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Medical and Surgical Management of Osteoarthritis of Knees

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ABSTRACT

Background: *Knee osteoarthritis (OA) is a progressive whole-joint degenerative disease and a major global cause of pain, disability, and reduced quality of life. Multiple medical, biologic, and surgical treatment options exist, yet optimal sequencing, patient selection, and timing of surgery remain areas of clinical uncertainty. A comprehensive synthesis of current evidence is required to guide individualized treatment pathways.* ***Objective:*** *To systematically review the literature on medical, intra-articular injection-based, and surgical management of knee osteoarthritis, with particular emphasis on comparative effectiveness, surgical indications, and optimal timing of operative intervention.* ***Methods:*** *This systematic review followed PRISMA guidelines. Searches of PubMed/MEDLINE, Scopus, Web of Science, and Cochrane Library were conducted for studies published between January 2000 and December 2024. Eligible studies included randomized controlled trials, cohort studies, and high-quality systematic reviews evaluating conservative management, intra-articular therapies, osteotomies, unicompartmental knee arthroplasty (UKA), and total knee arthroplasty (TKA). Data were extracted on patient characteristics, interventions, clinical outcomes, functional scores, and complications. Risk of bias was assessed using the Cochrane RoB tool, Newcastle–Ottawa Scale, and AMSTAR-2. A narrative synthesis was performed due to clinical heterogeneity.* ***Results:*** *A total of 432 records were identified, with 17 studies meeting inclusion criteria. Non-pharmacological strategies and NSAIDs provided symptomatic relief in early disease, while corticosteroids and hyaluronic acid offered short-term benefit. Platelet-rich plasma demonstrated longer-lasting improvements in early to moderate OA compared with corticosteroids and HA. High tibial and distal femoral osteotomies were effective joint-preserving procedures for younger, active patients with unicompartmental OA and malalignment. UKA yielded faster recovery and more natural knee kinematics in appropriately selected patients with isolated disease. TKA provided the most predictable long-term pain relief and functional improvement in advanced or multicompartmental OA, with implant survivorship exceeding 90% at 10–15 years. Timing and patient selection emerged as the most important determinants of surgical outcomes.* ***Conclusion:*** *Effective management of knee OA requires a stage-specific, individualized approach integrating conservative, biologic, and surgical strategies. Non-operative therapies remain foundational in early OA, while biologic injections may bridge symptoms until surgical intervention is appropriate. Osteotomy and UKA offer valuable joint-preserving options in selected patients, whereas TKA remains the definitive treatment for advanced disease. Aligning treatment modality with disease stage, alignment, compartment involvement, and patient goals optimizes long-term outcomes and joint function.*

Keywords
Knee osteoarthritis; osteotomy; unicompartmental knee arthroplasty; total knee arthroplasty; intra-articular injections; platelet-rich plasma; conservative management; surgical indications; degenerative joint disease

INTRODUCTION

Knee osteoarthritis (OA) is one of the most prevalent musculoskeletal disorders worldwide and is a leading cause of chronic pain, disability, and loss of independence, particularly in older adults (1,2). It is now recognized as a whole-joint disease rather than a purely cartilage-limited condition, characterized by progressive loss of articular cartilage, remodeling and sclerosis of subchondral bone, synovial inflammation, osteophyte formation, and alterations in periarticular muscles and ligaments (2,3,13). Emerging work on OA phenotypes highlights the interaction between mechanical overload, low-grade inflammation, metabolic factors, and subchondral bone signaling pathways, which together drive structural

deterioration and pain sensitization (2,3,6). As life expectancy and obesity rates continue to rise globally, the clinical and socioeconomic burden of knee OA is increasing, with substantial direct healthcare costs and indirect costs related to reduced productivity and long-term disability (4,9,11). Management of knee OA is inherently multimodal and stepwise, integrating non-pharmacological, pharmacological, injection-based, and surgical strategies aimed at pain relief, functional restoration, and slowing structural progression (5,10,11). International guidelines consistently emphasize core non-pharmacological interventions, including patient education, structured exercise therapy, weight reduction, and activity modification, with pharmacological agents such as NSAIDs, paracetamol, and short-course opioids used to modulate symptoms when necessary (5,10,13,15). Intra-articular injections—including corticosteroids, hyaluronic acid (HA), and platelet-rich plasma (PRP)—have gained prominence as intermediate options for individuals who remain symptomatic despite optimized conservative measures, with PRP and other biologic products increasingly investigated for their potential disease-modifying or structure-modulating effects (5,6,10,13,14). In parallel, surgical options such as osteotomy around the knee, unicompartmental knee arthroplasty (UKA), and total knee arthroplasty (TKA) continue to evolve, supported by advances in implant design, computer navigation, and robotic-assisted techniques that aim to improve alignment, implant longevity, and functional outcomes (1,12,16,17).

Despite this broad therapeutic armamentarium, there remains ongoing debate about the optimal sequencing and timing of medical, injection-based, and surgical interventions, particularly in younger, active patients and those with unicompartmental disease or malalignment (1,5,12,14,16). Existing reviews often focus either predominantly on non-operative management or on specific surgical techniques, without integrating the full continuum from early conservative care to joint-preserving procedures and definitive arthroplasty. Furthermore, rapid expansion of literature on biologic injections (such as PRP) and evolving indications for high tibial osteotomy, distal femoral osteotomy, UKA, and TKA have created uncertainty for clinicians regarding which modality to choose for which patient profile, and at what stage of disease (6,10,12,14,17). There is a particular need to clarify how intra-articular therapies and joint-preserving surgeries can delay or optimize the timing of arthroplasty, and how patient factors such as age, alignment, compartmental involvement, and functional expectations should influence these decisions.

In this context, a contemporary systematic review that consolidates evidence on medical, intra-articular, and surgical management of knee OA is warranted. By synthesizing data across conservative therapies, biologic injections, osteotomy procedures, UKA, and TKA, this review aims to (i) summarize current evidence on the effectiveness and limitations of non-surgical and surgical options; (ii) delineate indications, timing, and patient selection criteria for key surgical procedures; and (iii) propose an integrated, stage- and phenotype-based framework for treatment decision-making. Addressing these gaps is essential to support personalized care pathways that optimize symptom control, preserve joint function, and appropriately time surgical intervention in patients with knee osteoarthritis.

METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The objective was to synthesize evidence on medical, injection-based, and surgical interventions for knee osteoarthritis (OA), with a focus on comparative effectiveness, surgical indications, and timing of operative management. A protocol defining the review question, eligibility criteria, and analytical framework was developed prior to initiation, following the PICOS (Population, Intervention, Comparison, Outcomes, Study design) model.

A comprehensive electronic search was performed across four major databases: PubMed/MEDLINE, Scopus, Web of Science, and the Cochrane Library. The search covered all studies published between January 2000 and December 2024 to capture contemporary evidence and recent advances in biologic therapies and surgical techniques. The following combinations of MeSH terms and keywords were used: “knee osteoarthritis,” “degenerative knee disease,” “medical management,” “nonsurgical management,” “intra-articular injections,” “corticosteroids,” “hyaluronic acid,” “platelet-rich plasma,” “PRP,” “osteotomy,” “high tibial osteotomy,” “distal femoral osteotomy,” “unicompartmental knee arthroplasty,” “UKA,” “total knee arthroplasty,” and “TKA.” Boolean operators (AND/OR), truncations, and filters for human studies and English language publications were applied. Reference lists of included articles and relevant reviews were screened manually for additional eligible studies.

Eligibility criteria were defined a priori. Studies were included if they: (i) involved adults diagnosed with radiographic or clinically defined knee osteoarthritis; (ii) evaluated non-pharmacological, pharmacological, injection-based, or surgical interventions; (iii) reported clinical outcomes such as pain reduction, functional improvement, complication rates, survivorship, or need for further surgery; and (iv) were randomized controlled trials (RCTs), cohort studies, case–control studies, or systematic reviews/meta-analyses with high methodological quality. Exclusion criteria included: (i) studies focusing exclusively on hip or other joints; (ii) narrative reviews, editorials, expert opinions, case reports, and animal studies; (iii) studies without extractable outcome data; and (iv) papers not addressing either medical or surgical management of knee OA.

Two reviewers independently screened titles and abstracts retrieved from the search. Full-text articles were assessed for eligibility, and disagreements were resolved through discussion or consultation with a third reviewer. The PRISMA flow process included identification, removal of duplicates, title and abstract screening, full-text review, and final inclusion; 432 articles were initially identified, 310 proceeded to abstract screening, 72 full texts were reviewed, and 17 studies met all criteria for final synthesis.

Data extraction was performed independently using a standardized template. Extracted variables included study design, population characteristics, OA severity, intervention type, treatment parameters (e.g., type of injection, osteotomy technique, implant type), follow-up duration, clinical outcomes (pain scores, functional scales, radiographic progression), complication rates, revision rates, and authors’ key conclusions. For injection-based therapies, duration of symptom relief and comparative effectiveness were also extracted.

Risk of bias was assessed using appropriate validated tools according to study design. For randomized controlled trials, the Cochrane Risk of Bias tool was used, evaluating random sequence generation, blinding, allocation concealment, incomplete data, and selective reporting. For observational studies, the Newcastle–Ottawa Scale (NOS) was applied to assess selection, comparability, and outcome ascertainment. Systematic reviews/meta-analyses included in the synthesis were evaluated using the AMSTAR-2 tool. Studies with high risk of bias, unclear methodology, or insufficient data transparency were noted, and their findings were interpreted with caution during synthesis.

Given the heterogeneity in study designs, interventions, and outcome measures, a meta-analysis could not be conducted. Instead, a qualitative synthesis approach was implemented. Evidence was categorized into three main domains: (i) medical and non-surgical management, including pharmacological and biological injections; (ii) joint-preserving surgical interventions such as high tibial osteotomy and distal femoral osteotomy; and (iii) arthroplasty procedures including unicompartmental and total knee replacements. Within each domain, findings were compared by

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intervention type, patient selection criteria, clinical effectiveness, durability, and complication profiles. Special emphasis was placed on the timing of surgical intervention and integration of medical and operative modalities in a stepwise management framework.

This methodological approach ensured a rigorous and transparent synthesis of current evidence across the full continuum of care for knee osteoarthritis, enabling a comprehensive evaluation of treatment pathways, comparative benefits, and optimal patient selection for both medical and surgical strategies.

2.0 Pathophysiology and Clinical Burden of Knee Osteoarthritis

Knee osteoarthritis (OA) is now understood as a disease of the entire joint organ rather than an isolated cartilage disorder. It is characterized by progressive degradation of articular cartilage, remodeling and sclerosis of subchondral bone, synovial inflammation, meniscal and ligamentous degeneration, and periarticular muscle weakness (2,3,13,17). Biomechanical overload interacts with biochemical mediators, particularly pro-inflammatory cytokines such as interleukin-1β and tumour necrosis factor-α, leading to matrix metalloproteinase activation, loss of extracellular matrix, and suppression of intrinsic repair processes (2,6,13). Subchondral bone signaling, neurogenic inflammation, and central pain sensitization further contribute to the transition from intermittent mechanical pain to persistent, activity-limiting symptoms (2,3,17). Clinically, patients progress from episodic pain and stiffness to chronic pain, crepitus, reduced range of motion, deformity, and functional impairment that significantly affects mobility and quality of life.

Epidemiological studies consistently link knee OA with advancing age, obesity, malalignment (varus or valgus), prior joint trauma, female sex, and occupational or sports-related mechanical loading (4,7,9,11). The disease represents a major public health problem, with high global prevalence and increasing incidence in parallel with ageing populations and rising obesity rates (2,6,11,17). The socioeconomic burden is substantial, encompassing direct healthcare costs related to consultations, imaging, medications, injections, and surgery, as well as indirect costs due to work absenteeism, presenteeism, early retirement, and loss of productivity (4,9,11). These observations underline the need for early identification of at-risk individuals, timely initiation of evidence-based conservative strategies, and judicious use of surgical interventions to preserve long-term joint function.

Non-pharmacological management forms the cornerstone of knee OA treatment at all disease stages and is recommended as first-line therapy in contemporary guidelines (5,10,11). Weight reduction in overweight and obese patients reduces joint load and has been repeatedly associated with symptomatic improvement and slower functional decline (5,9,11,13). Structured physiotherapy programmes focusing on quadriceps and hip strengthening, neuromuscular control, and kinetic-chain optimization enhance joint stability and biomechanics, while gait retraining and activity modification reduce excessive joint stress (5,10,11,13). Assistive devices such as canes and unloader braces may be particularly useful in patients with medial compartment overload or symptomatic malalignment, helping to reduce pain flares and maintain function, even though the magnitude of effect is often modest (5,11,15). These core interventions play a crucial role in early disease and can delay or reduce the need for invasive procedures.

Pharmacological therapy is primarily aimed at symptom relief rather than structural modification. Oral nonsteroidal anti-inflammatory drugs (NSAIDs) remain the most widely prescribed agents for reducing pain and improving short-term function, but their use must be balanced against gastrointestinal, renal, and cardiovascular risks, particularly in older adults and those with comorbidities (5,10,13,15). Paracetamol has limited analgesic efficacy in knee OA and is now considered a secondary option, mainly for patients who cannot tolerate NSAIDs (10,13). Opioids are generally discouraged and, when used, should be restricted to short-term rescue therapy in carefully selected patients who are not candidates for or are awaiting surgery, given their limited functional benefit and substantial risks of dependence and adverse events (10,13,15).

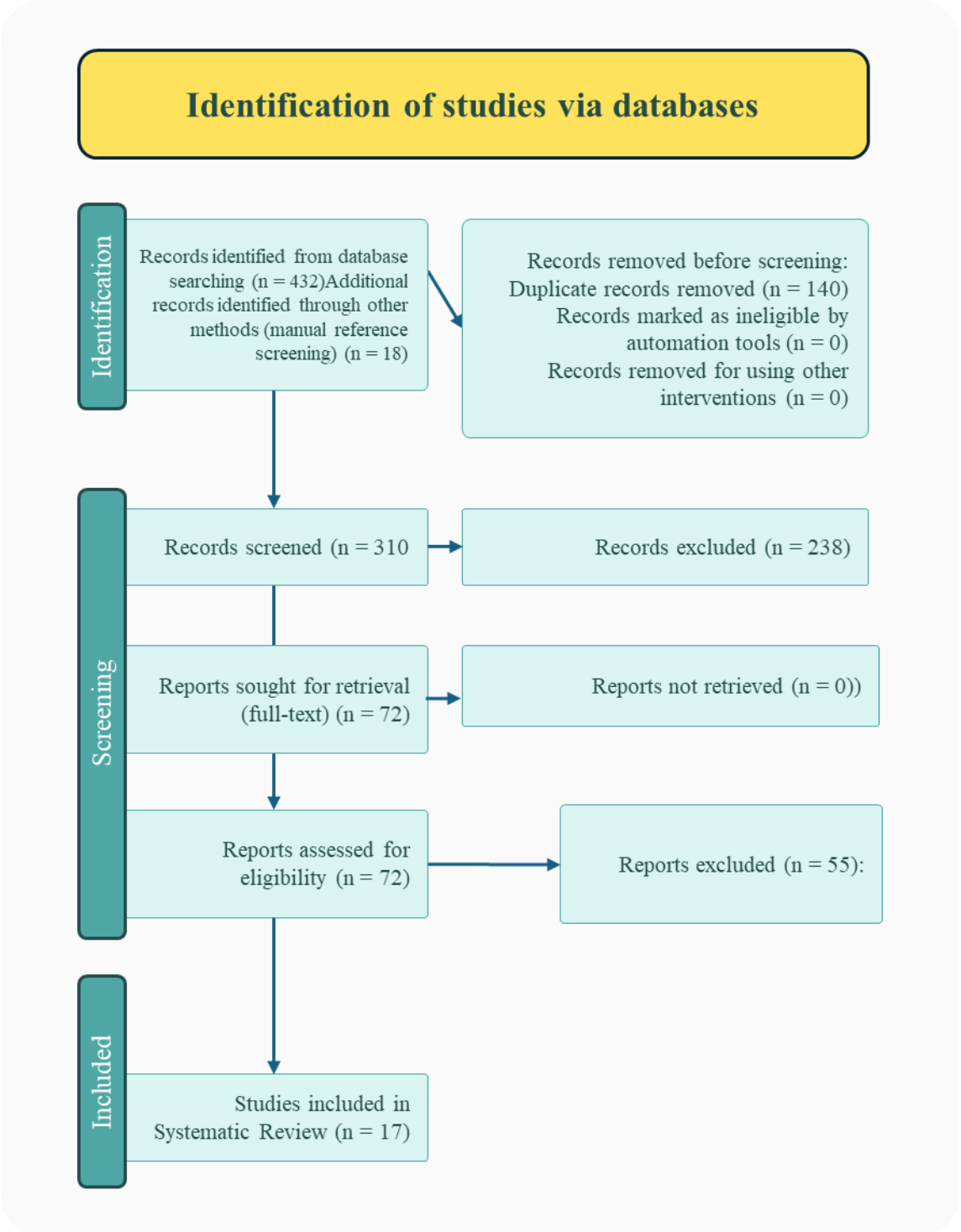
Intra-articular therapies provide local symptom control and are typically considered for patients who remain symptomatic despite optimized non-pharmacological and basic pharmacological management. Corticosteroid injections reduce synovial inflammation and can provide rapid pain relief, especially in the presence of effusion or acute inflammatory flares; however, their benefit is usually short-lived (approximately four to six weeks), and repeated injections may adversely affect cartilage health, so their frequency should be limited (5,10,13). Hyaluronic acid (HA) viscosupplementation aims to restore synovial fluid viscoelasticity, improve lubrication, and enhance shock absorption; while some trials report meaningful pain and functional improvement for up to six to twelve months in mild to moderate OA, others show minimal benefit, resulting in ongoing controversy regarding its overall effectiveness and cost-effectiveness (10,14). Platelet-rich plasma (PRP) has emerged as a promising biologic option; it delivers concentrated platelet-derived growth factors that may promote tissue healing and modulate inflammation, and several studies suggest that PRP can provide more durable symptom relief than corticosteroids or HA in early to moderate OA (6,10,13,14). Its efficacy appears to diminish in advanced, structurally severe OA, and heterogeneity in preparation protocols and study designs limits firm conclusions. Other biologics, including mesenchymal stem cell and adipose-derived products, remain investigational with insufficient high-quality evidence to support routine clinical use (6,13,14).

TABLE 1. Summary of Intra-articular Injection Therapies for Knee Osteoarthritis

Therapy	Mechanism of action	Ideal indications	Limitations
Corticosteroid injection	Suppresses synovial inflammation and inflammatory cytokines	Acute flares, effusion, short-term pain control	Short duration of effect; repeated use may harm cartilage
Hyaluronic acid (viscosupplementation)	Improves lubrication and shock absorption; restores viscoelastic properties	Mild–moderate OA, early cartilage degeneration	Limited benefit in advanced OA; higher cost
Platelet-rich plasma (PRP)	Growth factors promote tissue healing and modulate inflammation	Early–moderate OA; patients wishing to delay surgery	Heterogeneous protocols; variable evidence quality

When conservative measures are no longer sufficient to maintain acceptable pain control and function, or when structural progression leads to severe radiographic OA, deformity, instability, or mechanical symptoms such as locking, surgical intervention becomes an important consideration (1,12,14,16). Persistent pain despite prolonged non-operative care, progressive varus or valgus malalignment, marked joint space narrowing, and significant impairment of daily activities are key indicators that purely medical management may no longer be sustainable (1,12,16,17). The timing

of surgery is critical: intervention that is too early may expose patients to unnecessary procedural risks and future revision, whereas excessive delay can result in irreversible functional loss, muscle atrophy, and poorer postoperative outcomes (1,12,16,17). Decisions regarding transition to surgery must therefore integrate symptom severity, radiographic findings, alignment, comorbidities, patient age, activity level, and expectations, and should be framed within a stepwise, individualized treatment algorithm.



In this systematic review, these clinical and pathophysiological considerations provided the context for the evidence synthesis. A total of 432 records were identified through database searching, and an additional 18 records were retrieved from manual screening of reference lists. After removal of duplicates and initial title–abstract screening of 310 unique articles, 72 full-text studies were assessed for eligibility. Of these, 55 were excluded for reasons such as irrelevance to knee OA, lack of focus on medical, injection-based, or surgical management, or insufficient methodological quality. Ultimately, 17 studies met the inclusion criteria and formed the evidence base for the qualitative synthesis of medical, intra-articular, and surgical approaches described in the subsequent sections.

3.0 Knee Osteoarthritis Surgical Management

Surgical management of knee osteoarthritis (OA) is considered when symptoms persist despite optimized conservative and injection-based therapies, or when structural progression results in severe pain, deformity, and functional limitation. The overarching goals of surgery are to relieve pain, correct malalignment, restore joint mechanics, and preserve or replace the joint in a way that optimizes long-term function and implant survivorship (1,12,16,17). Choice of procedure depends on age, activity level, compartmental involvement, alignment, ligament status, and patient

expectations, with a contemporary shift toward individualized, phenotype- and stage-based selection rather than a one-size-fits-all approach (1,5,12,16,17).

Arthroscopic surgery, once widely used for degenerative knee disease, now has a very restricted role in the management of OA. High-quality randomized trials and subsequent guideline recommendations have shown that arthroscopic debridement or lavage does not confer meaningful long-term benefit over optimized non-operative care in patients with established degenerative changes (5,15,16). As a result, arthroscopy is no longer recommended as a routine treatment for knee OA and is reserved for selected patients with specific mechanical problems such as symptomatic loose bodies, true locking from a displaced meniscal fragment, or focal chondral flaps in the setting of early or mild OA (5,15,16). Even in these scenarios, the magnitude and durability of symptom improvement are constrained by the underlying degenerative pathology.

Joint-preserving realignment osteotomies around the knee play a crucial role in younger, active patients with unicompartmental OA and coronal plane malalignment. By shifting the mechanical axis away from the diseased compartment, osteotomy can reduce pain, slow structural progression, and delay the need for arthroplasty (4,12,14,16). Successful outcomes depend heavily on appropriate patient selection—typically individuals younger than 60 years, with isolated medial or lateral compartment disease, preserved range of motion, stable ligaments, and a correctable deformity (4,6,12,14). Accurate preoperative planning, precise correction, and adherence to rehabilitation protocols are key determinants of durability and function.

High tibial osteotomy (HTO) is most commonly indicated for varus-aligned medial compartment OA. The procedure involves creating an opening- or closing-wedge osteotomy of the proximal tibia to shift the weight-bearing axis laterally toward the relatively preserved compartment (8,12,14). In well-selected patients with moderate disease, good knee motion, and intact ligamentous stability, HTO can provide substantial pain relief and functional improvement and may postpone the need for total knee arthroplasty for 10–15 years in many cases (8,12,14,16). However, results are sensitive to the accuracy of alignment correction, bone healing, and patient compliance with postoperative rehabilitation, and outcomes are less favourable in the presence of advanced tricompartmental degeneration or severe cartilage loss.

Distal femoral osteotomy (DFO) is principally used for valgus malalignment associated with lateral compartment OA. Although it is performed less frequently than HTO and is technically more demanding due to the anatomy of the distal femur, DFO can effectively restore mechanical axis neutrality and redistribute load medially when executed in appropriately selected patients (12,14,16). Both HTO and DFO represent a paradigm of joint preservation in biologically young, high-demand individuals, allowing maintenance of native joint structures and deferring the need for arthroplasty while preserving future surgical options (12,14,16).

Unicompartmental knee arthroplasty (UKA) is designed to replace only the affected compartment—most often medial, less commonly lateral—while preserving the anterior and posterior cruciate ligaments and the uninvolved compartments. This selective resurfacing maintains more physiological knee kinematics and can feel closer to a native joint compared with total knee arthroplasty (12,16,17). UKA is best suited for patients with isolated unicompartmental OA, minimal deformity, intact cruciate and collateral ligaments, and stable alignment without significant inflammatory arthropathy (12,16). Advantages over TKA include smaller incisions, less blood loss, shorter hospital stay, faster rehabilitation, and better proprioception due to ligament preservation (12,16,17). Contemporary series report 10-year implant survival rates frequently exceeding 90% in appropriately selected patients (12,16). However, UKA is highly sensitive to patient selection and surgical technique; early failure may result from progression of disease in other compartments, under- or over-correction of alignment, persistent instability, or high-impact activity, underscoring the need for careful clinical and radiological evaluation before recommending this option (12,16,17).

Total knee arthroplasty (TKA) remains the standard surgical treatment for end-stage, multicompartmental OA and is generally indicated in patients with severe radiographic degeneration, substantial functional impairment, and persistent pain despite exhaustive non-operative and injection-based management (1,2,12,17). TKA involves resurfacing the distal femur and proximal tibia, and often the patella, to restore alignment, correct deformity, and balance the soft tissues (1,12,16). Advances in implant design, bearing surfaces, and alignment strategies, together with computer-assisted and robotic-assisted techniques, have improved the precision of component positioning and may enhance functional outcomes and implant longevity (1,12,16,17). Long-term survivorship of modern TKA implants commonly exceeds 90% at 10–15 years, accompanied by substantial improvements in pain, mobility, and health-related quality of life for the majority of patients (1,12,16,17).

Timing of TKA is critical. Performing TKA too early in relatively young, high-demand patients can increase lifetime revision risk, whereas excessive delay in the presence of progressive deformity, contractures, and muscle atrophy may compromise postoperative functional recovery and satisfaction (1,12,17). Consequently, in younger individuals, joint-preserving options such as osteotomy and, where appropriate, UKA are often preferred initially, reserving TKA for more advanced or diffuse disease or after failure of these interventions (1,12,14,16,17). Across the spectrum of surgical options, optimal outcomes depend on aligning the procedure with the patient's age, alignment, compartmental involvement, ligament status, comorbidities, and long-term functional goals.

4.0 Comparative Effectiveness and Surgical Decision-Making

Comparative evaluation of surgical options for knee osteoarthritis demonstrates clear patterns of effectiveness based on patient age, compartment involvement, severity of degeneration, and alignment. Joint-preserving procedures such as high tibial osteotomy (HTO) and distal femoral osteotomy (DFO) are most effective in biologically young, active individuals with isolated unicompartmental OA and correctable malalignment. These procedures redistribute load away from the diseased compartment, relieve pain, and can significantly delay the need for arthroplasty, reducing lifetime revision risk (4,12,14,16). In patients with limited disease confined to a single compartment and preserved ligamentous stability, unicompartmental knee arthroplasty (UKA) serves as an intermediate option that offers faster recovery, more physiological knee kinematics, and reduced morbidity compared with total knee arthroplasty (12,16,17). Conversely, in older adults or patients with advanced, multicompartmental degeneration, total knee arthroplasty (TKA) provides the most predictable long-term pain relief, functional restoration, and implant survival (1,12,17).

Optimal surgical decision-making requires the integration of multiple parameters, including the anatomical distribution of disease, degree and direction of malalignment, ligament integrity, radiographic severity, patient age, activity level, comorbidities, and functional expectations. Contemporary orthopedic practice increasingly favors individualized treatment algorithms, recognizing that age alone should not dictate surgical choice. Instead, a pathology-specific, patient-centered approach allows clinicians to select interventions that maximize durability while preserving future surgical options and long-term joint function (12,14,16).

Table 2. Comparative Overview of Surgical Options for Knee Osteoarthritis

Procedure	Indications	Advantages	Limitations
High Tibial Osteotomy (HTO)	Varus malalignment; medial compartment OA; <60 years	Joint preservation; delays TKA by 10–15 years; good function	Requires precise correction; longer rehabilitation
Distal Femoral Osteotomy (DFO)	Valgus malalignment; lateral compartment OA; younger active patients	Preserves native joint; effective load redistribution	Technically demanding; slower recovery; less common use
Unicompartmental Knee Arthroplasty (UKA)	Isolated medial/lateral OA; intact ligaments; minimal deformity	Faster recovery; natural kinematics; smaller incision	Not suitable for multicompartment OA; technique sensitive
Total Knee Arthroplasty (TKA)	End-stage multicompartment OA; severe symptoms despite conservative care	Long-term pain relief; high implant survival; functional restoration	Higher revision risk in younger patients; surgical complications possible

Medical–Surgical Strategy Integration Management of knee OA requires a dynamic and integrative strategy that aligns non-pharmacological measures, pharmacological therapy, injection-based treatments, and surgical interventions along a continuum of care. In early disease, core interventions—including weight reduction, physiotherapy, exercise therapy, and NSAIDs—remain the foundation of management and help slow symptom progression (5,10,13). Intra-articular therapies such as corticosteroids, hyaluronic acid, and platelet-rich plasma (PRP) offer adjunctive symptom relief for patients whose symptoms persist despite optimized conservative care. PRP, in particular, has shown promise in extending symptomatic control in early to moderate OA and may serve as a bridging therapy for individuals seeking to defer surgical intervention (6,10,13,14).

As disease progresses, biomechanical factors such as varus or valgus malalignment become increasingly influential in symptom severity and rate of structural decline. In such cases, realignment osteotomies (HTO or DFO) provide a crucial intermediate option, especially for young, active individuals, by correcting mechanical axis deviation and unloading the diseased compartment (8,12,14). For patients with isolated unicompartment disease who are not ideal candidates for osteotomy or who desire quicker return to function, UKA offers a minimally invasive alternative with favorable long-term survivorship in well-selected individuals (12,16,17). When degeneration becomes multicompartmental or pain remains refractory despite all non-operative and joint-preserving strategies, TKA becomes the definitive intervention, providing durable symptomatic relief and restoration of quality of life (1,12,17). An evidence-based staged approach ensures that each intervention is introduced at its optimal point in disease progression to maximize outcomes and minimize long-term morbidity.

DISCUSSION

Findings from this systematic review highlight the importance of patient selection, precise timing, and a multimodal approach in the management of knee osteoarthritis. Joint-preserving surgeries such as HTO and DFO remain highly valuable in younger, active patients with unicompartmental disease and malalignment, offering prolonged symptom relief while maintaining the native joint and deferring the need for TKA (8,12,14,16). UKA provides another effective option in carefully selected patients with isolated compartment involvement, allowing faster rehabilitation and more natural joint kinematics than TKA, though outcomes are highly dependent on surgical expertise and meticulous selection (12,16,17). For individuals with advanced, multicompartmental OA, TKA continues to deliver predictable long-term improvements in pain, mobility, and quality of life, provided it is performed at an appropriate stage of disease progression (1,12,17).

Non-operative modalities—including corticosteroid, HA, and PRP injections—offer meaningful symptom control in early to moderate OA but do not halt structural deterioration. Among them, PRP demonstrates the longest duration of symptom relief and may help delay surgical intervention in select patients (6,10,13,14). However, as disease advances, the efficacy of injection-based therapies diminishes, underscoring the need for timely transition to surgical options. The evidence consistently reinforces the need for an individualized, patient-centered strategy that accounts for disease stage, biomechanical profile, radiographic severity, and functional goals.

Overall, an integrated approach combining conservative management, biologic injections, realignment osteotomies, and arthroplasty—applied at the most appropriate stage for each patient—offers the highest likelihood of preserving joint function, reducing pain, and maintaining long-term quality of life. This emphasizes the critical role of orthopedic surgeons in guiding the transition between non-operative and operative treatments, ensuring that interventions are sequenced optimally and tailored to the patient's anatomical, functional, and lifestyle needs.

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