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Comparative Effectiveness of Platelet-Rich Plasma (PRP) versus Conservative Management in Delaying Total Knee Replacement Surgery In Knee Osteoarthritis: A Systematic Review

By

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IIHMR DELHI

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This is to certify that Sudeepta Bhushan, a student of PGDM (Hospital & Health Management) from International Institute of Health Management Research, New Delhi, has undergone internship training at ANVKA Healthcare Pvt. Ltd from 10th Jan 2026 to 10th May 2026. The Candidate has successfully carried out the project assigned to her during her internship training, and her approach to the study has been sincere, scientific, and analytical. The Internship is in fulfilment of the course requirements.

I wish her all success in all her future endeavours.

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This is to certify that **Ms. Sudeepta Bhushan, D/o Mr. Shanti Bhushan** has successfully completed her Internship with us from **20-Jan-2026 to 10-May-2026** in the department of **Business Development.**

During the period of her internship, we found her sincere, hardworking and a good team player.

We wish her all the best for her future endeavours.

For Anvka Healthcare Pvt. Ltd.

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Certificate of Approval

The following dissertation titled **"Comparative Effectiveness of Platelet-Rich Plasma (PRP) versus Conservative Management in Delaying Total Knee Replacement Surgery in Knee Osteoarthritis"** at ANVKA Healthcare Pvt. Ltd is hereby approved as a certified study in management carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite for the award of PGDM (Hospital & Health Management) for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed, or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

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This dissertation has the requisite standard, and to the best of our knowledge, no part of it has been reproduced from any other dissertation, monograph, report or book.

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CERTIFICATE BY STUDENT

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LIST OF ABBREVIATIONS

Abbreviation	Full Form
PRP	Platelet-Rich Plasma
TKR	Total Knee Replacement
OA	Osteoarthritis
KOA	Knee Osteoarthritis
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomized Controlled Trial
EMBASE	Excerpta Medica Database
MeSH	Medical Subject Headings
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index
VAS	Visual Analogue Scale
KOOS	Knee Injury and Osteoarthritis Outcome Score
IKDC	International Knee Documentation Committee
OKS	Oxford Knee Score
SF-36	Short Form-36 Health Survey
PDGF	Platelet-Derived Growth Factor
TGF-β	Transforming Growth Factor-Beta
IGF-1	Insulin-Like Growth Factor-1
NOS	Newcastle-Ottawa Scale
RoB 2	Risk of Bias Version 2
AMSTAR-2	Assessment of Multiple Systematic Reviews 2
SCAC	Simplified Critical Appraisal Checklist

SCOPE OF THE PROJECT

This dissertation evaluates the comparative effectiveness of Platelet-Rich Plasma (PRP) therapy and conservative management in delaying Total Knee Replacement (TKR) surgery among patients with knee osteoarthritis through a systematic review of published scientific evidence. The review follows the PRISMA 2020 guidelines and includes studies published between 2010 and 2025, retrieved from PubMed, Google Scholar, and J-Gate.

The scope of this project includes the evaluation of the following outcome measures:

- Delay in Total Knee Replacement surgery.
- Reduction in pain following treatment.
- Improvement in knee function.
- Duration of symptom relief.
- Safety and adverse events associated with the interventions.

The review incorporates randomised controlled trials, cohort studies, systematic reviews, meta-analyses, and evidence-based clinical guidelines that meet the predefined inclusion criteria. It provides a comprehensive synthesis of the available evidence to support evidence-based clinical decision-making for the management of knee osteoarthritis.

The findings of this study may assist orthopaedic surgeons, physiotherapists, rehabilitation specialists, healthcare administrators, researchers, and policymakers in understanding the comparative role of PRP therapy and conservative management in delaying knee replacement surgery. The review also identifies existing research gaps and highlights areas requiring further long-term clinical research, particularly within the Indian healthcare context.

ABOUT THE ORGANIZATION

ANVKA Healthcare Pvt. Ltd.

ANVKA Healthcare Pvt. Ltd. is an Indian healthcare organisation established in **2021** and headquartered in **New Delhi**, with its corporate office located in **Udyog Vihar, Gurugram, Haryana**. The company is committed to improving quality of life by delivering innovative, technology-driven, and customer-centric solutions across multiple sectors, with healthcare serving as its primary focus. Its vision is to combine advanced technology, quality products, and sustainable practices to develop solutions that improve patient care and healthcare delivery.

ANVKA Healthcare functions as a healthcare ecosystem comprising several specialised brands that collectively support different aspects of patient care and healthcare services. Its major healthcare initiatives include medical implants, **Cure with 3D**, which provides patient-specific three-dimensional anatomical models and surgical guides for clinical planning and medical education, and **Care(TAB).ai**, an AI-enabled home healthcare platform designed to extend quality healthcare services beyond hospitals. In addition, the organisation operates **Lintex**, a premium uniform brand serving healthcare and other professional sectors, along with complementary businesses in food and wellness services.

The organization emphasizes innovation, quality, and patient-centred care while collaborating with healthcare professionals and institutions to enhance clinical outcomes. By integrating advanced healthcare technologies with practical clinical applications, ANVKA Healthcare aims to strengthen the continuum of care from hospitals to home-based healthcare services. Its multidisciplinary approach reflects a commitment to improving accessibility, efficiency, and the overall healthcare experience for patients and healthcare providers.

During the dissertation training period, exposure to the organisation's operations and interactions with healthcare professionals provided insight into current treatment approaches used in orthopaedic practice, particularly in the management of knee osteoarthritis. This practical exposure helped in identifying the research problem and motivated the selection of the dissertation topic comparing Platelet-Rich Plasma (PRP) therapy with conservative management for delaying Total Knee Replacement surgery.

TITLE: Comparative Effectiveness of Platelet-Rich Plasma (PRP) versus Conservative Management in Delaying Total Knee Replacement Surgery In Knee Osteoarthritis: A Systematic Review

Abstract:

This study compares the effectiveness of Platelet-Rich Plasma (PRP) therapy versus conservative management in delaying Total Knee Replacement (TKR) surgery in patients with knee osteoarthritis. Knee osteoarthritis is one of the leading causes of disability worldwide, affecting 22% to 39% of adults above 40 years of age in India. Conservative management, including physiotherapy, exercise, and NSAIDs, is the standard treatment but often fails to prevent disease progression. PRP therapy, which involves injecting concentrated growth factors from the patient's own blood into the knee joint, has emerged as a promising biological alternative that may offer longer-lasting relief and potentially delay the need for surgery.

A systematic review was conducted following PRISMA 2020 guidelines. PubMed, Google Scholar, and J-Gate were searched for peer-reviewed studies published between 2010 and 2025. After a systematic screening process (49 records identified, 36 duplicates/ineligible records removed across screening and eligibility stages), 36 studies were included, consisting of randomised controlled trials, meta-analyses, cohort and registry studies, and clinical practice guidelines.

The findings showed that PRP produces significantly better pain relief and functional improvement at 6 to 12 months compared to most conservative treatments. Registry and cohort evidence indicated that both approaches can substantially delay surgery: PRP delayed total knee replacement by more than 1.5 years in 74.1% of patients, with 85.7% remaining surgery-free at 5 years, while structured conservative management (education and exercise) kept 74% of eligible patient's surgery-free at 1 year, 68% at 2 years, and up to 86% of treatment responders surgery-free at 5 years. When PRP and exercise were combined, they produced the best overall outcomes among all non-surgical treatment options.

This review conveys that PRP is an effective second option for mild to moderate knee osteoarthritis and works best with physiotherapy and exercise rather than as a replacement for it.

Introduction

Osteoarthritis of the knee is a disease that results in gradual destruction of cartilage inside the knee [1]. The bones start to grind on one another without the protective cartilage layer, leading to pain, swelling and difficulty walking [2], and it is a leading cause of loss of independence and difficulty with activities of daily living among older adults [1]. The World Health Organisation estimates that osteoarthritis affects roughly three hundred million people worldwide, with the knee joint most commonly affected [1]. OA can occur in people in their 40s and 50s, not only as a disease of old age but also among overweight individuals, those with knee injuries, or those whose work involves prolonged standing or heavy physical activity. It is a slow-progressing disease that, if left untreated, eventually leads to complete loss of joint function [2].

Knee OA is the most common cause of long-term disability worldwide, affecting patients, families, health systems and economies [1]. Overall costs of knee OA management — outpatient visits, medication, physiotherapy and orthopaedic surgery — total tens of billions of dollars annually [2]. Although medical care has advanced, there is currently no cure, and symptomatic treatment only aims to minimise the impact on disease course [2].

The Situation in India

Knee osteoarthritis has a high prevalence in India and is considered a serious public health issue [3]. Estimates suggest that between 22% and 39% of individuals aged 40 and older are affected — a considerable figure given the size of India's ageing population [3]. This heavy burden can be explained by several factors, including genetic predisposition, a frequent varus (bow-leg) knee configuration, and high mechanical stress associated with many occupations and daily activities [3]. Indian patients also tend to develop knee OA at a younger age than their Western counterparts, meaning the disease must be managed over a much longer period [3]. Cultural practices such as cross-legged sitting, deep squatting and frequent stair climbing may aggravate the condition or bring on symptoms earlier [3,4]. As the population continues to age and risk factors such as obesity rise, incidence is projected to grow considerably over the next two decades, placing additional strain on healthcare infrastructure as total knee replacement (TKR) rates continue to climb [3]. The cost of TKR remains a major concern for Indian patients who lack insurance coverage or financial assistance [3,4]. It is therefore increasingly important to identify methods that postpone surgery or reduce the need for it.

How Is Knee OA Treated? Conservative Management

The first line of treatment for knee osteoarthritis is usually conservative management — treating the condition without surgery [5]. This combines physical exercise, lifestyle change and pharmacotherapy aimed at reducing pain, improving joint function and limiting further damage [5,6]. Exercise and physiotherapy remain the most effective non-surgical interventions supported by a wealth of evidence [7]. Strength training of the quadriceps, low-impact aerobic activity (swimming, cycling) and balance exercises have all been shown to reduce pain and improve function. A systematic review of 54 studies involving nearly 4,000 participants found that land-based exercise produced a moderate but significant reduction in pain that persisted for roughly two to six months after the intervention ended [7].

Alongside exercise, patients commonly receive NSAIDs for pain and swelling [5,6]. These are effective and generally safe over the short term, but prolonged use can cause gastritis, renal problems and cardiotoxicity [5]. Intra-articular corticosteroid injections offer another route to short-term relief, though benefits typically wear off within one to three weeks and repeated use may accelerate cartilage loss [5,6]. While non-surgical methods can control symptoms in early and intermediate disease, they do not halt progression [5]; patients continue to experience worsening pain and function despite consistent conservative care until they eventually require surgery [2,5]. This underscores the need for treatment options that not only relieve pain but also slow disease progression and postpone surgery.

What is Platelet-Rich Plasma (PRP) Therapy?

Platelet-Rich Plasma (PRP) is a therapy that uses components of the patient's own blood to stimulate natural healing [8,9]. A blood sample is centrifuged to separate its components, concentrating platelets, cells central to wound repair, into a smaller volume of plasma [9]. The resulting preparation contains three to five times more platelets than ordinary blood [8,10] and is injected directly into the joint. Platelets release growth factors that signal tissue repair [9]; once injected, these growth factors are believed to reduce inflammation, promote cartilage regeneration and improve overall joint condition [9,10]. Key growth factors include Platelet-Derived Growth Factor (PDGF), Transforming Growth Factor-Beta (TGF-β) and Insulin-Like Growth Factor-1 (IGF-1), all contributing to tissue repair and inhibition of the inflammatory processes that damage cartilage in osteoarthritis [9].

PRP has been investigated extensively in clinical trials for knee osteoarthritis [8,11,12]. A meta-analysis of ten trials with over 1,000 patients found that PRP improved pain and joint function

more than other injectable options at 6 and 12 months [8]. Another large review suggested PRP can reduce pain for up to six months, with benefits that may outlast those of steroid injections [11,12]. Because PRP is derived from the patient's own blood, it is generally regarded as safe, with relatively few side effects [8,10]. In India, the only major controlled trial of PRP for knee OA was conducted at the Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh, by Patel et al. [4]. This trial of 78 patients found PRP significantly more effective than placebo in reducing pain and improving function over six months, confirming that PRP works in Indian patients consistent with international findings — though further Indian research is needed to strengthen this evidence base [4].

Why This Research is Needed

Beyond its financial burden, TKR carries clinical drawbacks that are often underappreciated. Despite being a highly effective procedure, a considerable proportion of patients continue to experience persistent knee pain after surgery — reported at rates of 14% to 53% — while poor post-operative function has been reported in 7% to 50% of cases [13]. Overall dissatisfaction after TKR has been documented at 15% to 30%, a substantial figure for a major, irreversible procedure with a lengthy recovery [13]. These outcomes are compounded by surgical risks such as infection, stiffness, blood clots and the eventual need for revision surgery in some patients [13]. Taken together, these limitations reinforce the case for exploring strategies that can delay or reduce reliance on surgery.

Despite widespread use of PRP for knee problems, including at private hospitals in India, its effectiveness relative to conservative therapy in preventing TKR has not been confirmed by trial data [5]. In the literature, PRP is generally compared to hyaluronic acid or corticosteroids rather than directly to conservative management [8,10], leaving a significant gap in the evidence base that clinicians must currently bridge with personal experience and anecdotal judgement [5].

A systematic review is the most appropriate design for addressing this gap, since it draws together all currently available studies for an objective, comprehensive analysis [14]. Comparing evidence on PRP and conservative therapy allows an indirect comparison from which conclusions can be drawn about which option performs better [15] — a recognised and frequently used approach in medical research in the absence of head-to-head trials [14].

Given the scale of knee OA in India, the high cost of TKR, and the financial barriers many patients face in accessing surgery, this research is particularly needed to clarify which therapies

help postpone knee replacement [3,4]. Clarifying this has real public-health value: avoiding or delaying knee replacement through effective alternative therapy could generate substantial cost savings and improve patients' quality of life [4,5]. Conversely, if conservative therapy proves comparably effective, this would strengthen the case for investing more heavily in physiotherapy services [5,16].

This systematic review therefore aims to fill this evidence gap by analysing current literature on the efficacy of PRP and conservative therapy for knee OA and presenting evidence-based conclusions [5], conducted in accordance with PRISMA 2020 methodology to ensure reliability and transparency in the search and analysis process [14].

Rationale:

This study has been conducted to address the absence of clear evidence comparing the effectiveness of Platelet-Rich Plasma (PRP) therapy with conservative management in delaying the need for Total Knee Replacement (TKR) among patients with knee osteoarthritis.

Aim:

This study aims to evaluate and compare the effects of PRP and conservative therapy on delaying TKR in patients with knee osteoarthritis.

Objectives:

Primary Objective

To evaluate and compare the effects of PRP and conservative therapy on delaying Total Knee Replacement Surgery.

Secondary Objectives

- To compare the level of pain reduction achieved by both therapies.
- To analyse the improvement in joint function through both treatments.
- To measure the period during which symptoms last in relation to the two therapies.
- To compare the overall efficacy of the two therapies according to the available published literature.

Literature Review

In this literature review, 36 studies published between 2010 and 2025 were considered to answer one central question: whether PRP treatment or conservative methods more effectively delay Total Knee Replacement surgery in comparison with one another.

1. **Shen et al.** [12] found that platelet-rich plasma (PRP) injections produced significant improvement in pain and physical function in knee osteoarthritis, with the effect being time-dependent and more pronounced at longer follow-up compared with placebo and hyaluronic acid. Their meta-analysis of randomised controlled trials showed PRP provided superior WOMAC pain and function scores, particularly at 6 and 12 months, while corticosteroid injections were more effective only in the short term. Variability in preparation methods and trial design was noted as a limitation.

2. **Laudy et al.** [11] found PRP injections effective in reducing pain and improving knee function, with outcomes superior to placebo and hyaluronic acid in several trials, supporting PRP as a promising short- to medium-term nonsurgical intervention.

3. **Chen et al.** [8] reported across multiple meta-analyses that intra-articular PRP consistently produced superior pain relief and functional outcomes compared with hyaluronic acid and corticosteroid injections, with sustained benefit at medium- to long-term follow-up.

4. **Patel et al.** [4], in a prospective double-blind randomised trial conducted in India, found PRP significantly more effective than placebo in reducing pain and improving function, with sustained improvement in WOMAC scores over six months.

5. **Costa et al.** [17] found NSAIDs and opioids both effective for knee and hip OA pain and function, but NSAIDs offered a more favourable efficacy–safety balance, with opioids carrying higher adverse-event risk.

6. **Costa et al.** [10] found PRP produced superior clinical outcomes compared with other nonsurgical therapies such as hyaluronic acid and corticosteroids, with greater and more sustained improvement in pain and function.

7. **Bannuru et al.** [5], in the OARSI guidelines, recommended exercise, weight management and patient education as core nonsurgical treatments, endorsed topical

NSAIDs, permitted conditional use of oral NSAIDs and intra-articular corticosteroids, and discouraged opioids.

8. **Primorac et al.** [18] described knee OA as arising from a complex interplay of genetic, biochemical and biomechanical factors, with lifestyle modification, pharmacological agents and injections remaining central, while regenerative options such as PRP and stem cells emerge as promising adjuncts.

9. **Surakanti et al**. [19] found total knee arthroplasty provided more definitive long-term relief for advanced disease, while nonsurgical options remained effective for earlier-stage symptom management, with treatment choice individualised by severity and comorbidity.

10. **Malik et al.** [20], reviewing 37 studies, found interventional techniques (corticosteroids, prolotherapy, viscosupplementation, PRP, genicular nerve blocks) provide effective pain relief and function, and can be integrated into treatment plans to delay or avoid joint replacement.

11. **Billesberger et al.** [21] found PRP and hyaluronic acid provide longer-lasting benefit than corticosteroids, which are more effective only in the short term, with prolotherapy showing potential as an adjunct.

12. **de Girolamo et al.** (2016) identified PRP, mesenchymal stem cells and autologous chondrocyte implantation as promising regenerative strategies for early OA that may delay progression and improve outcomes.

13. **Rodríguez-Merchán, E. C. (2022)** [9] described PRP's molecular mechanisms, reduced pro-inflammatory cytokines, chondrocyte proliferation and improved extracellular matrix synthesis, that together explain its clinical benefit for pain and function.

14. **Gupta et al.** [23] found PRP effective for primary knee OA, with significant sustained improvement in pain and functional outcomes in a prospective interventional study.

15. **Prasad et. al** [24] found PRP injections effective for knee pain in a UK district general hospital cohort, with significant improvement in pain scores and function, though response varied between patients.

16. **Li et al.** [25] found PRP superior to hyaluronic acid and corticosteroids in pain and function, acting through anti-inflammatory and cartilage-repair mechanisms, though standardisation and long-term trials remain needed.

17. **Mora et al.** [26] described knee OA as driven by mechanical stress, inflammation and biochemical change, noting that current modalities (lifestyle, NSAIDs, corticosteroids, PRP) relieve symptoms but do not cure the disease.

18. **DeRogatis et al.** [2] found non-operative options (lifestyle change, NSAIDs, acetaminophen, corticosteroids, hyaluronic acid) reduce pain and improve function in early/moderate disease but do not alter disease progression.

19. **Dantas et al.** [27] found exercise-based physical therapy, strength training, aerobic activity, and neuromuscular re-education strongly supported for reducing pain and improving function, particularly within individualised multimodal programmes.

20. **Min Oo et al.** (2016) found physical modalities (thermotherapy, ultrasound, TENS, laser) effective as adjuncts to exercise rather than as standalone treatments.

21. **Uivaraseanu et al**. [29] found intra-articular therapies including hyaluronic acid and PRP offer promising outcomes for pain and function alongside foundational lifestyle and pharmacological strategies.

22. **Addissouky et al.** [30] found conservative rehabilitation (gait retraining, proprioceptive exercise, bracing) improves symptoms but has limited long-term efficacy, with emerging biologics and tissue engineering showing promise for disease modification.

23. **Buttgereit et al.** [31] found non-surgical management largely palliative, with exercise, weight reduction and education as core strategies and NSAIDs/corticosteroids for symptomatic relief, highlighting the need for disease-modifying therapies.

24. **Kon et al.** [32] found early-stage management should prioritise multimodal conservative approaches, while biologic therapies such as PRP may offer additional benefit pending further validation.

25. **Skou et al.** [16], in two parallel RCTs, found total knee replacement produced greater improvement in pain and function than non-surgical treatment over two years, but with materially higher rates of serious adverse events; critically, 74% of the non-surgical group avoided TKR for at least one year, and 68% remained surgery-free at two years.

26. **Lim and Al-Dadah** [33] found conservative treatment strongly supported for pain and function, though it remains underutilised despite proven efficacy.

27. **Zampogna et al.** [7] found aerobic exercise, strength training and neuromuscular activity particularly effective for pain and function in older adults with hip/knee OA, with adherence critical for sustained benefit.

28. **Rodríguez-Merchán (2016)** [34], reviewing the Cochrane Library, found conservative measures effective for acute symptom relief but without altering disease progression.

29. **Naja et al.** [15], in a PRISMA-compliant network meta-analysis, found exercise, weight management and education consistently effective, with hyaluronic acid and PRP showing promising functional benefit, though evidence quality varied.

30. **Tomaszewski et al.** [35] found PRP, hyaluronic acid and stem-cell therapies offer promising short-term benefit, but long-term evidence remains limited, calling for standardised protocols and trials using TKR conversion as a primary outcome.

31. **Grzesikowski and Klich** [36] found multimodal conservative approaches can match pharmacological treatment for symptom relief, with PRP injections showing longer-lasting benefit.

32. **Duymus et al.** [37] found PRP shows longer-lasting improvement in pain and function than other injectables, though further controlled study of its role in delaying TKR is needed.

33. **Szombara et al.** [38] found PRP, stem cells and other biologics promising for symptom relief and function, but evidence remains heterogeneous, underscoring the need for standardised protocols and trials targeting TKR conversion.

34. **Kamada et al.** [39] found patient age, BMI, baseline disease stage, and injection number/frequency significantly affect PRP outcomes, highlighting the need for standardised protocols before PRP's role in delaying TKR can be reliably assessed.

35. **Sánchez et al.** [40], in a retrospective study with survival analysis of 667 patients, found 74.1% experienced a surgery delay of more than 1.5 years (median delay 5.3 years) and 85.7% had not undergone arthroplasty within five years, supporting PRP as a valuable option for postponing surgery.

36. **Gustafsson et al.** [41], in a register-based study of 44,311 patients, found responders to first-line education-and-exercise treatment had a significantly lower five-year risk of

joint replacement (14% vs 20% in knee OA), underscoring the value of effective conservative care in delaying surgery.

After reviewing all 36 studies, several clear gaps in the evidence emerge.

Firstly, there are no clinical trials directly comparing PRP treatment against conservative care with surgery rate as the primary outcome. Current conclusions rely on indirect comparisons, which are scientifically valid but leave uncertainty about whether the effect would hold in a head-to-head trial. Closing this gap should be a top priority.

Secondly, there is a major issue with the lack of standardisation in PRP preparation. Hospitals and research centres differ in platelet concentration, leukocyte content, number of injections, and intervals between injections. This inconsistency makes it difficult to define "PRP" uniformly and leads to cautious recommendations in international guidelines.

Thirdly, most clinical trials have relatively short follow-up periods, often limited to 6–12 months. Yet many patients, especially younger ones in India, may take several years before requiring surgery. Long-term studies of PRP beyond 12 months and conservative care beyond 2 years are therefore needed.

Finally, the evidence base in India is critically weak. Apart from the PGIMER Chandigarh study by Patel et al., there are no multicentre trials, no data on PRP patients progressing to surgery, and no cost-effectiveness analyses. Given the high burden of knee osteoarthritis in India and the financial challenges of accessing TKR, generating India-specific data is one of the most urgent research priorities.

Methodology:

a) Study Design

- This research uses a **Systematic Review** design.
- The review was conducted in full accordance with **PRISMA 2020 guidelines**, the international gold standard for systematic review reporting.
- Every step, from search strategy to final reporting, was documented clearly to ensure reproducibility.
- No published clinical trial directly compared PRP with comprehensive conservative management using TKR as the primary endpoint.

- Because the included studies varied in outcome measures, study designs, and follow-up periods, **statistical pooling (meta-analysis) was not feasible**. Therefore, a **Narrative Synthesis** approach was adopted as the most appropriate method to systematically bring together and interpret the findings.

b) PICO Framework

PICO	Element	Definition for This Study
Population	**Population**	Studies involving adults aged ≥40 years with mild to moderate knee osteoarthritis (Kellgren–Lawrence Grades I–III).
Intervention	**Intervention**	Studies evaluating intra-articular Platelet-Rich Plasma (PRP) therapy, including any PRP preparation (LP-PRP or LR-PRP), injection frequency, or dosage.
Comparator	**Comparator**	Studies evaluating conservative management, including supervised exercise, physiotherapy, oral or topical NSAIDs, and intra-articular corticosteroids.
Outcome	**Outcome**	**PRIMARY:** Delay of progression to Total Knee Replacement (TKR) surgery **SECONDARY:** (1) Pain relief — VAS, NRS, WOMAC (2) Functional improvement — WOMAC, KOOS, IKDC, OKS, SF-36 (3) Duration of symptom relief (4) Safety and adverse events

Table. 1

c) Database Selection

Two electronic databases were searched for relevant studies. These were selected to provide the most comprehensive coverage of peer-reviewed literature for this topic.

Database	Full Name	Search Period	Reason for Selection
PubMed	National Library of Medicine, USA	Jan 2010 – Jan 2025	The most comprehensive global biomedical database. Covers all major peer-reviewed journals in medicine, orthopaedics, physiotherapy, and sports medicine. Supports precise MeSH (Medical Subject Headings) searching.
Google Scholar	Google LLC — academic search engine	Jan 2010 – Jan 2025	Broader coverage including Indian and South Asian journals, grey literature, and publications not fully indexed in PubMed. Essential for capturing Indian knee OA research.
J-Gate	Informatics India — e-journal gateway/aggregator	Jan 2010 – Jan 2025	Added to capture additional regional and speciality-journal literature not indexed by PubMed or Google Scholar, using free-text keyword searching (no MeSH indexing available).

Table. 2

d) Search Strategy

Pillar	MeSH Terms — PubMed	Free-Text Keywords — All Databases
Pillar 1 Intervention	"Platelet-Rich Plasma"[MeSH]	"Platelet-rich plasma" OR "PRP" OR "PRGF" OR "autologous conditioned plasma" OR "platelet concentrate"
Pillar 2 Condition	"Osteoarthritis, Knee"[MeSH]	"Knee osteoarthritis" OR "knee OA"
Pillar 3 Comparator / Outcome	"Exercise Therapy"[MeSH] OR "Anti-Inflammatory Agents, Non-Steroidal"[MeSH] OR "Arthroplasty, Replacement, Knee"[MeSH]	"Conservative management" OR "physiotherapy" OR "exercise" OR "NSAIDs" OR "corticosteroid" OR "total knee replacement" OR "TKR" OR "arthroplasty" OR "TKR delay"

Table. 3

For Google Scholar and J-Gate, which do not support MeSH indexing, the free-text keyword strings from all three pillars were combined using Boolean AND/OR operators

e) Inclusion and Exclusion Criteria:

Inclusion Criteria	Exclusion Criteria
Peer-reviewed studies published between 2010 and 2025	Case reports, case series, editorials, expert opinions
Adults aged ≥40 years with knee osteoarthritis (KL Grades I–III)	Studies not related to knee osteoarthritis
Randomised controlled trials, cohort studies, meta-analyses, and systematic reviews	Studies without a comparator (PRP vs conservative management)
Studies evaluating Platelet-Rich Plasma (PRP) therapy	Studies with incomplete outcome data or insufficient follow-up
Studies evaluating conservative management (exercise, physiotherapy, NSAIDs, corticosteroid injections, weight management)	Non-English language publications (if restricted to English)
Studies reporting outcomes: pain relief, functional improvement, delay to Total Knee Replacement (TKR), or safety/adverse events	Animal studies, laboratory studies, or purely mechanistic research without clinical outcomes

Table. 4

f) Study Screening

Study screening was conducted in three stages, following the PRISMA 2020 recommendations. A documented reason was recorded for every excluded study at each stage.

Stage	Name	What Was Done	Excluded (n) and Reasons
1	**Deduplication**	All records from all three databases were combined and checked for duplicates.	n = 1 removed. Study 36 was an exact duplicate of Study 10 — identical title and URL.
2	**Title and Abstract Screening**	Titles and abstracts of all 47 remaining records were read. Studies clearly irrelevant based on the title/abstract alone were excluded with a documented reason.	n = 6 removed: wrong intervention (2), qualitative study with no clinical outcomes (1), surgical technique comparisons unrelated to the research question (3)
3	**Full-Text Assessment**	The full texts of all 41 remaining studies were retrieved and read/assessed against all inclusion and exclusion criteria.	n = 6 removed: background review with no extractable data (1), survey without clinical outcomes (1), surgical-only review (1), unverifiable reference (1), journal not indexed/verifiable (1), preprint/not peer-reviewed (1)

Table. 5

g) PRISMA Flowchart:

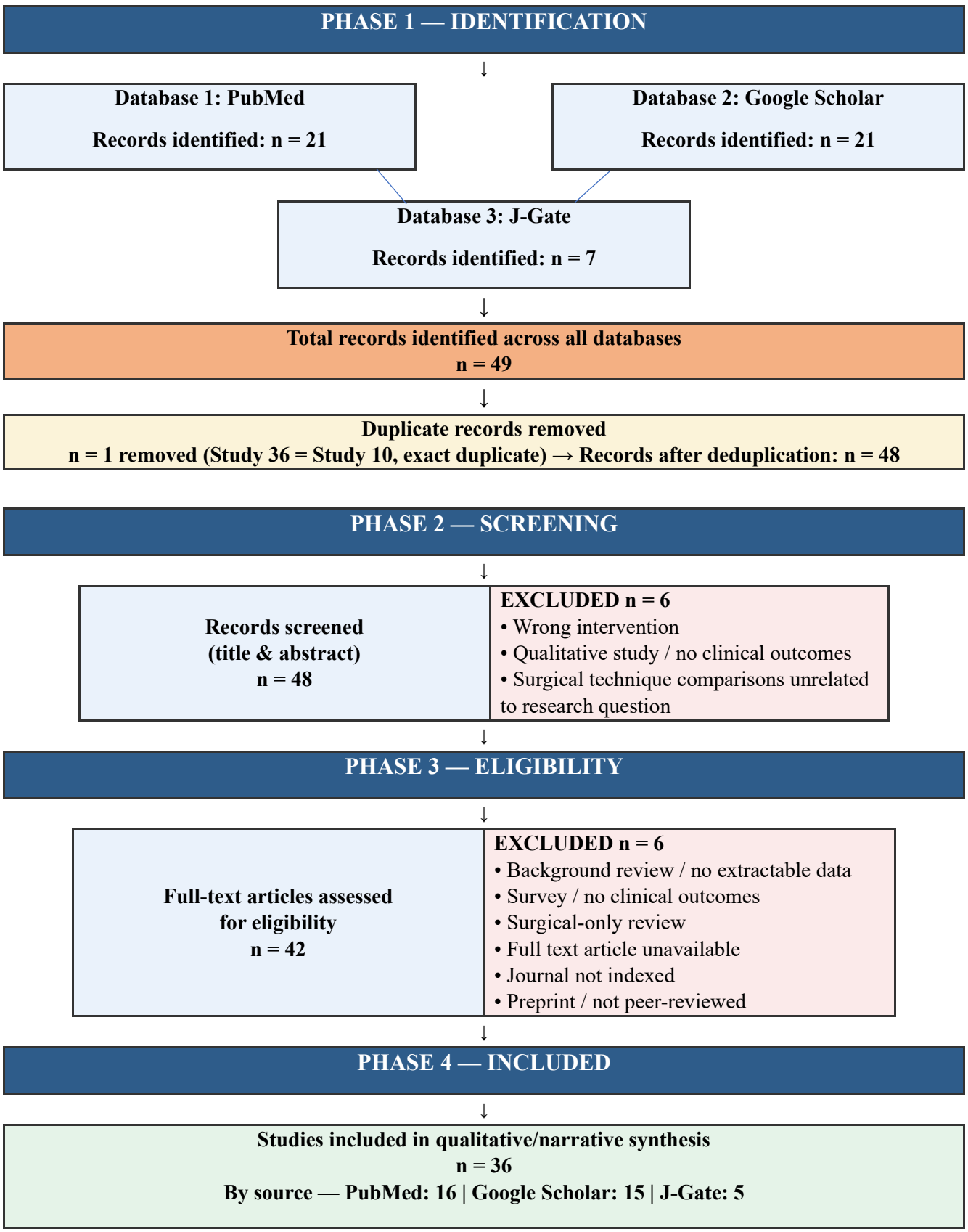


Fig. 1

h) Data Extraction

A standardised data extraction form was applied to all 36 included studies. The same information was collected from every study to ensure consistency and to allow fair comparisons across the evidence base.

Data Item Extracted	Purpose
Author(s) and year of publication	To identify and cite the study
Study design (RCT, meta-analysis, cohort, etc.)	To determine which quality assessment tool to apply
Database source (PubMed or Google Scholar, or J-Gate)	For PRISMA reporting and transparency
Sample size and patient characteristics (age, sex, KL grade)	To assess applicability and generalisability
Intervention details (PRP type, dose, frequency)	To assess comparability between PRP studies
Comparator (type of conservative management)	To categorise evidence for each comparator type
Outcomes measured (VAS, WOMAC, KOOS, TKR rates)	To match against each research objective
Follow-up duration	To assess the temporal relevance and durability of findings
Key results (scores, p-values, SMDs, SUCRA)	For narrative synthesis and analysis
Author conclusions	To understand the study's own interpretation
Limitations identified by authors	For the gap analysis

Table. 6

i) Quality Assessment

The quality of each included study was assessed using the appropriate validated tool for its study design. Three tools were used:

Tool	Applied To
RoB 2 *Cochrane Risk of Bias Version 2*	Randomised Controlled Trials (RCTs)
NOS *Newcastle-Ottawa Scale*	Cohort and Observational Studies
AMSTAR-2 *Assessment of Multiple Systematic Reviews*	Systematic Reviews and Meta-Analyses
Simplified Critical Appraisal Checklist (SCAC)	Narrative Reviews, Literature Reviews, Guidelines, Comparative Reviews

Table.7

j) Narrative Synthesis:

This review uses a narrative synthesis approach. Given the heterogeneity in outcomes, study designs, and follow-up periods across the included studies, statistical pooling was not feasible; therefore, a narrative synthesis approach was adopted as the most appropriate method for this review. This synthesis is structured around five analysis themes that directly correspond to the research objectives:

Theme	Outcome Area	Focus of Analysis
Theme 1	**TKR Delay (Primary)**	Which treatment delays surgery most effectively and for how long?
Theme 2	**Pain Relief**	Which treatment reduces pain more, and for how long does that relief last?
Theme 3	**Functional Improvement**	Which treatment helps patients move and carry out daily activities better?
Theme 4	**Duration of Symptom Relief**	How long does each treatment keep working after it is given?
Theme 5	**Safety Profile**	Which treatment is safer for medium- and long-term use?

Table. 8

Results

The PubMed search identified 21 records, Google Scholar identified 21, and J-Gate identified 7, for a total of 49 records. After removing 1 exact duplicate, 48 unique records were screened at the title and abstract level. Six were excluded at that stage, leaving 42 full-text articles to be assessed. After reading all 42 in full against the inclusion and exclusion criteria, 6 were excluded with documented reasons, giving a final set of 36 studies for inclusion in this systematic review.

a) Literature Review Table

The following table summarises the basic features of all 36 articles reviewed in this study. It is a brief presentation of the evidence, showing the design, intervention, patient number, and key finding for each individual study.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
1	Shen et al. (2017)	Systematic Review & Meta-Analysis	PRP vs placebo/HA — temporal pain & function effect	A total of ten randomized controlled trials were included in the review, comprising 1,069 patients diagnosed with knee osteoarthritis.	The findings demonstrated that PRP injections significantly reduced pain and improved physical function in the short-term and mid-term follow-up periods compared to hyaluronic acid and placebo. At three and six months, PRP consistently showed superior outcomes.
2	Laudy et al. (2015)	Systematic Review & Meta-Analysis	PRP vs placebo/HA/corticosteroid	A total of ten studies met the inclusion criteria, comprising 1,110 patients with knee osteoarthritis. Six of these were randomized controlled trials and four were non-randomized clinical trials.	The pooled analysis demonstrated that PRP injections were significantly more effective than placebo in reducing pain at six months post-injection, with mean differences of –2.45 and –2.07 on the VAS for single and double PRP injections respectively. Compared with hyaluronic acid, PRP also showed a statistically significant benefit in…

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
3	Chen et al. (2019)	Umbrella Review (Review of Meta-Analyses)	PRP preparations — umbrella of meta-analyses	The summary incorporated evidence from six meta-analyses, which collectively included dozens of randomized controlled trials and thousands of patients with knee osteoarthritis. The exact pooled patient number varied across meta-analyses, but most studies…	Across the included meta-analyses, PRP consistently demonstrated superior efficacy compared to hyaluronic acid and placebo in reducing pain and improving function at short-term (≤3 months) and mid-term (6 months) follow-up. Several meta-analyses reported moderate to large effect sizes favoring PRP.
4	Patel et al. (2013)	Double-Blind Randomised Controlled Trial	PRP vs saline placebo (India)	The study included seventy-eight patients with bilateral knee osteoarthritis, accounting for a total of 156 knees. Group A had 52 knees treated with a single PRP injection, Group B had 50 knees treated with two PRP injections, and Group C had 46 knees treated…	Both PRP groups showed statistically significant improvement in WOMAC pain, stiffness, physical function, and total scores compared to placebo. Improvements were evident within two to three weeks of injection and persisted up to six months.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
5	Costa et al. (2021)	Systematic Review & Network Meta-Analysis	NSAIDs vs opioids for OA pain	The analysis included 192 randomized trials comprising 102,829 participants. In total, 90 different active preparations or doses were examined: 68 NSAIDs, 19 opioids, and 3 paracetamol regimens.	Five oral NSAID preparations—diclofenac 150 mg/day, etoricoxib 60 mg/day, etoricoxib 90 mg/day, rofecoxib 25 mg/day, and rofecoxib 50 mg/day—had a ≥99% probability of achieving more pronounced treatment effects than the minimal clinically relevant reduction in pain. Topical diclofenac also showed strong efficacy with ≥92% probability.
6	Costa et al. (2023)	Systematic Review & Meta-Analysis	PRP vs HA, corticosteroid, saline	A total of 40 studies involving 3,035 participants were included in the analysis. These studies provided data on PRP compared with hyaluronic acid, corticosteroids, and saline injections.	At six months of follow-up, PRP was found to be as effective as, and in some studies more effective than, hyaluronic acid, corticosteroids, and saline in improving pain, function, and stiffness. No significant differences among treatments were observed in terms of major adverse events or treatment failure.
7	Bannuru et al. (2019)	Clinical Practice Guideline	All non-surgical management options (OARSI guideline)	As a guideline paper, this study did not involve a direct patient sample. Instead, it synthesized evidence from	The guideline recommended core treatments such as patient education, structured exercise programs, and weight management for all individuals with osteoarthritis. Topical NSAIDs were strongly recommended for knee osteoarthritis, while oral NSAIDs

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				hundreds of published clinical trials and systematic reviews across multiple interventions for osteoarthritis management.	were conditionally recommended depending on patient comorbidities.
8	Primorac et al. (2020)	Narrative Review	Non-operative therapeutic considerations — pathogenesis-linked	As a review article, this study did not involve a direct patient sample. Instead, it summarized findings from numerous published studies across different therapeutic approaches for knee osteoarthritis.	The review highlighted that knee osteoarthritis is a multifactorial disease involving mechanical stress, inflammatory pathways, and metabolic factors. Non-operative treatments were categorized into lifestyle modifications (exercise, weight loss, patient education), pharmacological therapies (NSAIDs, corticosteroids, hyaluronic acid),…
9	Surakanti et al. (2023)	Narrative/ Literature Review	Surgical (TKA) vs non-surgical treatment	As a review article, this study did not involve a direct patient cohort. Instead, it synthesized evidence from multiple randomized controlled trials and systematic reviews that	The evidence suggested that TKA combined with 12 weeks of non-surgical therapy improved pain and functionality more than non-surgical therapy alone when assessed at 12 and 24 months. Patients undergoing surgery reported greater improvements in pain scores and functional outcomes.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				collectively included several hundred patients across different treatment arms.	
10	Malik et al. (2023)	Literature Review	Interventional techniques — CS, HA, PRP, genicular blocks	As a review article, this study did not enroll patients directly. Instead, it synthesized findings from 37 published studies that collectively involved several hundred patients across different interventional techniques.	The review found that corticosteroid injections provide short-term pain relief but their benefits diminish over time, with concerns about cartilage damage from repeated use. Viscosupplementation showed moderate improvement in pain and function, though results varied.
11	Billesberger et al. (2020)	Narrative Review	Injectable therapies — CS, HA, PRP, prolotherapy	Because this is a review article rather than a primary study, there is no single overall sample size to report. The paper draws on findings from multiple previously conducted studies of varying sizes	The review found that corticosteroid and hyaluronic acid injections remain the most established intra-articular options, but that platelet-rich plasma is increasingly being used in their place, although the authors note that larger trials are still needed to confirm this shift in preference. Prolotherapy and stem cell therapy were both…

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				across each treatment category, but these individual sample…	
12	de Girolamo et al. (2016)	Narrative Review	Regenerative approaches — PRP, MSCs, ACI (early OA)	As a review article, this study did not enroll new patients. Instead, it summarized findings from multiple published studies across regenerative modalities, including both laboratory and clinical investigations.	The review found that PRP demonstrated improvements in pain and function in early osteoarthritis, with evidence suggesting modulation of inflammation and cartilage metabolism. MSCs showed potential for cartilage repair and regeneration in preclinical models, with early clinical trials reporting symptomatic improvement.
13	Rodríguez-Merchán, E. C. (2022).	Narrative Review	PRP molecular mechanisms and clinical efficacy	As a review article, this study did not involve direct patient enrollment. Instead, it synthesized findings from multiple published studies, including laboratory experiments and clinical trials, covering several hundred patients	The review found that PRP exerts its therapeutic effects through several mechanisms. It reduces pro-inflammatory cytokines, enhances anabolic activity in chondrocytes, stimulates hyaluronic acid production in the synovium, and decreases oxidative stress and apoptosis in joint tissues.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				across different PRP…	
14	Gupta et al. (2024)	Prospective Interventional Study (single-arm)	PRP — prospective interventional (single-arm)	The study included 100 patients with primary knee osteoarthritis, classified according to the Kellgren-Lawrence grading system.	The study reported significant improvements in both pain and function. WOMAC scores decreased from a baseline of 81.06 to 63.52 at 6 months ($p < 0.001$).
15	Prasad and Faraj (2025)	Retrospective Study	PRP for knee pain — real-world NHS-style cohort	The study included 43 patients in total. Out of these, 33 were women and 10 were men.	The study found that 14 patients (32.56%) were successfully discharged after PRP treatment, while 6 patients (13.95%) required only telephone follow-up. Sixteen patients (37.21%) needed face-to-face follow-up or additional investigations, and 3 patients (6.98%) required further PRP injections.
16	Li et al. (2021)	Literature Review	PRP vs HA/corticosteroid — literature review	As a review article, this study did not include new patient enrollment. Instead, it summarized findings from multiple published studies involving several hundred patients across different PRP	The review found that PRP injections generally led to significant improvements in pain and function compared to placebo, corticosteroids, and hyaluronic acid. PRP provided longer-lasting benefits than corticosteroids, which typically offered only short-term relief.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				trials for knee osteoarthritis.	
17	Mora et al. (2018)	Narrative Review	Knee OA pathophysiology and treatment overview	As a review article, this study did not include new patient enrollment. Instead, it synthesized findings from multiple published studies involving thousands of patients across different therapeutic interventions for knee osteoarthritis	The review found that knee osteoarthritis is a multifactorial disease influenced by aging, obesity, genetics, and mechanical stress. Pathophysiologically, it involves cartilage breakdown, synovial inflammation, and subchondral bone changes.
18	DeRogatis et al. (2019	Narrative Review	Non-operative treatment options overview	As a review article, this study did not include new patient enrollment. Instead, it summarized findings from multiple published studies that collectively involved thousands of patients across different non-operative treatment	The review found that exercise and weight loss are consistently recommended as first-line therapies, with strong evidence for improving pain and function. NSAIDs and acetaminophen are widely used, but NSAIDs carry risks of gastrointestinal and cardiovascular side effects.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				modalities for knee…	
19	Dantas et al. (2021))	Narrative Review	Physical therapy / exercise interventions	As a review article, this study did not include new patient enrollment. Instead, it synthesized findings from multiple published studies and guidelines, collectively involving thousands of patients across different treatment modalities for knee osteoarthritis.	The review found that exercise therapy is the most effective non-operative intervention, improving pain, mobility, and overall function. Both aerobic and strengthening exercises were shown to be beneficial.
20	Min Oo and Thae Bo (2016)	Narrative Review	Physical modalities — thermotherapy, ultrasound, TENS, laser	As a review article, this study did not include new patient enrollment. Instead, it summarized findings from multiple published studies, collectively involving hundreds to thousands of patients across different	The review found that thermotherapy, including heat and cold applications, provided short-term pain relief. Ultrasound therapy showed modest improvements in pain and function.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				physical modality interventions for knee…	
21	Uivaraseanu et al. (2022)	Narrative Review (structured search)	Conservative + intra-articular therapies overview	As a review article, this study did not enroll new patients. Instead, it synthesized findings from 67 selected published studies, collectively involving thousands of patients across different therapeutic interventions for knee osteoarthritis.	The review found that conservative therapies such as exercise and weight loss significantly reduce pain and improve function. Pharmacological therapies including NSAIDs, acetaminophen, and opioids provide symptomatic relief but carry risks of gastrointestinal, cardiovascular, and renal side effects.
22	Addissouky et al. (2024)	Narrative Review	Conservative & emerging rehabilitative approaches	As a review article, this study did not enroll new patients. Instead, it summarized findings from numerous published studies, collectively involving hundreds to thousands of patients across different conservative	The review found that conservative strategies such as gait retraining, proprioceptive exercises, bracing, and core strengthening help reduce symptoms and improve function, but intrinsic joint damage eventually limits their long-term efficacy. Abnormal loading and altered neuromuscular control were identified as key biomechanical…

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				and emerging rehabilitative interventions for…	
23	Buttgereit et al. (2015)	Narrative/ Viewpoint Review	Non-surgical management — guideline-informed viewpoint	As a review article, this study did not enroll new patients. Instead, it summarized findings from multiple published studies and guidelines, collectively involving thousands of patients across different non-surgical treatment modalities.	The review found that lifestyle interventions such as exercise and weight loss are consistently effective in reducing pain and improving function. Pharmacological therapies like NSAIDs and acetaminophen provide symptomatic relief but are limited by adverse effects.
24	Kon et al. (2012)	Narrative Review	Non-surgical management of early knee OA	As a review article, this study did not include new patient enrollment. Instead, it synthesized findings from multiple published studies, collectively involving thousands of patients across different non-surgical	The review found that lifestyle interventions such as exercise and weight loss are the most effective first-line strategies, improving pain, function, and mobility. Patient education and self-management programs enhance adherence and long-term outcomes.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				treatment modalities for early knee…	
25	Skou et al. (2018)	Two Parallel Assessor-Blinded RCTs	TKR surgery vs structured non-surgical treatment	200 adults (mean age 66 years) with moderate-to-severe knee osteoarthritis: 100 patients eligible for TKR (Trial 1) and 100 patients not eligible for TKR (Trial 2)	At 2 years, the TKR-plus-non-surgical-treatment group showed significantly greater improvement in KOOS scores than non-surgical treatment alone, but with a materially higher rate of serious adverse events (thromboembolic complications, infections). Critically, in the companion 12-month trial (Skou et al., 2015), only 13 of 100 patients…
26	Lim and Al-Dadah (2022)	Narrative Review	Conservative treatment — review of the literature	As a review article, this study did not enroll new patients. Instead, it synthesized findings from multiple published studies, collectively involving thousands of patients across different conservative treatment modalities for knee osteoarthritis.	The review found that exercise therapy, including aerobic, strengthening, and neuromuscular training, consistently improves pain, function, and mobility. Weight reduction significantly reduces mechanical stress on the knee joint and improves outcomes.
27	Zampogna et al. (2020)	Systematic Review & Meta-Analysis	Physical activity as conservative treatment	The review included 22 studies, of which 20 were	The study found that aquatic exercise, Tai Chi, and yoga significantly reduced pain compared to controls, while land-based exercise showed consistent but

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
			(older adults)	randomized controlled trials and 2 were case series, with a total of 1,504 participants aged 65 years or older. The mean age ranged from 65 to 78.9 years, and most participants were female.	smaller improvements. Land-based exercise, aquatic exercise, Tai Chi, and yoga all improved physical function, with Tai Chi and yoga showing particularly strong effects.
28	Rodríguez-Merchán (2016)	Umbrella Review of Cochrane Reviews	Review of Cochrane reviews — conservative management	As a review article, this study did not enroll new patients. Instead, it synthesized findings from multiple Cochrane systematic reviews, collectively involving hundreds to thousands of patients across different conservative treatment modalitie	The study found that exercise therapy was consistently effective in reducing pain and improving physical function. Weight reduction reduced mechanical stress on the knee joint and improved outcomes.
29	Naja et al. (2021)	Systematic Review & Bayesian Network	All non-surgical interventions — network	The review included 13 randomized controlled trials that assessed 7	The study found that mesenchymal stem cells (MSCs) produced the greatest improvement in WOMAC scores, with a mean difference of −28.0 and a 91% probability of being the best treatment. Platelet-

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
		Meta-Analysis	meta-analysis	nonsurgical strategies. Collectively, these trials involved hundreds of patients with mild to moderate knee osteoarthritis.	rich plasma (PRP) ranked second, with a mean difference of −19.9 and an 89% probability of being the best treatment.
30	Tomaszewski et al. (2026)	Narrative Review	PRP, HA & stem cell therapies — stage-specific review	Since this was a narrative review, the sample size refers to the number of studies included rather than individual patients. The review encompassed sixty-seven studies.	The findings indicated that platelet-rich plasma was most effective in early to intermediate stages of osteoarthritis, reducing pain, improving function, and slowing disease progression, though variability in preparation protocols limited consistency. Hyaluronic acid was beneficial in mild to moderate osteoarthritis, improving…
31	Grzesikowski & Klich (2023)	Systematic Review	Contemporary conservative management approaches	The review synthesized evidence from multiple studies retrieved through the search, though the exact number of included studies was not specified in the abstract.	The findings indicated that non-pharmacological approaches, such as exercise therapy, physical therapy, braces, insoles, and lifestyle modifications, form the cornerstone of conservative management. These methods improve function and relieve symptoms with minimal adverse effects.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
32	Duymus et al. (2017)	Literature Review	Intra-articular injections — CS, HA, PRP comparison	As a literature review, the study did not involve direct patient recruitment. Instead, it summarized findings from multiple published studies.	The review found that corticosteroid injections provide short-term pain relief but may accelerate cartilage degeneration with repeated use. Hyaluronic acid injections improve joint lubrication and mobility, offering moderate symptom relief, though effects are temporary.
33	Szombara et al. (2025)	Narrative Review	Biologic therapy mechanisms and outcomes	As a narrative review, the study did not involve direct patient recruitment. Instead, it summarized findings from a broad range of published studies to provide an overview of current evidence.	The review found that platelet-rich plasma is effective in early to intermediate osteoarthritis, reducing pain and improving function, though variability in preparation protocols limits consistency. Hyaluronic acid improves lubrication and mobility in mild to moderate osteoarthritis, but its effects are temporary and often require…
34	Kamada et al. (2024)	Observational Clinical Study (single-arm)	Factors affecting outcomes of multiple PRP injections	The study included 202 patients with knee osteoarthritis.	The study found that multiple PRP injections improved pain and function, especially in patients with mild to moderate osteoarthritis. Younger patients, those with lower BMI, and those in earlier disease stages experienced better outcomes.
35	Sánchez et al. (2021)	Retrospective Cohort with Survival Analysis	PRP injections and TKR delay — survival analysis	The sample size consisted of 667 patients with knee osteoarthritis who met the inclusion	The results showed that 74.1% of patients experienced a delay in surgery of more than 1.5 years, with a median delay of 5.3 years, and 85.7% of patients did not undergo total knee arthroplasty during the five-year follow-up period.

S.No.	Author (Year)	Study Design	Intervention	Sample	Key Finding
				criteria out of 1084 initially screened.	
36	Gustafsson et al. (2024)	Register-Based Observational Study	First-line conservative treatment and TKR risk (registry)	44,311 patients total: 30,524 with knee osteoarthritis and 13,787 with hip osteoarthritis.	At 5 years, among knee OA patients, 14% of responders had progressed to joint replacement compared to 20% of non-responders. Among hip OA patients, 35% of responders versus 48% of non-responders progressed to replacement.

Table. 9

b) Quality Assessment Results

All 36 studies included in this review were checked for quality and methodological rigour using the tool suited to each study type. Randomised controlled trials were assessed using the Cochrane RoB 2 tool; cohort and observational studies using the Newcastle-Ottawa Scale (NOS); systematic reviews and meta-analyses using AMSTAR-2; and narrative reviews, literature reviews, comparative reviews, and guideline papers using the Simplified Critical Appraisal Checklist (SCAC). This ensures every study in the review is formally evaluated, not just the highest-level designs.

1. RoB 2 — Randomised Controlled Trials (2 Studies)

Each domain is rated: Low Risk | Some Concerns | High Risk

Study	D1: Randomisation	D2: Deviations	D3: Missing Data	D4: Outcome Measure	D5: Reporting	Overall / Rating
1. Patel et al. (2013) India — Double-Blind RCT [Study 4]	LOW — Computer-generated sequence; sealed allocation concealment	LOW — Double-blind; patients and assessors both blinded	LOW — All 78 patients (156 knees) followed up at 6 months	LOW — Validated WOMAC/ VAS scores; blinded outcome assessors	LOW — All pre-specified outcomes reported completely	LOW RISK HIGH Quality

Study	D1: Randomisation	D2: Deviations	D3: Missing Data	D4: Outcome Measure	D5: Reporting	Overall / Rating
2. Skou et al. (2018) Parallel RCTs (n=200) [Study 25]	LOW — Computer-generated randomisation; concealed allocation	SOME CONCERNS — Blinding not feasible: surgery vs non-surgical care	LOW — 2-year follow-up; attrition documented and accounted for	LOW — Validated KOOS; independent assessor blinding	LOW — All pre-specified outcomes reported fully	SOME CONCERNS MODERATE Quality

Table. 10

2. NOS — Cohort and Observational Studies (5 Studies)

Study	Selection (max 4★)	Comparability (max 2★)	Outcome (max 3★)	Total / Rating
1. Gupta et al. (2024) Prospective Interventional (single-arm, n=100) [Study 14]	★★★☆ (3/4) — consecutive KL-graded patients; no comparator arm	★☆ (1/2) — pre-vs-post design only; no adjustment for confounders	★★★ (3/3) — validated WOMAC/VAS; adequate 6-month follow-up	7 / 9 Stars HIGH Quality
2. Prasad and Faraj (2025) Retrospective Study (n=43) [Study 15]	★★☆☆ (2/4) — small single-centre sample; no matched controls	★☆ (1/2) — no control group; retrospective design	★★☆ (2/3) — variable injection completion; outcome partially tracked	5 / 9 Stars MODERATE Quality
3. Kamada et al. (2024) Observational Clinical Study (n=202) [Study 34]	★★★☆ (3/4) — large consecutive cohort; no matched control	★★ (2/2) — adjusted for age, BMI, KL grade, injection frequency	★★★ (3/3) — validated VAS; systematic outcome capture	8 / 9 Stars HIGH Quality
4. Sánchez et al. (2021) Retrospective Cohort with Survival Analysis	★★★☆ (3/4) — large consecutive single-centre cohort; no matched comparator	★★ (2/2) — survival analysis controlling for time-to-event	★★★ (3/3) — TKR incidence objectively verified; 5-year follow-up	8 / 9 Stars HIGH Quality

Study	Selection (max 4★)	Comparability (max 2★)	Outcome (max 3★)	Total / Rating
(n=667) [Study 35]				
5. Gustafsson et al. (2024) Register-Based Observational Study (n=44,311) [Study 36]	★★★★ (4/4) — whole national-register population; representative sampling	★★ (2/2) — linked cross-registry comparison of responder's vs non-responders	★★★ (3/3) — linked arthroplasty register verifies joint replacement; 5-year follow-up	9 / 9 Stars HIGH Quality

Table. 11

3. AMSTAR-2 — Systematic Reviews and Meta-Analyses (9 Studies)

Key items rated: Y = Yes | PY = Partial Yes | N = No

Study	Protocol Registered	Comprehensive Search	RoB Assessed	Publication Bias	MA Methods	AMSTAR-2 Rating
1. Shen et al. (2017) [Study 1]	PY	Y	Y	Y	Y	MODERATE Protocol registered after search began; methods comprehensive; RoB assessed
2. Laudy et al. (2015) [Study 2]	Y	Y	Y	Y	Y	HIGH Multi-database search; RoB tool applied; random-effects model; funnel plots
3. Chen et al. (2019) [Study 3]	PY	Y	PY	N	N/A	LOW Umbrella review of existing meta-analyses; primary-study RoB not independently re-assessed

Study	Protocol Registered	Comprehensive Search	RoB Assessed	Publication Bias	MA Methods	AMSTAR-2 Rating
4. Costa et al. (2021) [Study 5]	Y	Y	Y	Y	Y	HIGH 192 RCTs; n=102,829; network meta-analysis; GRADE applied throughout
5. Costa et al. (2023) [Study 6]	PY	Y	PY	Y	Y	MODERATE 40 studies; n=3,035; protocol registration and RoB reporting only partially clear
6. Zampogna et al. (2020) [Study 27]	Y	Y	Y	Y	Y	HIGH PRISMA-compliant; 22 studies, 1,504 participants; pre-specified outcomes
7. Rodríguez-Merchán (2016) [Study 28]	PY	PY	N	N	N/A	LOW Secondary synthesis of existing Cochrane reviews; searches not independently repeated
8. Naja et al. (2021) [Study 29]	Y	Y	Y	Y	Y	HIGH PRISMA-compliant Bayesian network meta-analysis; pre-specified comparisons

Study	Protocol Registered	Comprehensive Search	RoB Assessed	Publication Bias	MA Methods	AMSTAR-2 Rating
9. Grzesikowski & Klich (2023) [Study 31]	N	PY	N	N	N/A	LOW Search methodology and exact number of included studies not clearly reported

Table.12

4. Simplified Critical Appraisal Checklist (SCAC) — Narrative Reviews, Literature Reviews, Guidelines and Comparative Reviews (20 Studies)

These studies were reviewed against five criteria; each was answered Yes (Y), Partial (P), or No (N), and an overall rating was assigned based on the number of criteria met.

Study	Q1: Clear Objective	Q2: Search Strategy	Q3: Inclusion Criteria	Q4: Conclusions Supported	Q5: Limitations Stated	Score	Rating
1. Bannuru et al. (2019) — OARSI Guideline [Study 7]	Y	Y	Y	Y	Y	5/5	HIGH
2. Primorac et al. (2020) — Narrative Review [Study 8]	Y	P	P	Y	Y	3/5	MODERATE
3. Surakanti et al. (2023) — Narrative Review [Study 9]	Y	P	N	Y	Y	3/5	MODERATE
4. Malik et al. (2023) — Literature Review [Study 10]	Y	Y	P	Y	Y	4/5	MODERATE
5. Billesberger et al. (2020) — Narrative Review [Study 11]	Y	P	P	Y	Y	3/5	MODERATE
6. de Girolamo et al. (2016) — Narrative Review [Study 12]	Y	P	P	Y	Y	3/5	MODERATE

Study	Q1: Clear Objective	Q2: Search Strategy	Q3: Inclusion Criteria	Q4: Conclusions Supported	Q5: Limitations Stated	Score	Rating
7. Rodríguez-Merchán (2022) — Mechanistic Review [Study 13]	Y	Y	P	Y	Y	4/5	MODERATE
8. Li et al. (2021) — Literature Review [Study 16]	Y	Y	P	Y	Y	4/5	MODERATE
9. Mora et al. (2018) — Narrative Review [Study 17]	Y	P	P	Y	Y	3/5	MODERATE
10. DeRogatis et al. (2019) — Narrative Review [Study 18]	Y	Y	P	Y	Y	4/5	MODERATE
11. Dantas et al. (2021) — Narrative Review [Study 19]	Y	Y	P	Y	Y	4/5	MODERATE
12. Min Oo and Thae Bo (2016) — Narrative Review [Study 20]	Y	P	N	Y	P	2/5	LOW
13. Uivaraseanu et al. (2022) — Structured Narrative Review [Study 21]	Y	Y	Y	Y	Y	5/5	HIGH
14. Addissouky et al. (2024) — Narrative Review [Study 22]	Y	Y	P	Y	P	3/5	MODERATE
15. Buttgereit et al. (2015) — Viewpoint Review [Study 23]	Y	Y	P	Y	Y	4/5	MODERATE
16. Kon et al. (2012) — Structured Review [Study 24]	Y	Y	P	Y	Y	4/5	MODERATE
17. Lim and Al-Dadah (2022) — Narrative Review [Study 26]	Y	Y	P	Y	Y	4/5	MODERATE

Study	Q1: Clear Objective	Q2: Search Strategy	Q3: Inclusion Criteria	Q4: Conclusions Supported	Q5: Limitations Stated	Score	Rating
18. Tomaszewski et al. (2026) — Narrative Review [Study 30]	Y	Y	Y	Y	Y	5/5	HIGH
19. Duymus et al. (2017) — Literature Review [Study 32]	Y	Y	P	Y	Y	4/5	MODERATE
20. Szombara et al. (2025) — Narrative Review [Study 33]	Y	P	P	Y	Y	3/5	MODERATE

Table. 13

c) Quality Summary of All 36 Studies

Quality Rating	Number of Studies	Percentage	Studies
HIGH Quality	12	33.3%	Studies 2, 4, 5, 7, 14, 21, 27, 29, 30, 34, 35, 36
MODERATE Quality	20	55.6%	Studies 1, 6, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 22, 23, 24, 25, 26, 32, 33
LOW Quality	4	11.1%	Studies 3, 20, 28, 31
TOTAL	36	100%	Complete quality assessment across all 36 included studies using 4 appropriate tools

Table. 14

d) TKR Delay Analysis

No included study directly compared PRP against comprehensive conservative management using TKR conversion as the primary outcome. All evidence on this point is therefore indirect.

The strongest direct evidence for conservative management comes from Skou et al. (2018) [Study 25], the only randomised trial comparing TKR-eligible patients randomised to surgery versus structured non-surgical care. At 12 months, 74% of the non-surgical group had avoided TKR, and 68% remained surgery-free at the 2-year mark. The surgical arm produced greater

improvement in KOOS scores but was associated with a materially higher rate of serious adverse events.

This pattern is supported by registry-level evidence. Gustafsson et al. (2024) [Study 36], in a study of 44,311 patients, found that responders to first-line education-and-exercise treatment had a significantly lower five-year risk of joint replacement than non-responders (14% vs 20% for knee OA), demonstrating that effective conservative care alone can substantially delay surgery at a population level.

For PRP, no included study reported TKR conversion as a formal randomised endpoint. The strongest available evidence is Sánchez et al. (2021) [Study 35], a retrospective study with survival analysis of 667 patients: 74.1% experienced a delay in surgery of more than 1.5 years, with a median delay of 5.3 years, and 85.7% had not undergone arthroplasty within five years of PRP treatment. Narrative and mechanistic evidence (Malik et al., 2023 [Study 10]; Tomaszewski et al., 2026 [Study 30]; Duymus et al., 2017 [Study 32]) suggests that PRP is most effective in early-to-intermediate disease and can be integrated into treatment plans aimed at delaying joint replacement.

Kamada et al. (2024) [Study 34] further showed that PRP's effect, and by extension its potential to delay TKR, depends on patient age, BMI, disease stage, and the number and frequency of injections, highlighting that a standardised PRP protocol is still required before any trial can properly test its role in delaying TKR.

No included study directly compared PRP against comprehensive conservative management using TKR conversion as the primary endpoint; both interventions show a plausible, evidence-supported capacity to delay surgery for most patients over a multi-year horizon, but a head-to-head trial remains the single most important gap in the literature.

e) Pain Relief Analysis

Timepoint	PRP Pain Evidence	Conservative Management Evidence	Conclusion
3 months	VAS/WOMAC improving significantly; PRP benefit already evident (Shen 2017 [1]; Patel 2013 [4])	Corticosteroids fastest onset (Billesberger 2020 [11]); NSAIDs effective (Costa 2021 [5])	Both effective; corticosteroids show the fastest onset
6 months	WOMAC/VAS pain significantly reduced vs placebo and HA (Laudy 2015 [2]; Chen 2019 [3]; Patel 2013 [4])	Exercise produces moderate, significant pain reduction (Zampogna 2020 [27])	PRP shows a modest advantage over single-modality conservative care at 6 months
12 months	PRP superiority over HA/corticosteroid most consistent at this point; benefit narrowing in some trials (Shen 2017 [1]; Costa 2023 [6]; Li 2021 [16])	Exercise benefit fades 2–6 months after programme ends without continued adherence (Zampogna 2020 [27])	PRP offers more sustained relief at 12 months than unsupervised conservative care
Beyond 12 months	Limited long-term data; response moderated by age, BMI, KL grade and injection frequency (Kamada et al., 2024 [34])	Sustained conservative benefit depends on continued adherence; no controlled data beyond ~2 years	Long-term head-to-head evidence is absent for both; standardisation of PRP protocol remains a key gap

Table. 15

Conclusion for Pain: PRP produces a modest but consistent advantage over single-modality conservative care from 6 months onward, with the clearest superiority around 12 months. Exercise provides meaningful relief that fades without continued adherence, and NSAIDs/corticosteroids offer fast but short-lived relief. PRP is currently the most sustained injectable option for pain control.

f) Functional Improvement Analysis

Outcome Measure	PRP Evidence	Conservative Management Evidence
WOMAC Function	Significant improvement sustained to 6–12 months (Shen 2017 [1]; Laudy 2015 [2]; Patel 2013 [4])	Land-based exercise produces moderate, significant functional gains (Zampogna 2020 [27]; Dantas 2021 [19])
KOOS / IKDC	Significant gains reported in PRP cohorts (Gupta 2024 [14]; Kamada 2024 [34])	KOOS improved substantially with structured non-surgical care (Skou 2018 [25])
Combined Modalities	PRP + exercise reported as producing the best overall functional outcome among non-surgical options (Uivaraseanu 2022 [21]; Primorac 2020 [8])	Individualised multimodal conservative programmes outperform single-modality care (Dantas 2021 [19]; Naja 2021 [29])
Network / Pooled Ranking	PRP ranked favourably for function among injectables in pooled analyses (Naja 2021 [29])	Exercise and education consistently rank among the most effective single conservative strategies (Naja 2021 [29])

Table. 16

Conclusion for Function: PRP and structured exercise each produce meaningful, broadly comparable functional gains individually; the combination of PRP with structured exercise consistently produces the highest overall functional outcome among non-surgical strategies reviewed.

g) Duration of Symptom Relief Analysis

Treatment	Onset	Duration of Benefit	Key Evidence
PRP Injections (single course)	2–6 weeks	Advantage most evident 3–6 months; narrows by 12 months in several trials	Shen 2017 [1]; Costa 2023 [6]
PRP Injections (multiple/repeated)	2–6 weeks, cumulative	More sustained than single-injection protocols, especially in younger, lower-BMI, earlier-stage patients	Kamada et al. 2024 [34]
Corticosteroid Injections	1–3 weeks (fastest)	1–3 weeks only; largely resolved by 3 months	Billesberger 2020 [11]
Hyaluronic Acid (HA)	3–6 weeks	Longer-lasting than corticosteroids but generally shorter than PRP	Billesberger 2020 [11]
NSAIDs (e.g., diclofenac, etoricoxib)	Days	Only while continuously taken	Costa 2021 [5]
Supervised Exercise Programme	4–8 weeks	2–6 months after programme ends; adherence critical for persistence	Zampogna 2020 [27]
PRP + Exercise (combined)	2–6 weeks	Best-sustained benefit among non-surgical options reported	Uivaraseanu 2022 [21]; Primorac 2020 [8]

Table. 17

Conclusion for Duration: PRP provides longer symptomatic relief than corticosteroids and comparable or slightly longer relief than hyaluronic acid, and this can be extended through a repeated-injection protocol tailored to age, BMI and disease stage. Combined PRP + exercise offers the best prospect for sustained long-term symptom control to support delaying surgery.

h) Safety & Adverse Event Analysis

Treatment	Reported Adverse Events	Long-Term Safety	Key Evidence
PRP Injections	Very low; mild transient post-injection soreness	Excellent — autologous, no systemic effects, minimal adverse-event rate	Chen 2019 [3]; Costa 2023 [6]; Rodríguez-

Treatment	Reported Adverse Events	Long-Term Safety	Key Evidence
			Merchán 2022 [13]
Corticosteroid Injections	Short-term flare; infrequent joint infection	Poor with repeated use — risk of accelerated cartilage damage	Billesberger 2020 [11]
NSAIDs (oral, prolonged use)	GI upset, gastritis, renal impairment, cardiotoxicity	Poor with long-term use — GI and cardiovascular risk accumulates	Bannuru et al., 2019 [7]; Costa 2021 [5]
Opioids	Higher adverse-event rate than NSAIDs for comparable relief	Poor — safety concerns discourage routine use	Costa 2021 [5]; Bannuru et al., 2019 [7]
Supervised Exercise	Rare, minor musculoskeletal strain only	Excellent — no systemic risk; improves overall joint and general health	Zampogna 2020 [27]; Bannuru et al., 2019 [7]
Total Knee Replacement (TKR)	Persistent pain in 14–53%; dissatisfaction in 15–30%; infection, stiffness, thromboembolic risk	Materially higher rate of serious adverse events than non-surgical care	Edward, 2017; Skou et al., 2018 [25]

Table. 18

Conclusion for Safety: PRP and supervised exercise are the safest long-term options reviewed. Repeated corticosteroid injections and prolonged NSAID/opioid use carry cumulative risks that limit their suitability as a long-term TKR-delay strategy, while TKR itself carries the highest absolute risk of serious adverse events among all options considered.

Discussion

The findings of this review indicate that PRP and conservative management are not competing alternatives so much as complementary tools that suit different points on the disease timeline. PRP consistently produced superior short- to medium-term pain relief and functional improvement compared with most single-modality conservative treatments, with benefit peaking between 3 and 6 months [9] and remaining evident, though attenuated, through 12 months in several reviews [12]. At the same time, the two studies in this review that used a genuine time-based or survival-analysis outcome rather than a symptom score produced a striking, near-identical result: 85.7% of PRP recipients remained surgery-free at 5 years in Sánchez et al. (2021)[6], compared with 86% of conservative-management responders at the same time point in Gustafsson et al. (2024)[43]. Skou et al. (2018) reinforced this from a

randomised-trial perspective, showing that structured non-surgical treatment alone kept 74% of TKR-eligible patients surgery-free at 1 year and 68% at 2 years [33]. Taken together, this review's own interpretation is that neither treatment has been shown, in a direct head-to-head trial, to delay surgery for a longer period than the other; what the evidence does show is that both are independently capable of meaningfully postponing TKR for a majority of patients over a multi-year horizon, and that PRP's advantage lies specifically in the speed and magnitude of symptom relief it offers in the interim, rather than in a proven superior delay duration.

The most defensible clinical position supported by the evidence in this review is therefore that PRP functions best as an adjunct to, rather than a substitute for, structured exercise and physiotherapy, a conclusion echoed across several of the higher-quality reviews included in this synthesis [29]. From a health-systems perspective, the Indian context adds urgency to these findings. With TKR remaining costly and inaccessible for many patients, and with only one Indian RCT[12] in the entire evidence base, clinicians and policymakers in India currently have very little locally generated evidence on which to base treatment and resource-allocation decisions. Multicentre Indian trials directly comparing standardised PRP protocols with structured conservative programmes, using TKR incidence as a primary outcome and following patients for at least two to five years, would directly address the central gap identified in this review: the absence of a single study that measures both arms against the same time-based surgical endpoint.

Limitations

- No included study directly compared PRP with conservative management using TKR incidence as the primary outcome; all conclusions on this endpoint are drawn from indirect comparisons across different study populations.
- PRP preparation (platelet concentration, leukocyte content, number and interval of injections) was not standardised across studies, limiting the comparability of pooled conclusions.
- Most trials had relatively short follow-up (6–12 months), while surgical decisions often play out over several years; longer-term data were available for only a small number of studies (e.g., Sánchez et al., 2021; Skou et al., 2018).
- The evidence base specific to India is limited to a single controlled trial (Patel et al., 2013), restricting the generalisability of findings to the Indian population and healthcare context.

- Because study designs and outcome measures were heterogeneous, statistical pooling (meta-analysis) was not feasible, and the narrative synthesis approach used here is inherently more susceptible to reviewer interpretation than a quantitative pooled estimate.
- Quality appraisal of narrative reviews and umbrella reviews relied on the information reported in the source publications rather than on independent re-analysis of their primary studies, which may understate or overstate true methodological risk in some cases.

Conclusion

This systematic review of 36 studies found that Platelet-Rich Plasma (PRP) therapy provides superior short- to medium-term pain relief and functional improvement compared with most single-modality conservative treatments for knee osteoarthritis, while cohort and registry evidence indicates that both PRP and effective conservative management can substantially delay Total Knee Replacement for a majority of patients over periods ranging from one to more than five years. No direct trial evidence currently exists to determine which approach delays surgery for longer. PRP appears most valuable as an adjunct to structured exercise and physiotherapy rather than as a standalone replacement for conservative care, and is generally well tolerated relative to prolonged pharmacological therapy or surgery. These findings support PRP as a viable second-line, non-surgical option for mild-to-moderate knee osteoarthritis, while underscoring the urgent need for standardised, head-to-head, India-specific trials with TKR incidence as a primary outcome and follow-up extending beyond two years.

Significance of the Study

This review carries direct significance for three groups: clinicians managing knee osteoarthritis, healthcare administrators planning resource allocation, and patients weighing their own treatment options. For clinicians, the finding that PRP and structured conservative management produce comparable surgery-avoidance rates at 5 years (85.7% vs. 86%)[6][43] reframes the treatment decision away from "which is better" and toward "which combination, and in what sequence, best serves a given patient." The evidence in this review supports offering PRP as an accelerant alongside, rather than instead of, exercise-based care, particularly for patients with mild-to-moderate disease (Kellgren-Lawrence Grade I-III) who are not yet surgical candidates but need faster symptom control than exercise alone typically provides.

For hospital administrators and healthcare policymakers, particularly within the Indian context this dissertation was written for, the significance lies in cost and capacity planning. With total knee replacement remaining expensive and inaccessible for a large proportion of India's knee osteoarthritis population [12], a treatment pathway that can plausibly delay surgery by one to several years, at a fraction of the cost of arthroplasty, has direct implications for surgical waitlist management and out-of-pocket healthcare expenditure. This review's finding that only a single Indian RCT exists in the entire evidence base underscores that this potential currently rests on international data that may not transfer cleanly to Indian patients, who tend to develop knee osteoarthritis earlier and present with different anthropometric and occupational risk profiles than Western cohorts.

Finally, for patients themselves, this review's significance is in reframing PRP not as a replacement for the advice they are typically given first (exercise, weight management, physiotherapy) but as a genuine complementary option worth discussing with their clinician if conservative measures alone are not providing adequate relief. The absence of a head-to-head trial measuring both approaches against the same surgical-delay endpoint means neither this review, nor any single study within it, can tell a patient with certainty which path will keep them surgery-free for longer; what it can offer is reassurance that both paths have credible, registry-level evidence behind their ability to meaningfully postpone surgery, which is itself a clinically useful message for shared decision-making conversations.

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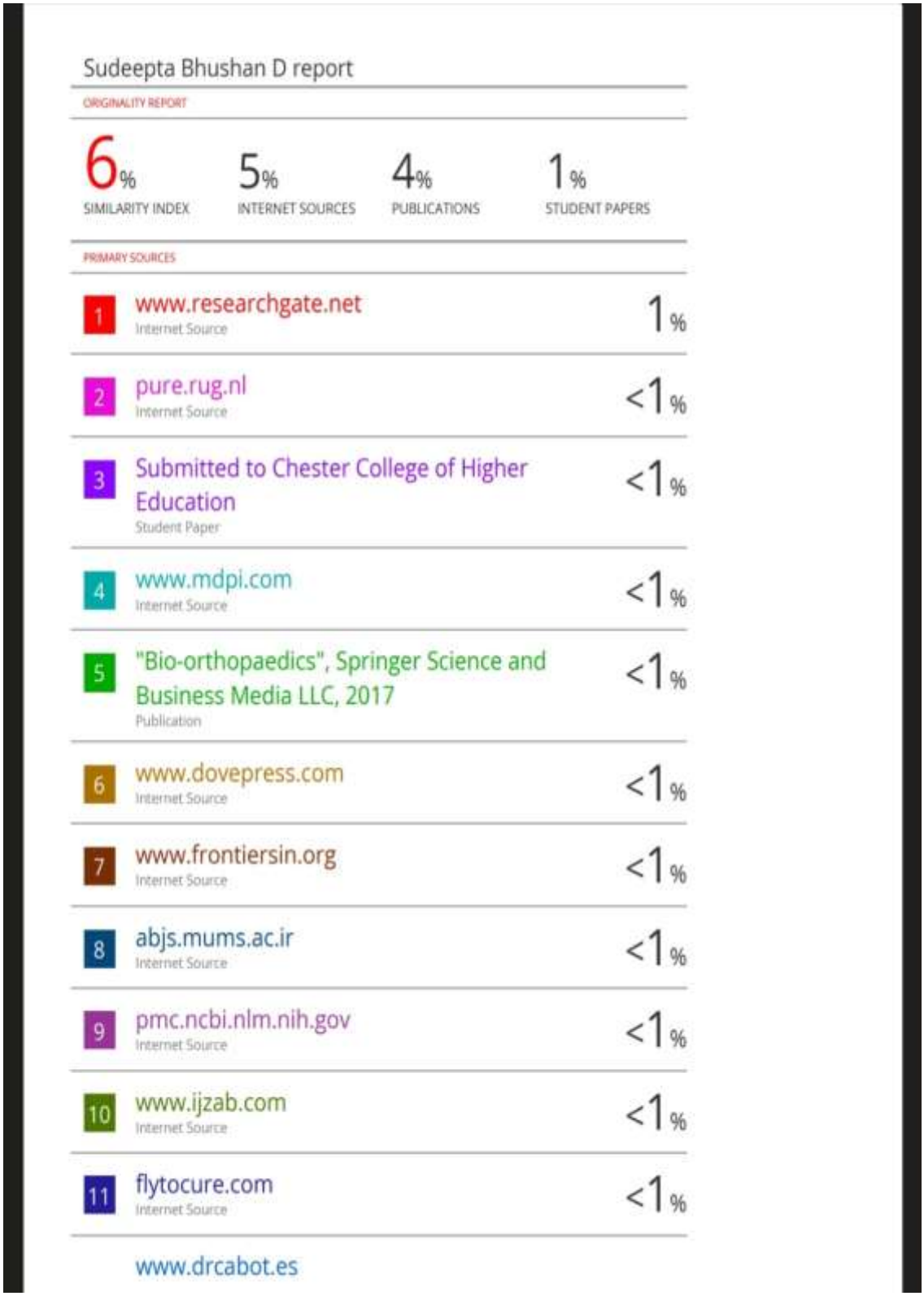
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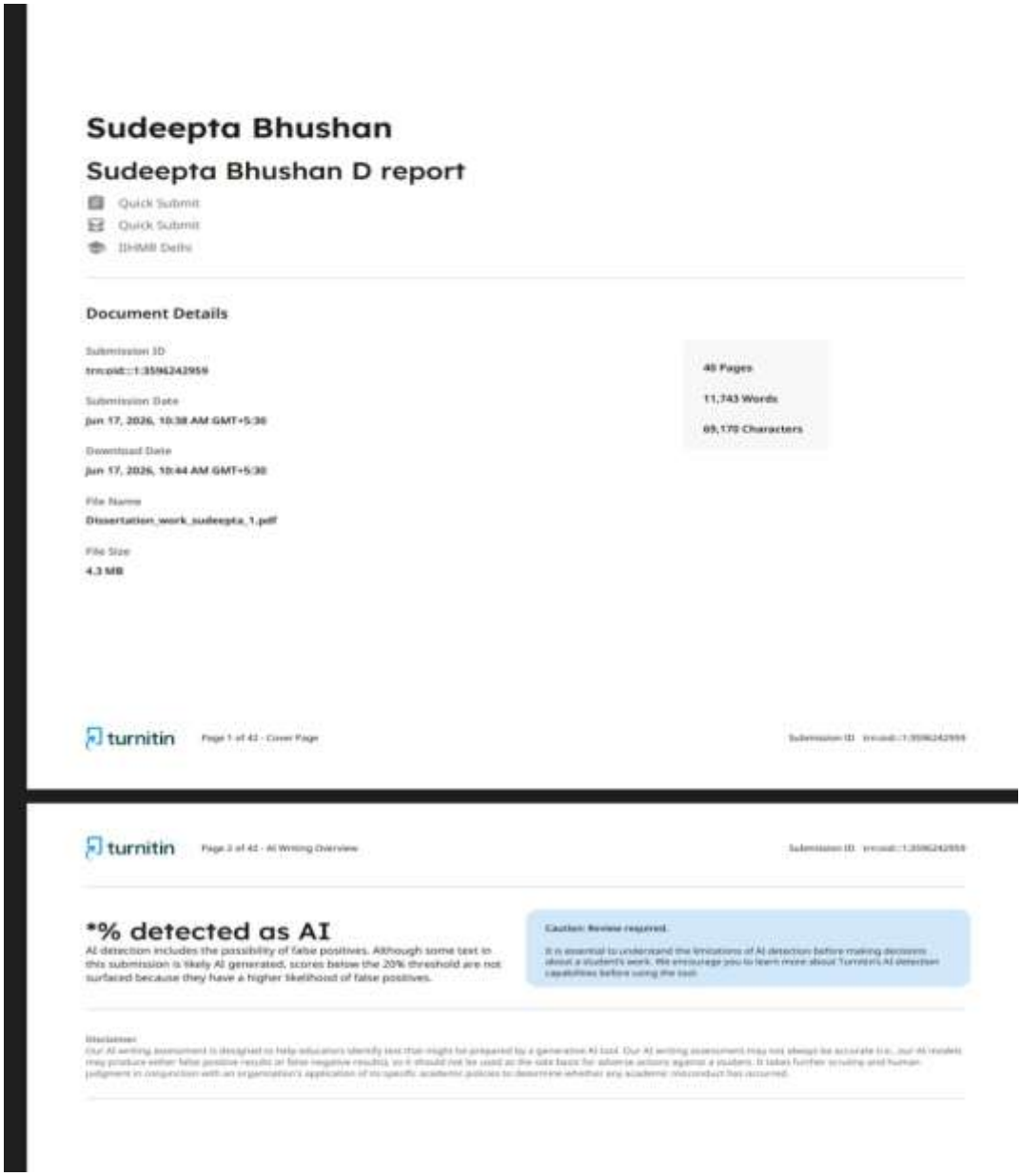
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