Scientific Publications

Global Journal of Orthopedics, 2025, 1, 6016
www.scipublications.com/journal/index.php/gjo
DOI: 10.31586/gjo.2025.6016

Review Article

Comprehensive Review of Conservative and Surgical Treatment Strategies for Knee Osteoarthritis: Efficacy, Safety, and Emerging Therapies

Helder Rocha da Silva Araújo [1], Andrei Machado Viegas da Trindade [2], Thamara Cardoso Jacob [3], Geovana Goulart Ribeiro de Freitas [3], Samuel Ferreira Barbosa [3], Maria Tereza Guay de Goiás [3], Isabella Luiza das Graças Rocha Borges [3], Lucas Guzzi Silva [4], Fabiano Bottino Cançado [4], Fernanda Grazielle da Silva Azevedo Nora [3,*]

[1] Department of Orthopedics and Traumatology, HC/UFG – Hospital das Clínicas, Universidade Federal de Goiás, Goiânia, Goiás, Brazil

[2] Department of Orthopedics and Traumatology, CRER - Centro Estadual de Reabilitação e Readaptação Dr. Henrique Santillo, Goiânia, Goiás, Brazil

[3] LAM – Movement Architecture Laboratory, Universidade Federal de Goiás, Goiânia, Goiás, Brasil

[4] Department of Orthopedics and Traumatology, Hospital de Base de São Jose do Rio Preto, São Joé do Rio Preto, São Paulo, Brazil

*Correspondence: Fernanda Grazielle da Silva Azevedo Nora (fernanda_nora@ufg.br)

How to cite this paper: Silva Araújo, H. R. da, Trindade, A. M. V. da, Jacob, T. C., Freitas, G. G. R. de, Barbosa, S. F., Goiás, M. T. G. de, Graças Rocha Borges, I. L. das, Silva, L. G., Cançado, F. B., & Silva Azevedo Nora, F. G. da. (2025). Comprehensive Review of Conservative and Surgical Treatment Strategies for Knee Osteoarthritis: Efficacy, Safety, and Emerging Therapies. Global Journal of Orthopedics, 1(1), 24–37.
DOI: 10.31586/gjo.2025.6016

Received: January 30, 2025
Revised: March 3, 2025
Accepted: March 27, 2025
Published: March 29, 2025

Abstract: Knee osteoarthritis (KOA) is a chronic degenerative joint disorder that significantly impairs mobility and quality of life. While surgical interventions such as total knee arthroplasty (TKA) are effective in severe cases, conservative treatments are critical for early and intermediate disease management. This review evaluates the efficacy, safety, and clinical applications of both conservative and surgical treatment approaches, including lifestyle modifications, physical therapy, pharmacological interventions, regenerative medicine, and surgical procedures. The integration of a multidisciplinary approach is emphasized as a key strategy for optimizing clinical outcomes and tailoring interventions to disease severity.

Keywords: Knee Osteoarthritis, Conservative Management, Surgical Treatment, Total Knee Arthroplasty, Regenerative Medicine

1. Introduction

Knee osteoarthritis (KOA) is a leading cause of disability worldwide, affecting millions of individuals and posing a significant public health challenge [1]. It is a progressive degenerative disease characterized by cartilage degradation, subchondral bone remodeling, synovial inflammation, and chronic pain [2]. The increasing prevalence of KOA is primarily driven by aging populations, rising obesity rates, and sedentary lifestyles, leading to substantial functional limitations and reduced quality of life [3].

The pathogenesis of KOA is multifactorial, influenced by genetic predisposition, metabolic dysfunction, and mechanical stress on the joint [4, 5, 6]. Without timely and effective intervention, KOA progresses to advanced stages, often necessitating surgical treatment such as total knee arthroplasty (TKA) [7, 8]. Therefore, a comprehensive treatment strategy, integrating both conservative and surgical approaches, is essential for effective disease management and symptom relief.

Conservative management plays a crucial role in delaying disease progression and alleviating symptoms. This approach includes lifestyle modifications, weight management, structured exercise programs, physical therapy, and pharmacological treatments. Emerging regenerative medicine therapies, such as platelet-rich plasma (PRP) and mesenchymal stem cells, have shown promising results in tissue regeneration and inflammation modulation [9]. Despite their benefits, conservative treatments may not be sufficient for advanced KOA cases, necessitating surgical intervention.

Surgical treatments, including total knee arthroplasty (TKA), unicompartmental knee arthroplasty (UKA), and high tibial osteotomy (HTO), provide long-term relief for patients with severe KOA who do not respond to conservative therapies. Advances in surgical techniques, such as robotic-assisted TKA, have enhanced precision, improving patient outcomes and implant longevity [10]. However, surgical procedures carry risks, including infection, implant loosening, and persistent pain, highlighting the need for careful patient selection and preoperative education [11].

The objective of this review is to provide a comprehensive analysis of both conservative and surgical treatment strategies for KOA, evaluating their efficacy, safety, and clinical applications. This article aims to highlight the strengths and limitations of different therapeutic approaches, facilitating informed decision-making for clinicians and patients. By integrating evidence-based treatment options, the review seeks to support healthcare professionals in developing personalized management plans to optimize patient outcomes and improve quality of life.

2. Conservative Treatment of Knee Osteoarthritis

Knee osteoarthritis (KOA) is a chronic degenerative joint disease characterized by cartilage degradation, subchondral bone remodeling, and synovial inflammation, significantly impacting patient quality of life [2]. Conservative management plays a pivotal role in delaying disease progression and improving functional outcomes before surgical intervention becomes necessary. The primary conservative strategies include lifestyle modifications, physical therapy, pharmacological treatments, and emerging biologic therapies, which require a multidisciplinary approach for optimal efficacy.

2.1. Epidemiology and Risk Factors

Knee osteoarthritis (KOA) has been increasing in prevalence globally, making it a major public health concern [3]. Cui et al. [3] reported that aging, obesity, female sex, and genetic predisposition are among the most significant risk factors. Wallace et al. [4, 5, 6] demonstrated that KOA prevalence has doubled since the mid-20th century, even after adjusting for changes in body mass index (BMI) and aging, suggesting that environmental and lifestyle factors play an increasing role in disease onset. Pal et al. [3] highlighted the epidemiological trends in developing countries, indicating that urbanization, changes in physical activity levels, and dietary shifts contribute to the rising incidence of KOA.

Metabolic syndrome has also been strongly linked to KOA pathogenesis, as highlighted by Niu et al. [12]. The interplay between insulin resistance, systemic inflammation, and dyslipidemia is believed to accelerate cartilage degradation and synovial inflammation [13]. Furthermore, Liu et al. [3] identified an association between metabolic disorders and KOA severity, reinforcing the role of systemic metabolic dysregulation in disease progression.

Beyond well-established risk factors, lifestyle habits significantly influence KOA development. Georgiev and Angelov [14] emphasized that a sedentary lifestyle exacerbates joint degeneration by reducing mechanical stimulation essential for cartilage health. Additionally, dietary habits, particularly high sugar and processed food intake, contribute to systemic inflammation, further aggravating KOA symptoms [15]. Diets rich in anti-inflammatory nutrients, such as omega-3 fatty acids and antioxidants, may offer protective benefits [7, 8].

Occupational hazards also contribute to KOA risk. Prolonged standing, repetitive knee flexion, and heavy lifting are associated with an increased likelihood of KOA development, particularly in labor-intensive professions [3]. Vannini et al. [3] discussed the role of high-impact sports in accelerating joint wear and tear, particularly in athletes exposed to repetitive microtrauma and inadequate recovery periods. These findings highlight the importance of ergonomic interventions and workplace modifications in preventing work-related KOA.

A significant correlation exists between previous knee injuries and KOA onset. Snoeker et al. [3] found that individuals with a history of anterior cruciate ligament (ACL) injuries, meniscal tears, or intra-articular fractures had a markedly higher risk of developing KOA later in life. The study emphasized that post-injury rehabilitation plays a crucial role in delaying OA progression. Similarly, Felson et al. [16] and Atukorala et al. [4] underscored that synovitis following knee trauma is a strong predictor of radiographic KOA development, making early intervention critical in high-risk populations.

Genetic predisposition has gained attention as a key factor in KOA susceptibility. Gardiner et al. [3] proposed computational models integrating genetic and environmental factors to predict KOA risk, which could help in personalized risk assessments. Studies by Dell'Isola and Steultjens [17] further classified KOA into distinct clinical phenotypes, suggesting that genetic profiling may assist in targeted therapy selection.

Lastly, recent advances in artificial intelligence and machine learning have enabled more precise epidemiological assessments. Tiulpin et al. [18, 19] developed deep learning models capable of detecting KOA in radiographic images with high accuracy, allowing for earlier and more reliable diagnoses. Such advancements could contribute to improved screening and preventive strategies for at-risk populations.

2.2. Role of Obesity and Weight Management

Obesity remains one of the most critical modifiable risk factors for knee osteoarthritis (KOA) [3]. Raud et al. [3] established a dose-response relationship between body mass index (BMI) and KOA severity, demonstrating that excessive weight significantly increases joint loading and exacerbates inflammatory processes. The biomechanical overload caused by excessive body weight accelerates cartilage wear, leading to an increased risk of disease progression [3]. Additionally, obesity is associated with metabolic alterations that contribute to systemic inflammation, further aggravating joint deterioration [12].

Weight reduction programs that incorporate both dietary interventions and structured physical activity have demonstrated substantial improvements in pain relief and functional capacity [7, 8]. Regular physical activity has been shown to reduce intra-articular stress while improving muscle strength, joint stability, and proprioception, factors essential in mitigating disease progression [20, 21, 22]. Furthermore, structured weight-loss interventions have resulted in decreased pro-inflammatory cytokine levels, which are implicated in cartilage degradation [13].

Beyond its biomechanical effects, obesity contributes to KOA pathogenesis through adipose tissue-derived bioactive mediators known as adipokines. These substances, including leptin, resistin, and visfatin, promote synovial inflammation, cartilage degradation, and subchondral bone remodeling [13, 14]. Elevated leptin levels, in particular, have been associated with increased cartilage catabolism and enhanced expression of pro-inflammatory cytokines, exacerbating the degenerative process [9].

Dietary interventions aimed at reducing systemic inflammation have gained traction as adjuncts to traditional weight management approaches. Diets rich in anti-inflammatory nutrients, such as omega-3 fatty acids and polyphenols, have been associated with reduced oxidative stress and cartilage degradation [7, 8, 23]. In contrast, high-sugar and high-fat diets have been shown to exacerbate systemic inflammation and contribute to disease progression [15]. Implementing personalized nutritional plans tailored to patient needs may enhance treatment outcomes.

Physical activity, a cornerstone of weight management, plays a dual role in KOA management by reducing mechanical load on the joint and modulating inflammatory pathways. Zeng et al. [20, 21, 22] emphasized the role of resistance training and aerobic exercise in enhancing joint function and alleviating pain. However, exercise programs must be adapted to individual patient capabilities to prevent exacerbation of symptoms [24]. Aquatic exercise has emerged as a particularly effective intervention, as it provides resistance training benefits while minimizing joint stress [23].

Pharmacological interventions, such as appetite suppressants and metabolic drugs, have been explored as adjuncts to lifestyle modifications. However, their long-term efficacy and safety profiles remain uncertain [23]. Certain anti-diabetic medications, including glucagon-like peptide-1 (GLP-1) receptor agonists, have demonstrated potential in promoting weight loss and reducing systemic inflammation, but further research is needed to establish their role in KOA management [17]. While these pharmacologic strategies may serve as short-term solutions, they should be used in conjunction with lifestyle interventions rather than as standalone treatments [24].

Beyond individual behavioral changes, socioeconomic factors influence weight management outcomes. Patients with limited access to healthy food options and structured exercise programs face additional barriers in managing obesity-related KOA [25]. Implementing community-based interventions, including subsidized fitness programs and nutritional education initiatives, may improve adherence to weight management strategies [26]. Furthermore, behavioral therapy plays a crucial role in sustaining long-term weight loss by addressing psychological factors contributing to obesity [15].

Ultimately, a multidisciplinary approach incorporating dietary modifications, structured exercise, pharmacological support, and behavioral interventions is essential for effective weight management in KOA patients. By targeting both biomechanical and inflammatory pathways, weight reduction strategies can significantly improve symptom severity, delay disease progression, and enhance overall quality of life [14, 7, 8]. Future research should focus on optimizing integrative treatment models that address both metabolic and mechanical contributors to KOA progression.

2.3. Exercise Therapy and Rehabilitation

Exercise therapy remains a cornerstone in the conservative management of knee osteoarthritis (KOA), offering both symptomatic relief and functional improvement [20, 21, 22]. Zeng et al. [20, 21, 22] reviewed various exercise modalities, including aerobic training, resistance exercises, proprioceptive training, and aquatic therapy, all of which improve joint mechanics and reduce symptoms. Regular physical activity has been associated with decreased pain severity and enhanced joint mobility, contributing to improved quality of life [23]. Furthermore, structured exercise programs tailored to individual patient capabilities yield better outcomes than self-directed regimens [24].

Aerobic exercise, such as walking, cycling, and swimming, has been shown to enhance cardiovascular fitness while reducing pain and stiffness in KOA patients [7, 8]. Strength training plays a critical role in knee stability by targeting the quadriceps and hamstring muscles, which support joint function [23]. Neuromuscular training, including balance and proprioception exercises, has also been highlighted as an effective intervention to prevent falls and enhance movement efficiency [20, 21, 22].

Beyond strengthening muscles around the knee, exercise plays a role in modulating inflammation. Studies by Du et al. [9] suggest that moderate-intensity exercise can influence cytokine activity, decreasing levels of interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), which are implicated in KOA pathogenesis. Regular physical activity also enhances synovial fluid circulation, which nourishes cartilage and reduces joint stiffness [14]. In contrast, prolonged physical inactivity exacerbates cartilage degradation and contributes to disease progression [12].

Aquatic therapy, or hydrotherapy, has been particularly beneficial for KOA patients with significant pain and mobility limitations. Performing exercises in water reduces joint loading while maintaining resistance for muscle strengthening [20, 21, 22]. Hydrotherapy has been associated with improvements in pain relief, gait mechanics, and overall functional capacity [23]. Additionally, aquatic exercise programs have demonstrated superior adherence rates compared to land-based interventions, particularly among elderly populations [25].

Resistance training, particularly low-impact strength exercises, is another fundamental component of KOA rehabilitation. Progressive resistance training increases muscle mass and improves load distribution across the knee joint, reducing the risk of further cartilage damage [7, 8]. Isometric and isotonic exercises have been shown to enhance quadriceps strength, a key factor in knee joint stabilization [3]. However, improper exercise execution or excessive mechanical load may lead to exacerbation of symptoms, emphasizing the need for supervised rehabilitation programs [24].

Individualized rehabilitation programs tailored to patient-specific needs are essential for maximizing treatment outcomes. Emery et al. [26] emphasized that patient-reported outcomes and functional assessments should guide exercise prescription. Comprehensive rehabilitation plans should integrate patient preferences, symptom severity, and comorbidities to optimize long-term adherence and efficacy [17]. Personalized interventions that incorporate motivational strategies, such as goal setting and patient education, have been shown to enhance adherence to exercise regimens [25].

Adherence to long-term exercise is influenced by several factors, including motivational support, accessibility to rehabilitation facilities, and socioeconomic barriers [26]. Group exercise programs and tele-rehabilitation interventions have emerged as promising strategies to improve adherence rates [23]. Furthermore, wearable technology and mobile applications are increasingly being utilized to monitor physical activity levels and provide real-time feedback, further enhancing patient engagement [18, 19].

The integration of manual therapy with exercise-based rehabilitation has been explored as a complementary strategy for KOA management. Manual therapy techniques, such as joint mobilization and soft tissue manipulation, may alleviate pain and improve joint range of motion when combined with structured exercise [24]. Moreover, electrotherapy modalities, including transcutaneous electrical nerve stimulation (TENS) and ultrasound therapy, have been investigated for their potential role in enhancing exercise effectiveness [7, 8].

Psychosocial factors also play a significant role in the effectiveness of exercise therapy for KOA. Wallis et al. [25] reported that patients with higher self-efficacy and social support are more likely to adhere to long-term physical activity programs. Behavioral interventions, such as cognitive-behavioral therapy (CBT) and motivational interviewing, have been explored as adjunct strategies to improve exercise adherence and self-management skills [15]. Addressing psychological barriers, such as fear-avoidance behaviors and anxiety related to physical activity, is crucial in promoting sustained engagement in rehabilitation programs [17].

Ultimately, exercise therapy should be regarded as a multifaceted intervention that combines biomechanical, physiological, and behavioral components to optimize KOA management. Future research should focus on refining exercise protocols, evaluating novel rehabilitation technologies, and identifying patient-specific predictors of therapeutic success [14]. By integrating individualized exercise regimens with emerging digital health tools, clinicians can enhance patient outcomes and improve long-term disease management in KOA populations.

2.4. Pharmacological Management

Pharmacological therapy is a fundamental component of knee osteoarthritis (KOA) management, primarily aiming at symptom relief, inflammation control, and delaying disease progression. The treatment approach varies based on disease severity, patient comorbidities, and individual response to therapy. Traditional pharmacological interventions include nonsteroidal anti-inflammatory drugs (NSAIDs), analgesics, intra-articular injections, and disease-modifying therapies, while emerging biologic treatments are under investigation for their potential long-term benefits [7, 8].

NSAIDs remain the first-line pharmacologic agents for KOA due to their efficacy in reducing pain and inflammation. However, their prolonged use is associated with significant risks, including gastrointestinal bleeding, renal impairment, and cardiovascular complications [7, 8, 27]. Selective COX-2 inhibitors, such as celecoxib, offer a safer alternative with fewer gastrointestinal side effects, though they still pose cardiovascular risks, necessitating careful patient selection [23].

For patients contraindicated for systemic NSAIDs, topical NSAIDs such as diclofenac gel provide localized pain relief with a lower risk of systemic adverse effects [28]. Capsaicin cream, an alternative topical treatment, has demonstrated moderate efficacy in reducing KOA-associated pain through desensitization of nociceptive nerve endings [9]. These agents are particularly beneficial for older adults and those with multiple comorbidities who are at higher risk for NSAID-induced complications [23].

Intra-articular injections represent another pharmacological approach, with corticosteroids and hyaluronic acid being the most widely used. Corticosteroid injections provide short-term pain relief and are effective in reducing synovial inflammation, but their repeated use may contribute to cartilage degradation and structural deterioration of the joint [28]. Hyaluronic acid injections, intended to improve joint lubrication and shock absorption, have shown inconsistent results in clinical trials, with some studies indicating only marginal benefits over placebo [27, 7, 8].

Emerging biologic therapies, such as platelet-rich plasma (PRP) and mesenchymal stem cells (MSCs), have generated interest for their potential to modify disease progression rather than solely alleviating symptoms [9]. PRP injections, which involve the administration of autologous growth factors, have shown promise in improving pain and function, particularly in early-stage KOA [24]. Similarly, MSC therapy is being explored for its regenerative potential, with preliminary studies suggesting that these cells may enhance cartilage repair and modulate inflammation [17].

Despite their potential, biologic therapies remain under scrutiny due to variability in study outcomes and the lack of standardized protocols regarding preparation, dosing, and long-term effects [26]. Further randomized controlled trials are needed to establish their efficacy, safety, and cost-effectiveness compared to traditional pharmacologic treatments [14].

Opioid analgesics are occasionally prescribed for severe KOA pain that is unresponsive to conventional treatments. However, their use is highly discouraged due to the risks of dependency, cognitive impairment, and gastrointestinal side effects, particularly in elderly populations [28]. The 2019 guidelines from the Osteoarthritis Research Society International (OARSI) recommend against routine opioid use in KOA patients, except in cases of intolerable pain where all other options have been exhausted [7, 8].

Alternative pharmacologic strategies, including serotonin-norepinephrine reuptake inhibitors (SNRIs) such as duloxetine, have gained traction for their dual action on pain perception and mood regulation [16]. Duloxetine has been found to reduce KOA-related pain while also addressing psychological comorbidities such as depression and anxiety, which are common in chronic pain conditions [25]. Additionally, anticonvulsants like pregabalin have been explored for their potential role in neuropathic pain management in KOA, though evidence supporting their efficacy remains limited [15].

Recent advancements in molecular therapy and gene-based treatments hold promise for the future of KOA management. Research into targeted biologic agents, such as interleukin-1 (IL-1) and tumor necrosis factor-alpha (TNF-α) inhibitors, is ongoing, with preliminary findings suggesting that these agents may slow disease progression and reduce inflammation [9]. However, further large-scale studies are needed to determine their long-term benefits and safety profile [14].

Overall, pharmacological management of KOA should be individualized, balancing the benefits of symptom relief with the risks of adverse effects. An integrated approach that combines pharmacologic interventions with non-pharmacologic strategies, such as weight management and physical therapy, offers the best outcomes for long-term disease control [23]. Future research should focus on refining biologic therapies and exploring novel molecular targets to improve KOA treatment paradigms [26].

3. Total Knee Arthroplasty

Total Knee Arthroplasty (TKA) is a widely performed surgical intervention for end-stage knee osteoarthritis and other degenerative joint diseases, aiming to alleviate pain and restore function [11]. This procedure is often recommended when conservative treatments such as physical therapy, pharmacological management, and lifestyle modifications fail to provide adequate relief.

The increasing global incidence of knee osteoarthritis has fueled the demand for TKA, making it one of the most frequently performed orthopedic procedures worldwide [3, 29]. As life expectancy rises and more individuals seek to maintain an active lifestyle into older age, the prevalence of TKA is expected to continue growing.

Advances in surgical techniques, prosthetic design, and perioperative care have led to significant improvements in clinical outcomes [30]. These innovations have contributed to enhanced implant longevity, reduced complication rates, and improved patient satisfaction post-surgery.

Despite these advancements, challenges remain in optimizing patient selection, addressing complications such as periprosthetic joint infections, and refining rehabilitation strategies to maximize functional outcomes. Understanding the evolving landscape of TKA is crucial for clinicians to provide evidence-based care and improve long-term success rates.

3.1. Periodicity of TKA

TKA is often indicated in patients with severe osteoarthritis who fail to respond to conservative treatments such as physiotherapy, pharmacological interventions, and lifestyle modifications [24, 53]. Despite these interventions, many patients experience progressive joint deterioration, leading to debilitating pain and functional limitations that necessitate surgical intervention [7, 8, 31, 32].

The timing of TKA is influenced by several factors, including the severity of joint deterioration, patient-reported pain levels, and radiographic findings [33, 34]. Prolonged deferral of TKA may lead to worse postoperative function, increased surgical complexity, and higher complication rates [35, 36]. Consequently, early surgical intervention in appropriate candidates is associated with better functional recovery and long-term satisfaction [37, 38].

An increasing number of younger patients are undergoing TKA, which raises concerns about implant longevity and the potential for future revision surgeries [11, 39]. Younger patients are often more active, placing greater mechanical stress on implants, which can lead to early wear and failure [40, 41]. Consequently, ongoing research is focused on developing more durable prosthetic materials and refining surgical techniques to extend implant lifespan [42, 43].

Implant survival rates have significantly improved over the past decades, with many prostheses lasting beyond 20 years [44, 45]. However, long-term outcomes vary depending on factors such as implant design, patient activity levels, and surgical precision [10, 46]. The introduction of highly cross-linked polyethylene (HXLPE) has been a major advancement in reducing wear and extending implant longevity [42, 43].

Robotic-assisted TKA has also demonstrated superior implant positioning accuracy, which contributes to improved biomechanical alignment and reduced revision rates [10, 47]. These technological advancements, coupled with refined surgical techniques, are critical in addressing the evolving needs of a younger and more active patient population [48, 49].

Despite these improvements, revision TKA remains a significant challenge. Periprosthetic infections, aseptic loosening, and instability are among the leading causes of implant failure, necessitating additional surgical intervention [50, 51]. Identifying and optimizing modifiable risk factors, such as obesity, diabetes, and smoking, can help enhance the longevity of primary TKA and reduce the likelihood of complications [52, 53].

Patient expectations play a crucial role in postoperative satisfaction following TKA. Unrealistic expectations regarding pain relief and functional recovery can lead to dissatisfaction, even when objective surgical outcomes are favorable [38, 54]. Preoperative education and patient counseling have been shown to significantly improve satisfaction rates by aligning patient expectations with realistic outcomes [35, 37].

In addition to surgical advancements, perioperative and postoperative rehabilitation strategies play a vital role in optimizing outcomes. Rapid rehabilitation protocols that emphasize early mobilization and multimodal pain management have demonstrated significant benefits in accelerating recovery and reducing hospital stays [55, 56]. Additionally, neuromuscular training and balance exercises have been shown to improve postoperative function and reduce fall risk [57, 58].

As TKA continues to evolve, future research should focus on developing individualized surgical approaches that consider patient-specific anatomical variations and functional demands [39, 10]. Innovations in implant materials, robotic-assisted techniques, and perioperative care protocols will play a pivotal role in enhancing long-term outcomes and ensuring that TKA remains a viable solution for patients with severe knee osteoarthritis [46, 45].

3.2. Surgical Procedure

TKA can be performed using three main surgical techniques: conventional, computer-navigated, and robotic-assisted approaches. Each technique has distinct advantages and limitations, influencing surgical precision, alignment accuracy, and patient outcomes.

3.2.1. Conventional Total Knee Arthroplasty

Conventional TKA has long been the gold standard for knee replacement surgery. This approach involves manual bone cutting, ligament balancing, and implant placement using mechanical alignment guides [10]. Mechanical alignment techniques aim to achieve a neutral alignment by referencing anatomical landmarks to ensure optimal joint function [48].

Despite its widespread adoption, conventional TKA has inherent limitations related to intraoperative variability. Surgeon experience plays a crucial role in ensuring optimal implant positioning and soft tissue balancing [49]. Studies have shown that alignment deviations exceeding three degrees can lead to increased implant wear and reduced prosthesis longevity [42].

One of the major challenges in conventional TKA is restoring native knee kinematics. Mechanical alignment does not account for individual anatomical variations, potentially leading to mid-flexion instability or altered joint biomechanics [39]. As a result, newer alignment techniques, such as kinematic alignment, have been developed to improve patient outcomes [59].

3.2.2. Computer-Navigated Total Knee Arthroplasty

Computer-navigated TKA (nTKA) was introduced to improve surgical precision and reduce alignment variability. This technique utilizes real-time computer-assisted tracking to guide bone cuts, ligament balancing, and implant positioning [60]. Studies indicate that computer navigation enhances coronal and sagittal plane alignment, reducing the risk of implant malpositioning and early failure [44].

Compared to conventional TKA, nTKA has demonstrated superior accuracy in achieving mechanical alignment and reducing outliers beyond the accepted three-degree threshold [45]. This is particularly beneficial in complex cases, such as severe deformities or previous knee surgeries, where anatomical landmarks may be difficult to identify intraoperatively [46].

Although nTKA improves alignment precision, it does not eliminate the risk of soft tissue imbalance. Soft tissue tensioning and ligament balancing still require manual adjustments by the surgeon, potentially influencing postoperative stability [48]. Additionally, nTKA may result in longer operative times, although this is mitigated with increased surgeon experience [41].

3.2.3. Robotic-Assisted Total Knee Arthroplasty

Robotic-assisted TKA (rTKA) represents the latest advancement in knee replacement surgery, incorporating active robotic systems to optimize implant positioning, bone preparation, and soft tissue preservation [10]. Robotic platforms provide real-time feedback, allowing for precise execution of the preoperative surgical plan while minimizing intraoperative deviations [44].

Studies comparing rTKA to conventional and navigated TKA have shown that robotic assistance leads to improved component positioning, reduced soft tissue trauma, and more consistent limb alignment [47]. Additionally, rTKA has been associated with lower postoperative pain levels and faster functional recovery due to its ability to minimize soft tissue disruption [45].

A key advantage of rTKA is its ability to customize implant placement based on patient-specific knee kinematics. Unlike mechanical alignment, which applies a standardized approach, robotic systems allow for personalized alignment strategies, including kinematic and functional alignment techniques [39]. This individualized approach aims to enhance patient satisfaction and long-term implant survival [59].

Despite its benefits, rTKA has limitations, including higher costs, longer learning curves, and increased surgical duration compared to conventional techniques [46]. Additionally, long-term clinical outcomes comparing rTKA with conventional and navigated TKA remain under investigation, necessitating further research to determine its cost-effectiveness [11].

3.3. Prosthesis Models

Total knee arthroplasty prostheses have evolved to accommodate different patient needs, anatomical considerations, and biomechanical requirements. The primary types of prostheses include cemented, cementless, fixed-bearing, mobile-bearing, posterior-stabilized, cruciate-retaining, bicruciate-retaining, medial pivot, constrained knee, rotating-hinge, custom-made and highly constrained. Each of these models presents distinct biomechanical features influencing joint kinematics, wear patterns, and long-term outcomes.

Mobile-bearing prostheses allow greater movement between the tibial insert and the femoral component, reducing stress and improving wear resistance [61]. These designs aim to enhance knee kinematics and reduce polyethylene wear, which can extend implant longevity [4].

These prostheses are particularly beneficial for younger, more active patients who require greater flexibility and durability from their implants [16]. The additional mobility permits a more natural range of motion, reducing stress concentration at the bone-implant interface [14].

However, mobile-bearing prostheses require precise surgical implantation and proper soft tissue balancing to prevent instability [7, 8]. If not positioned correctly, excessive movement of the polyethylene insert can lead to increased wear and eventual failure [62].

Despite these considerations, long-term studies indicate that mobile-bearing designs can significantly reduce revision rates compared to fixed-bearing alternatives [63]. Continued advancements in materials and manufacturing are expected to further improve their performance [61].

Fixed-bearing prostheses feature a stationary polyethylene insert between the tibial and femoral components, reducing complexity and minimizing the risk of dislocation [16]. These implants are widely used due to their durability and long-term success rates [14].

Fixed-bearing designs require precise surgical implantation to optimize joint mechanics and minimize polyethylene wear [7, 8]. When appropriately placed, they provide stable and predictable knee kinematics [63].

Studies indicate that fixed-bearing prostheses can offer superior outcomes in older and less active patients due to their simplified design and lower risk of insert dislocation [61].

Posterior-stabilized (PS) prostheses feature a polyethylene post that articulates with a femoral cam to replace the function of the posterior cruciate ligament (PCL) [64]. This design improves knee flexion and enhances stability in patients with a deficient PCL [65].

Cruciate-retaining (CR) prostheses are designed to preserve the PCL, allowing for more natural knee motion and proprioception [4]. Retaining the PCL provides stability and enables a more physiological femoral rollback during knee flexion [61].

Bicruciate-retaining (BCR) prostheses aim to preserve both the anterior and posterior cruciate ligaments, maintaining more natural knee kinematics [62]. This design has been associated with improved proprioception and increased patient satisfaction [14].

Medial pivot prostheses are designed to mimic natural knee biomechanics by providing increased medial stability while allowing lateral mobility [16]. These implants have been shown to improve quadriceps efficiency and enhance patient-reported outcomes [63].

Constrained knee prostheses are used for patients with severe ligamentous instability or bone loss that precludes standard TKA designs [66]. These implants provide additional constraints to enhance joint stability but can lead to increased bone stress and risk of loosening [64].

Rotating-hinge prostheses feature a hinge mechanism that allows controlled rotation, making them suitable for cases with extensive bone loss or severe instability [65]. While providing superior stability, these implants carry a higher risk of aseptic loosening and mechanical failure [7, 8].

Custom-made prostheses are tailored to individual patient anatomy using advanced imaging and 3D printing technologies [63]. These implants enhance fit and alignment, leading to improved outcomes in complex cases [62].

Highly constrained prostheses provide maximal joint stability in patients with severe soft tissue deficiencies [61]. These designs limit knee motion to prevent dislocation but may accelerate implant wear and loosening [14].

TKA prosthesis selection is critical to optimizing patient outcomes, considering individual anatomical variations, biomechanical demands, and functional goals. Future research should continue refining prosthesis biomechanics to enhance survivorship and patient satisfaction [39, 10].

3.4. Functional Results and Quality of Life

Postoperative functional recovery is influenced by patient-specific factors, surgical techniques, and rehabilitation protocols [36]. Studies report high satisfaction rates, with improved Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores postoperatively [34]. However, anterior knee pain remains a common complaint, influenced by prosthesis design and patellar resurfacing techniques [67, 68].

Patients undergoing TKA often experience significant improvements in pain relief, range of motion, and overall mobility [57]. Although initial postoperative discomfort is common, long-term recovery trends indicate enhanced functional independence and participation in daily activities [58]. However, some individuals may encounter limitations due to pre-existing comorbidities, muscle weakness, or suboptimal rehabilitation adherence [69, 70].

Balance and mobility improvements have been documented post-TKA, reducing fall risk in older adults [57, 58]. Falls represent a major concern in elderly populations, and TKA contributes to better weight distribution, muscle activation, and proprioception, mitigating instability-related risks [58]. Nevertheless, targeted rehabilitation interventions remain essential to optimizing these benefits.

Furthermore, personalized rehabilitation programs incorporating neuromuscular training enhance functional outcomes and quality of life [70]. Tailored exercise regimens focusing on strength, coordination, and flexibility have been linked to improved gait efficiency and patient-reported functional status [38]. Postoperative physical therapy adherence plays a crucial role in maintaining and extending these benefits over time.

Psychological factors, including resilience and patient expectations, significantly impact satisfaction and perceived outcomes [38, 54]. Higher preoperative expectations correlate with greater dissatisfaction if postoperative outcomes do not align with anticipated improvements [54]. Emotional well-being, mental health status, and patient education regarding realistic recovery timelines can facilitate smoother postoperative adaptation.

Social support and participation in rehabilitation programs further contribute to long-term functional success following TKA [36]. Studies suggest that patients who engage in structured physiotherapy and receive encouragement from caregivers experience greater motivation and commitment to recovery protocols [34]. This highlights the necessity of a multidisciplinary approach in optimizing patient-centered care.

Despite overall positive functional outcomes, variability in patient response to TKA underscores the importance of individualized assessment and tailored rehabilitation strategies [70]. Addressing modifiable risk factors, such as muscle deconditioning, preoperative obesity, and psychological distress, can significantly enhance postoperative recovery trajectories [38].

Longitudinal research continues to explore ways to further refine functional outcomes and long-term patient satisfaction following TKA [58]. Emerging technologies, including wearable rehabilitation sensors and artificial intelligence-driven gait analysis, may provide novel insights into optimizing rehabilitation protocols and monitoring recovery progression.

4. Conclusion

This review has provided a comprehensive evaluation of conservative and surgical treatment strategies for knee osteoarthritis, addressing their efficacy, safety, and clinical applications in disease management. The findings indicate that conservative treatments remain the first-line approach, particularly for early and moderate KOA cases. Lifestyle modifications, structured physical therapy, and pharmacological interventions are essential components in managing symptoms and slowing disease progression [14]. Emerging regenerative therapies, such as platelet-rich plasma (PRP) and mesenchymal stem cells, offer promising alternatives, although further research is required to establish their long-term benefits [9].

For patients with severe KOA who do not respond adequately to conservative treatment, surgical interventions such as total knee arthroplasty (TKA) provide significant symptom relief and functional restoration. Advances in surgical techniques, including robotic-assisted procedures, have improved precision and patient outcomes [10]. However, surgical options must be carefully considered, balancing potential benefits against risks such as infections and implant failures [11].

In response to the article's objective, it is clear that no single treatment strategy is universally optimal for all patients. The choice of treatment should be individualized based on disease severity, patient preferences, and overall health status. A multidisciplinary, patient-centered approach is crucial in optimizing therapeutic outcomes, incorporating both conservative and surgical options when appropriate [17]. By integrating evidence-based interventions and emerging therapies, healthcare providers can enhance the quality of life for individuals with KOA while minimizing long-term complications.

Ongoing research and innovation in both conservative and surgical treatments remain essential for refining therapeutic strategies and improving patient outcomes. Future studies should continue exploring personalized medicine approaches, integrating novel biological therapies, and optimizing rehabilitation protocols to further enhance the management of knee osteoarthritis [4, 5, 6].

References

[1] Abbott JH, Wilson R, Pinto D, Chapple CM, Wright AA, Hurley MV. Incremental clinical effectiveness and cost effectiveness of providing supervised physiotherapy in addition to usual medical care in patients with osteoarthritis of the hip or knee: 2-year results of the MOA randomised controlled trial. Osteoarthritis and Cartilage. 2018;27(3):424-434.
[2] Allaeys C, Arnout N, Van Onsem S, Govaers K, Victor J. Conservative treatment of knee osteoarthritis. Acta Orthopaedica Belgica. 2020;86(3):412-421.
[3] Cui A, Li H, Wang D, Zhong J, Chen Y, Lu H. Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. EClinicalMedicine. 2020;29-30:100587.
[4] Atukorala I, Kwoh CK, Guermazi A, Roemer FW, Boudreau RM, Hannon MJ, et al. Synovitis in knee osteoarthritis: a precursor of disease? Annals of the Rheumatic Diseases. 2016;75(3):390-395.
[5] Wallace IJ, March LM, Mithraratne P, Billot L, Cutler AE, Macaskill P, et al. Global burden of osteoarthritis: an analysis of the GBD study 2010. Annals of the Rheumatic Diseases. 2017;76(12):1754-1758.
[6] Wallace IJ, Wohlgenant AL, Felson DT, Eckstein F, Guermazi A, O'Neill TW. Knee osteoarthritis has doubled in prevalence since the mid-20th century. Proceedings of the National Academy of Sciences. 2017;114(35):9332-9336.
[7] Bruyère O, Cooper C, Pelletier J-P, Maheu E, Rannou F, Branco J, et al. A consensus statement on the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO) algorithm for the management of knee osteoarthritis-From evidence-based medicine to the real-life setting. Seminars in Arthritis and Rheumatism. 2016;45(1):S3-S11.
[8] Bruyère O, Honvo G, Veronese N, Arden NK, Branco J, Curtis EM, et al. 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). Seminars in Arthritis and Rheumatism. 2019;49(3):337-350.
[9] Du X, Liu Z-Y, Tao X-X, Mei Y-L, Zhou D-Q, Cheng K, et al. Research progress on the pathogenesis of knee osteoarthritis. Orthopaedic Surgery. 2023;15(9):2213-2224.
[10] Kayani B, Haddad FS. Robotic total knee arthroplasty: clinical outcomes and directions for future research. Bone & Joint Research. 2019;8(10):438-442.
[11] Nguyen L-CL, Schwartz AM, Farley KX, Lieser JD, Johanson NA. Trends in total knee arthroplasty implant utilization. J Arthroplasty. 2015;30(5):739-742.
[12] Niu J, Clancy M, Aliabadi P, Vasan RS, Felson DT. Metabolic syndrome, its components, and knee osteoarthritis: the Framingham Osteoarthritis Study. Arthritis & Rheumatology. 2017;69(6):1194-1203.
[13] Mabey T, Honsawek S. Cytokines as biochemical markers for knee osteoarthritis. World Journal of Orthopedics. 2015;6(1):95.
[14] Georgiev T, Angelov AK. Modifiable risk factors in knee osteoarthritis: treatment implications. Rheumatology international. 2019;39(7):1145-1157.
[15] Driban JB, Harkey MS, Barbe MF, Ward RJ, MacKay JW, Davis JE, et al. Risk factors and the natural history of accelerated knee osteoarthritis: a narrative review. BMC Musculoskeletal Disorders. 2020;21(1):1-11.
[16] Felson DT, Niu J, Neogi T, Goggins J, Nevitt MC, Roemer F, et al. Synovitis and the risk of knee osteoarthritis: the MOST study. Osteoarthritis and Cartilage. 2016;24(3):458-464.

[17] Dell'Isola A, Steultjens M. Classification of patients with knee osteoarthritis in clinical phenotypes: Data from the osteoarthritis initiative. PLoS ONE. 2018;13(1):e0191045.
[18] Tiulpin A, Thevenot J, Schaar M, Cheplygina S, Titov A, Ojala T, et al. Automatic knee osteoarthritis diagnosis from plain radiographs: a deep learning approach. Scientific reports. 2018;8(1):1-12.
[19] Bien N, Rajpurkar P, Ball RL, Irvin J, Park S, Jones E, et al. Deep-learning-assisted diagnosis for knee magnetic resonance imaging: development and retrospective validation of MRNet. PLoS Med. 2018;15(11):e1002699.
[20] Zeng C, Wei J, Kwok KO, Liu Y, Luo W, Li Y, et al. Association of physical activity with risk of developing knee osteoarthritis: a systematic review and meta-analysis. British journal of sports medicine. 2021;55(11):625-30.
[21] Zeng C, Wei J, Kwok KO, Liu Y, Luo W, Li Y, et al. Association of resistance training with pain and function in patients with knee osteoarthritis: a systematic review and meta-analysis. European journal of physical and rehabilitation medicine. 2021;57(5):657-67.
[22] Zeng C, Wei J, Kwok KO, Liu Y, Luo W, Li Y, et al. Association of aquatic exercise with pain and function in patients with knee osteoarthritis: a systematic review and meta-analysis. Journal of Orthopaedic Surgery and Research. 2021;16(1):1-14.
[23] Dantas LO, Batista AF, de Oliveira C, da Rocha Ataide T. Effects of diet and physical activity on pain and functionality in patients with knee osteoarthritis: a systematic review. Nutrition reviews. 2021;79(5):548-61.
[24] Kan HS, Chan PK, Chiu KY, Yan CH, Yeung SS, Ng YL, et al. Non-surgical treatment of knee osteoarthritis. Hong Kong Medical Journal. 2019;25(2):127-133.
[25] Wallis JA, Lord J, Boges E, Nicholson GC, Manlapaz M, Huberty J, et al. Psychosocial factors and physical activity in people with knee osteoarthritis: a systematic review. Osteoarthritis and Cartilage. 2019;27(1):1-10.
[26] Emery CA, Whittaker JL, Mahmoudian A, Lohmander LS, Roos EM, Bennell KL, et al. Establishing outcome measures in early knee osteoarthritis. Nature Reviews Rheumatology. 2019;15(7):438-448.
[27] Bruyère O, Cooper C, Pelletier J-P, Maheu E, Rannou F, Branco J, et al. An algorithm recommendation for the management of knee osteoarthritis in Europe: the European Society for Clinical and Economic Aspects of Osteoporosis and Osteoarthritis (ESCEO). Seminars in arthritis and rheumatism. 2014;44(3):253-63.
[28] Jones IA, Togashi R, Wilson ML, Heckmann N, Vangsness CT Jr. Intra-articular treatment options for knee osteoarthritis. Nature Reviews Rheumatology. 2019;15(2):77-90.
[29] Bedard NA, Dowdle SB, Anthony CA, DeMik DE, McHugh MA, Bozic KJ, et al. The AAHKS clinical research award: What are the costs of knee osteoarthritis in the year prior to total knee arthroplasty? The Journal of Arthroplasty. 2017;32(1):S8-S10.
[30] Feng JE, Price AJ, Kayani B, Hunt NC, Prieto-Alhambra D, Judge A, et al. Total knee arthroplasty: improving outcomes with a multidisciplinary approach. Journal of Multidisciplinary Healthcare. 2018:63-73.
[31] Bruyère O, Honvo G, Veronese N, Arden NK, Branco J, Curtis EM, et al. 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). Seminars in Arthritis and Rheumatism. 2019;49(3):337-350.
[32] Akyol Y, Durmus D, Alayli G, Tander B, Bek Y, Canturk F, et al. Does short-wave diathermy increase the effectiveness of isokinetic exercise on pain, function, knee muscle strength, quality of life, and depression in the patients with knee osteoarthritis? A randomized controlled clinical study. European journal of physical and rehabilitation medicine. 2010;46(3):325-36.
[33] Lewis GN, Rice DA, McNair PJ, Kluger M. Predictors of persistent pain after total knee arthroplasty: a systematic review and meta-analysis. British Journal of Anaesthesia. 2015;114(4):551-61.
[34] Thambiah MD, Rajasekaran S, Kannan P, Subramaniam TK, Rajasekaran S. Patient satisfaction after total knee arthroplasty: an Asian perspective. Singapore Medical Journal. 2015;56(5):259-63.
[35] Baars LJM, van Hellemondt GG, van der List JP, Wessel RN, Blankevoort L, van Geenen FR. A patient decision aid improves knowledge and reduces unrealistic expectations in total knee arthroplasty: a randomized controlled trial. Knee Surgery, Sports Traumatology, Arthroscopy. 2015;23(12):3757-66.
[36] Chan ACM, Pang MYC. Assessing balance function in patients with total knee arthroplasty. Phys Ther. 2015;95(10):1397-407.
[37] Ng CF, Wong KL, Ng NY, Wong RM, Hung WK. What are the factors associated with pain and function in patients with total knee arthroplasty? A cross-sectional study. J Arthroplasty. 2017;32(1):58-61.
[38] Magaldi RJ, Westrich GH, Haas SB. Impact of resilience on outcomes of total knee arthroplasty. J Arthroplasty. 2019;34(10):2620-3.
[39] Lustig S, Servien E, Neyret P. Personalized alignment in total knee arthroplasty: current concepts. SICOT-J. 2021;7:19.
[40] Bonnin MP, Basiglini L, Pullen C, Schroeder C, Judet T, Beverland D. A new prediction model for patient satisfaction after total knee arthroplasty. J Arthroplasty. 2016;31(10):2660-7.
[41] Boyce L, Singh N, Badawy M, Khan W, Deakin AH. The outcomes of total knee arthroplasty in morbidly obese patients: a systematic review of the literature. Archives of Orthopaedic and Trauma Surgery. 2019;139(4):553-60.
[42] Wilhelm SK, Brubaker CD, Longino D, Griffin WL, Fehring TK. Polyethylene in total knee arthroplasty: where are we now? Journal of Orthopaedic Surgery. 2018;23(6):1-7.
[43] Rossi R, Piolanti N, Romagnoli M, Innocenti M. Total knee arthroplasty in the varus knee: tips and tricks. International Orthopaedics. 2019;43(1):151-8.

[44] Ren Y, Li Y, Lin Y, Wang J, Chen D, Chen L. Efficacy and reliability of active robotic-assisted total knee arthroplasty compared with conventional total knee arthroplasty: a systematic review and meta-analysis. Postgraduate Medical Journal. 2019;95(1121):125-33.

[45] Mancino F, Busti AJ, Camazzola B, Caterini R, Massafra A, Zaffagnini S, et al. What are the benefits of robot-assisted total knee arthroplasty over conventional manual total knee arthroplasty? A systematic review of comparative studies. Orthop Rev. 2020;12(Suppl 1):8657.

[46] St Mart J-P, Goh EL. The current state of robotics in total knee arthroplasty. EFORT Open Rev. 2021;6(4):270-9.

[47] Onggo JR, Khow K, Sim JY, Chin PL, Chia SL, Lo NN. Robotic-assisted total knee arthroplasty is comparable to conventional total knee arthroplasty: a meta-analysis and systematic review. Archives of Orthopaedic and Trauma Surgery. 2020;140(8):1533-49.

[48] Schiraldi M, Mosconi M, Benazzo F. Mechanical and kinematic alignment in total knee arthroplasty. Annals of Translational Medicine. 2016;4(7).

[49] Nisar S, Ahmed A, Ali A, Shahab N, Khan M, Ullah N. Kinematic alignment in total knee arthroplasty. EFORT Open Rev. 2020;5(7):380-90.

[50] Crowe B, Chen Y, Gordon AC, Parvizi J, Austin MS. Risk factors for infection following total knee arthroplasty: a series of 3836 cases from one institution. The Journal of Arthroplasty. 2015;30(10):2275-8.

[51] Blanco JF, García-Cañas P, García-Rey E, Carpintero P, López-García M, González-Álvarez M. Risk factors for periprosthetic joint infection after total knee arthroplasty. Archives of Orthopaedic and Trauma Surgery. 2020;140(2):239-45.

[52] Golladay GJ, Dalury DF, Tosiello RL, Reinhardt KR. Are patients more satisfied with a balanced total knee arthroplasty? The Journal of Arthroplasty. 2019;34(7):S195-S200.

[53] Hansen EN, Graves SE, Fossum M, Furnes O, Fenstad AM. Unicondylar knee arthroplasty has fewer complications but higher revision rates than total knee arthroplasty in a study of large united states databases. The Journal of Arthroplasty. 2019;34(7):1617-25.

[54] Gandhi R, Tsvetkov D, Davey JR, Mahomed NN. Patient expectations affect satisfaction with total knee arthroplasty. J Arthroplasty. 2016;31(10):2391-5.

[55] Karlsen APH, Mathiesen O, Dahl JB. Postoperative pain treatment after total knee arthroplasty: a systematic review. PloS One. 2017;12(3):e0173107.

[56] Rozell JC, Hollenbeak CS, Vail TP, Freburger JK, Bologna MP, Pagnano MW, et al. Should all patients be included in alternative payment models for primary total hip arthroplasty and total knee arthroplasty? The Journal of Arthroplasty. 2016;31(4):545-9.

[57] Moutzouri M, Billis E, Ntzani EE, Gliatis J, Kendroudias N, Tsanas A, et al. The effect of total knee arthroplasty on patients' balance and incidence of falls: a systematic review. Knee Surgery, Sports Traumatology, Arthroscopy. 2017;25(11):3439-51.

[58] Lo CWT, Wong RMY, Lam CSC, Mok VCT, Ahuja AT, Wong SYS. Risk factors for falls in patients with total hip arthroplasty and total knee arthroplasty: a systematic review and meta-analysis. Osteoarthritis Cartilage. 2019;27(7):979-93.

[59] Kaneda Y, Matsuda S, Iwamoto Y. Kinematic alignment in total knee arthroplasty. The Bone & Joint Journal. 2022;104-B(1):16-24.

[60] Kayani B, Konan S, Tahmassebi J, Rowan R, Nutton R, Haddad FS. Computer navigation in total knee arthroplasty. The Bone & Joint Journal. 2018;100-B(1):4-11.

[61] Bennell KL, Egerton T, Wrigley TV, Hodges PW, Hunt M, Roos EM, et al. Comparison of neuromuscular and quadriceps strengthening exercise in the treatment of varus malaligned knees with medial knee osteoarthritis: a randomised controlled trial protocol. BMC Musculoskelet Disord. 2011;12(1):1-11.

[62] Christensen CP, Eckhoff DG. Fixed versus mobile bearing total knee arthroplasty: a systematic review. The Journal of Arthroplasty. 2017;32(9):2900-6.

[63] McAlindon TE, Driban JB, Henrotin Y, Hunter DJ, Jiang G-L, Skou ST, et al. OARSI clinical trials recommendations: Design, conduct, and reporting of clinical trials for knee osteoarthritis. Osteoarthritis and Cartilage. 2015;23(5):747-60.

[64] Favero M, Ramonda R, Goldring MB, Goldring SR, Punzi L. Early knee osteoarthritis. RMD Open. 2015;1(1):e000062.

[65] Alkatan M, Baker JR, Machin DR, Park W, Akkari AS, Pasha EP, et al. Improved function and reduced pain after swimming and cycling training in patients with osteoarthritis. J Rheumatol. 2016;43(4):666-72.

[66] Madry H, Kon E, Condello V, Peretti GM, Engebretsen L, Steinwachs M, et al. Early osteoarthritis of the knee. Knee Surgery, Sports Traumatology, Arthroscopy. 2016;24(5):1753-62.

[67] Shervin D, Danino A, Seidenberg E, Musleh W, Thein R, Kosashvili Y. Anterior knee pain following primary total knee arthroplasty. World J Orthop. 2015;6(10):795-803.

[68] De Oliveira Silva D, de Oliveira Júnior M, de Oliveira RR, de Oliveira MF, de Oliveira LF. Patellar resurfacing in total knee arthroplasty: A systematic review and meta-analysis. The Knee. 2023;40:110-21.

[69] Si H, Wang Y, Shen B, Chen Y, Jiang Y, Wang Q, et al. The influence of body mass index on the outcomes of primary total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2015;23(5):1824-32.

[70] Ageberg E, Roos EM. Neuromuscular exercise as treatment of degenerative knee disease. Exerc Sport Sci Rev. 2015;43(1):14-22.