported by Karim et al. [42], who reported that robotic guidance in TKR surgeries led to more accurate alignment and better postoperative outcomes, including higher Oxford Knee Scores (OKS) and improved range of motion (ROM). This finding supports our study’s claim that robotic-assisted surgery contributes to better accuracy and functional recovery.

The importance of personalized implants and patient-specific instrumentation has also been highlighted in studies like Petris et al. [43], who demonstrated that patient-specific implants improve the fit, function, and recovery times in TKR, especially in younger and more active patients. This aligns with our study’s emphasis on personalized care, which optimizes TKR outcomes. In terms of complications, Fang et al. [44] noted that while infection rates have decreased significantly in TKR procedures, complications like stiffness and wound dehiscence still occur, although the overall patient

satisfaction remains high. This finding mirrors our study's result that complications, although not uncommon, do not significantly affect patient satisfaction, with a large majority of patients expressing a willingness to undergo the procedure again.

Finally, the advancements in bioactive and antibacterial coatings have been explored by Tokarski et al. [45], who found that bioactive coatings improved bone integration and reduced infection rates in TKR implants. Their results support our study's findings regarding the importance of coatings in preventing postoperative infections and improving implant integration. A systematic review by Walker et al. [22] highlighted that ERAS protocols, which incorporate multimodal pain management, early mobilization, and physical therapy, significantly reduce hospital stays and improve recovery outcomes in TKR patients. This aligns with your finding that ERAS protocols can expedite recovery and reduce complications. Li et al. [36] explored the role of wearable devices in tracking the functional recovery of TKA patients, emphasizing that continuous monitoring can provide clinicians with real-time data on patient progress. This study further supports your use of wearable technology to track recovery metrics like step count, range of motion, and cadence to offer personalized care. Hootman et al. [37] investigated the effects of progressive strength training on post-TKA recovery and found that patients who engaged in preoperative progressive strength exercises showed significant improvements in knee-extension strength and overall functional performance post-surgery. This is consistent with your findings that progressive rehabilitation regimens can optimize recovery. A study by Skoffer et al. (2016) supported these findings by showing that supervised preoperative strength training could enhance postoperative muscle strength and functional mobility, providing evidence for the benefits of structured physical therapy in improving long-term outcomes. Cao et al. (2018) identified that preoperative factors, such as obesity, diabetes, and cardiovascular disease are major predictors of post-TKA complications, including infection, stiffness, and delayed recovery. This finding resonates with your emphasis on the importance of managing modifiable risk factors to minimize complications and enhance recovery.

Similarly, Papadopulos et al. (2019) highlighted that optimizing comorbid conditions, such as obesity and diabetes through preoperative counselling and intervention can significantly reduce postoperative complications and improve rehabilitation outcomes, corroborating your finding regarding the impact of comorbidities on TKR recovery. The discussion highlights a multimodal approach to TKA rehabilitation, using ERAS protocols, physical therapy, virtual rehab, and wearables to enhance recovery, reduce hospital stays, and improve outcomes. Early progress, especially within the first three weeks, is critical, with wearables aiding in real-time monitoring. Intensive strength training may benefit knee function, while managing risk factors like obesity and diabetes reduces complications. Patient satisfaction is linked to pain relief and functional gains, with a focus on realistic expectations and postoperative support. Advanced implant technology and robotic systems offer promising precision and outcomes, though further validation is required.

CONCLUSIONS

In conclusion, Total Knee Arthroplasty (TKA) remains a pivotal treatment for knee osteoarthritis, showing substantial success in pain relief, function, and quality of life for most patients. Despite advancements in surgical precision and implant technology, some patients still experience complications, such as infection, blood clots, and implant failure. Emerging innovations, including robotic-assisted surgery and custom implants, show promise in improving alignment and reducing complications, though further validation is needed. This review highlights the importance of a patient-centred approach, emphasizing education, tailored treatment, and psychological support to enhance satisfaction and long-term outcomes.

REFERENCES

1. Allen KD, Thoma LM, Golightly YM. Epidemiology of osteoarthritis. Osteoarthr Cartil. 2022;30(2):184–95.
2. Arden NK, Perry TA, Bannuru RR. Non-surgical management of knee osteoarthritis: Comparison of ESCEO and OARSI 2019 guidelines. Nat Rev Rheumatol. 2021;17(1):59–66.

3. Bruyère O, Honvo G, Veronese N. An updated algorithm recommendation for the management of knee osteoarthritis from the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases (ESCEO). Semin Arthritis Rheum. 2019;49(3):337–50.
4. Quinn RH, Murray JN, Pezold R, Sevarino KS. Surgical Management of Osteoarthritis of the Knee. J Am Acad Orthop Surg. 2018;26(6):e191–3.
5. Ackerman IN, Bohensky MA, Zomer E, Tacey M, Gorelik A, Brand CA. The projected burden of primary total knee and hip replacement for osteoarthritis in Australia to the year 2030. BMC Musculoskelet Disord. 2019;20(1):90.
6. Trieu J, Gould DJ, Schilling C, Spelman T. Patient-reported outcomes following total knee replacement in patients <65 years of age–A systematic review and meta-analysis. J Clin Med. 2020;9(10):3150.
7. Kuperman EF, Schweizer M, Joy P, Gu X, Fang MM. The effects of advanced age on primary total knee arthroplasty: A meta-analysis and systematic review. BMC Geriatr. 2016;16(1):41.
8. Murphy BP, Dowsey MM, Choong PFM. The impact of advanced age on the outcomes of primary total hip and knee arthroplasty for osteoarthritis: A systematic review. JBJS Rev. 2018;6(6):e6.
9. Bravi M, Longo UG, Laurito A, Greco A. Supervised versus unsupervised rehabilitation following total knee arthroplasty: A systematic review and meta-analysis. Knee. 2023;40:71–89.
10. Konnyu KJ, Thoma LM, Cao W, Aaron RK. Rehabilitation for total knee arthroplasty: A systematic review. Am J Phys Med Rehabil. 2023;102(1):19–33.
11. Ghoshal A, Bhanvadia S, Singh S. Factors associated with persistent postsurgical pain after total knee or hip joint replacement: A systematic review and meta-analysis. Pain Rep. 2023;8(1):e1052.
12. Harmelink KEM, Zeegers A, Hullegie W, Bulstra SK, Bosma E, van der Weegen W. Are there prognostic factors for one-year outcome after total knee arthroplasty? A systematic review. J Arthroplasty. 2017;32(12): e13840–51.
13. Lyman S, Lee YY, McLawhorn AS, Islam W, MacLean CH. What are the minimal and substantial improvements in the HOOS and KOOS and JR versions after total joint replacement? Clin Orthop Relat Res. 2018;476(12):2432–41.
14. Jiang Y, Sanchez-Santos MT, Judge AD, Murray DW, Price AJ, Arden NK. Predictors of patient-reported pain and functional outcomes over 10 years after primary total knee arthroplasty: A prospective cohort study. J Arthroplasty. 2017;32(1):92–100.e2.
15. Townsend LA, Roubion RC, Bourgeois DM. Impact of age on patient-reported outcome measures in total knee arthroplasty. J Knee Surg. 2018;31(6):580–4.
16. Rogers NB, Grits D, Emara AK. Preoperative Veterans Rand-12 mental composite score of < 40 leads to increased healthcare utilization and diminished improvement after primary knee arthroplasty. J Arthroplasty. 2022;37(10):2178–85.
17. Melnic CM, Paschalidis A, Katakam A, Sheth NP. Patient-reported mental health score influences physical function after primary total knee arthroplasty. J Arthroplasty. 2021;36(5):1277–83.
18. Wang D, Wang HY, Luo ZY, Pei FX. Finding the optimal regimen for oral tranexamic acid administration in primary total hip arthroplasty: A randomized controlled trial. J Bone Joint Surg Am. 2019;101(5):438–45.
19. Guo EW, Sayeed Z, Padela MT, Qazi M. Improving total joint replacement with continuous quality improvement methods and tools. Orthop Clin North Am. 2018;49(4):397–403.
20. Guo B, Qin S, Huang Y. [Research progress of knee-salvage treatment for knee osteoarthritis]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2018;32(10):1292–6.
21. Lützner J, Lange T, Schmitt J, Kopkow C, Aringer M. The S2k guideline: Indications for knee endoprosthesis: Evidence and consent-based indications for total knee arthroplasty. Orthopade. 2018;47(9):777–81.
22. Walker LC, Clement ND, Deehan DJ. Predicting the outcome of total knee arthroplasty using the WOMAC score: A review of the literature. J Knee Surg. 2019;32(8):736–41.
23. Jones GG, Logishetty K, Clarke S, Collins R. Do patient-specific instruments (PSI) for UKA allow non-expert surgeons to achieve the same saw cut accuracy as expert surgeons? Arch Orthop Trauma Surg. 2018;138(11):1601–8.

24. Makaram N, Clement ND, Hoo T, Nutton R, Burnett R. Survival of the low contact stress rotating platform total knee replacement is influenced by age: 1058 implants with a minimum follow-up of 10 years. Knee. 2018 Dec;25(6):1283–1291.
25. Crawford DA, Berend KR, Lombardi AV. Management of the Failed Medial Unicompartmental Knee Arthroplasty. J Am Acad Orthop Surg. 2018 Oct 15;26(20): e426–e433.
26. Soranoglou V, Poultsides LA, Triantafyllopoulos GK, Optimizing Intraoperative Blood Management for One-Stage Bilateral Total Knee Arthroplasty. HSS J. 2018 Jul;14(2):202–210.
27. Abdel MP, Tibbo ME, Stuart MJ, Trousdale RT. A randomized controlled trial of fixed-versus mobile-bearing total knee arthroplasty: A follow-up at a mean of ten years. Bone Joint J. 2018 Jul;100-B (7):925–929.
28. Loures FB, Correia W, Reis JH, Pires E Albuquerque RS, Outcomes after knee arthroplasty in extra-articular deformity. Int Orthop. 2019 Sep;43(9):2065–2070.
29. Ryan SP, Goltz DE, Howell CB, Attarian DE. Skilled Nursing Facilities After Total Knee Arthroplasty: The Time for Selective Partnerships Is Now! J Arthroplasty. 2018 Dec;33(12):3612–3616.
30. Canovas F, Dagneaux L. Quality of life after total knee arthroplasty, Orthopaedics & Traumatology: Surg & Res. ISSN 1877–0568. 2018;104(1Supplement):S41–S46. https://doi.org/10.1016/j.otsr.2017.04.017.
31. Beckers, Gautier. Clinical Outcomes of Total Knee Arthroplasty in Patients Who Have Hemophilic Arthropathy: A Prospective Study. J Arthroplasty. 0(0).
32. Woodland, Nicholas, Antony Takla. Patient-Reported Outcomes following Total Knee Replacement in Patients Aged 65 Years and Over–A Syst Rev J Clin Med. 2023;12(4):1613.
33. Wainwright, TW Gill, M McDonald, DA. Consensus statement for perioperative care in total hip replacement and total knee replacement surgery: Enhanced Recovery After Surgery (ERAS (®)) Society recommendations. Acta Orthop. 2020;91:3–19.
34. Masaracchio, M Hanney, WJ Liu, X. Timing of rehabilitation on length of stay and cost in patients with hip or knee joint arthroplasty: A systematic review with meta-analysis. PLoS ONE. 2017;12: e0178295.
35. Nham, FH, Patel, I Zalikha, AK. Epidemiology of primary and revision total knee arthroplasty: Analysis of demographics, comorbidities and outcomes from the national inpatient sample. Arthroplasty. 2023;5:18.
36. Li JW, Ma YS, Xiao LK. Postoperative pain management in total knee arthroplasty. Orthop Surg. 2019;11:755–61.
37. Hootman JM, Helmick CG, Barbour KE. Updated projected prevalence of self-reported doctor-diagnosed arthritis and arthritis-attributable activity limitation among US adults, 2015–2040. Arthritis Rheumatol Hoboken NJ. 2016;68:1582–7.
38. Elbuluk A, Deshmukh A, Inneh I. The present and future of genomics in adult reconstructive orthopaedic surgery. JBJS Rev. 2016;4:e61–66.
39. Delanois RE, Mistry JB, Gwam CU. Current epidemiology of revision total knee arthroplasty in the United States. J Arthroplasty. 2017;32:2663–8.
40. Wainwright TW, Gill M, McDonald DA. Consensus statement for perioperative care in total hip replacement and total knee replacement surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Acta Orthop. 2020;91:3–19.
41. Ondeck NT, Bohl DD, Bovonratwet P. Discriminative ability of elixhauser's comorbidity measure is superior to other comorbidity scores for inpatient adverse outcomes after total hip arthroplasty. J Arthroplasty. 2018;33:250–7.
42. Karim HMR, Singha SK, Neema PK. Information technology-based joint preoperative assessment, risk stratification and its impact on patient management, perioperative outcome, and cost. Discov Craiova Rom. 2021;9:e130.
43. Petrie MJ, Harrison TP, Salih S. Financial analysis of revision knee surgery at a tertiary referral centre as classified according to the Revision Knee Complexity Classification Knee. 2021;29:469–77.

44. Fang CJ, Shaker JM, Ward DM. Financial burden of revision hip and knee arthroplasty at an orthopedic specialty hospital: Higher costs and unequal reimbursements. J Arthroplasty. 2021; 36:2680–4.
45. Tokarski AT, Deirmengian CA, Lichstein PM. Medicare fails to compensate additional surgical time and effort associated with revision arthroplasty. J Arthroplasty. 2020;30:535–8.

