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Research Article

EVALUATING THE FUNCTIONAL OUTCOMES OF PLATELET RICH PLASMA IN KNEE OSTEOARTHRITIS TREATMENT

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ABSTRACT

Knee osteoarthritis (OA) is a chronic, progressive degenerative joint disease that leads to pain, stiffness, and loss of mobility. Platelet-Rich-Plasma (PRP) therapy has recently gained prominence as a biological treatment modality due to its ability to promote cartilage healing, reduce inflammation, and improve joint function. This study aimed to evaluate the functional outcomes of intra-articular PRP therapy in patients with knee OA by analysing improvements in pain, stiffness, and physical function. The study also investigated potential predictors of therapeutic response based on demographic and clinical characteristics. A prospective observational study was conducted over six months in the Department of Orthopedics at Government General Hospital. Sixty patients with clinically and radiographically confirmed knee OA (predominantly Kellgren–Lawrence Grade 2) were enrolled. Data collected included age, sex, occupation, comorbidities, disease duration, and radiographic severity. All participants received intra-articular PRP injections, and their functional status was assessed using the Western Ontario and McMaster Universities Osteoarthritis Index and the Visual Analog Scale (VAS) at baseline and six weeks post-treatment. The mean age of participants was 52.5 ± 8.98 years, and 61.7% were female. Comorbid conditions were present in 45% of patients, with hypertension being the most common (21.7%), followed by Asthma were present with 11.7% of patients followed by Pancreatitis were present with 6.7%, followed by Pneumonia were present with 5%. Baseline WOMAC scores significantly improved from 53.2 ± 9.5 to 40.7 ± 9.1 ($p < 0.001$) after six weeks. Pain scores reduced from 13.8 ± 3.4 to 9.2 ± 2.9, stiffness scores from 4.6 ± 1.5 to 3.1 ± 1.2, and physical function scores from 35.1 ± 7.2 to 28.2 ± 6.9 (all $p < 0.001$). VAS scores also demonstrated significant improvement, shifting from moderate to mild pain in most patients. PRP therapy significantly improved clinical outcomes in patients with early to moderate knee OA. It offers a safe, effective, and minimally invasive alternative for functional improvement and symptomatic relief.

Keywords: Platelet-Rich Plasma, Knee Osteoarthritis, Intra-articular Injection, Pain Management, Regeneration.

INTRODUCTION

Osteoarthritis (OA) is a prevalent and progressive joint disease that represents a major global health burden. It is the most common form of arthritis and a leading cause of pain, disability, and reduced quality of life, particularly among the elderly. OA is characterized by the degeneration of articular cartilage, subchondral bone changes, osteophyte formation, and synovial inflammation. Traditionally considered a "wear-and-tear" condition, OA is now understood to be a multifactorial disease involving complex mechanical, biochemical, and inflammatory interactions that contribute to cartilage degradation and joint dysfunction (World Health Organization, 2003). The World Health Organization (WHO) estimates that more than 500 million people worldwide suffer from OA, with its prevalence expected to rise due to aging populations, sedentary lifestyles, and increasing rates of obesity. In India alone, approximately 62.35 million individuals were affected by OA in 2019 a sharp rise from 23.46 million in 1990. Knee osteoarthritis (KOA) is the most common subtype, followed by hip and hand OA. Among Indians, women are more frequently affected than men, often due to hormonal influences, anatomical differences, and longevity (Sellam, 2013). Knee osteoarthritis presents a unique

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challenge because the knee is a major weight-bearing joint involved in mobility, daily functioning, and postural stability. The joint consists of three bones the femur, tibia, and patella along with supporting structures such as ligaments, tendons, muscles, bursae, and synovial fluid. The joint's anatomy allows for flexion, extension, and minor rotational movements, making it vulnerable to both mechanical stress and inflammatory changes over time. When the cartilage cushioning the knee wears away, it leads to bone-on-bone contact, resulting in pain, stiffness, and decreased range of motion (Jang S. J, 2013).

The etiology of osteoarthritis is multifactorial. Primary risk factors include age, female sex, genetic predisposition, obesity, and occupational or athletic overuse. As people age, the ability of chondrocytes to maintain and repair cartilage diminishes, while hormonal changes (especially decreased estrogen levels in postmenopausal women) further accelerate joint deterioration. Secondary OA may arise from identifiable causes such as rheumatoid arthritis, joint injuries, infections (zptom control, functional improvement, and slowing disease progression. Current strategies include both pharmacological and non-pharmacological approaches. First-line pharmacologic treatments include acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs), and topical analgesics. In more advanced cases, intra-articular corticosteroid injections or hyaluronic acid (visco supplementation) may be employed. For persistent pain unresponsive to standard therapy, medications such as duloxetine and tramadol may be considered, though long-term opioid use is discouraged due to safety concerns.

Non-pharmacological management is a critical component of OA treatment and includes weight loss, physical therapy, exercise (aerobic and strength training), thermal therapy (heat and cold), assistive devices (e.g., braces, orthotics), patient education, psychological support, and joint protection techniques. Alternative therapies such as acupuncture, yoga, tai chi, and dietary supplements (e.g., glucosamine, chondroitin sulfate, omega-3 fatty acids) may also offer benefit for some patients (Gobbi A, 2015). Despite these options, many patients with early to moderate OA continue to experience persistent symptoms, underscoring the need for more effective disease-modifying therapies. In this context, Platelet-Rich Plasma (PRP) has emerged as a novel biological treatment that harnesses the regenerative potential of autologous blood products to promote cartilage repair, reduce inflammation, and improve joint function. PRP is a concentration of platelets in a small volume of plasma, derived from the patient's own blood through a process of centrifugation. Platelets are known to release numerous growth factors and cytokines that play critical roles in tissue healing, angiogenesis, and modulation of inflammation. These include platelet-derived growth factor (PDGF), transforming growth factor-beta (TGF-β), insulin-like growth factor-1 (IGF-1), vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), fibroblast growth factor (FGF), and connective tissue growth factor (CTGF). Collectively, these molecules help stimulate chondrocyte proliferation, enhance extracellular matrix synthesis, promote cartilage regeneration, and regulate synovial inflammation. The procedure for PRP therapy involves drawing venous blood, typically 20 mL, which is then processed in a centrifuge to separate the platelet-rich fraction from red blood cells and platelet-poor plasma. This PRP is collected and injected intra-articular into the knee joint under sterile conditions, usually without the use of local anesthetics, as these may interfere with platelet activation. The injection is well tolerated, with most patients experiencing minimal adverse effects such as mild post-injection soreness (Di Martino, 2019).

Several clinical studies have reported positive outcomes following PRP therapy in patients with KOA, including reductions in pain, improved physical function, and delays in disease progression. PRP is particularly effective in early to moderate stages (Kellgren-Lawrence Grades I–III), where cartilage loss is partial and regenerative potential remains viable. Compared to corticosteroids or hyaluronic acid injections, PRP has shown longer-lasting benefits and fewer side effects, making it an appealing option for both patients and clinicians (Sampson S, 2010). Nevertheless, variability in preparation methods, platelet concentration, injection protocols, and patient selection criteria have limited the standardization of PRP therapy. Further high-quality research is needed to define optimal protocols and long-term outcomes. Despite these challenges, PRP represents a promising and minimally invasive treatment that aligns with the modern approach of biological joint preservation and functional restoration (van Buul, 2011). The objectives of the study are to evaluate the changes in pain, joint stiffness, and physical function in patients with knee osteoarthritis (KOA) receiving platelet-rich plasma (PRP) therapy using standardized outcome measures such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Visual Analog Scale (VAS). The study also aims to identify demographic and clinical predictors of response to PRP therapy, including age, sex, duration of symptoms, occupational status, associated comorbidities, and radiographic severity of osteoarthritis.

MATERIALS AND METHODS

Study Design

A prospective observational study design was employed to evaluate the functional outcomes of Platelet-Rich Plasma (PRP) therapy in patients with knee osteoarthritis.

Study Site

The study was conducted in the Orthopedic Department, In-patient Unit, Government General Hospital (GGH), Kurnool, Andhra Pradesh, India.

Study Duration

The study was carried out over a period of six months.

Sampling Method

During the study duration, a total of 60 eligible patients were recruited using a consecutive sampling technique.

Study Materials and Data Collection

Patient data was recorded using a structured case report form, which included demographic information, clinical history, comorbidities, medication history, and radiographic findings. Functional status was assessed using standardized tools: the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Visual Analog Scale (VAS). Assessments were done at baseline and six weeks after PRP therapy (Nakagawa K, 2007).

RESULTS AND DISCUSSION

The study included 60 patients diagnosed with knee osteoarthritis. The mean age of participants was 52.52 ± 8.98 years. The majority were in the 51–60 years age group (40%). Gender distribution showed that females comprised 61.7% (n = 37), while males accounted for 38.3% (n = 23). Participants were grouped by age: under 40 (10%), 41–50 (30%), 51–60 (40%), and over 60 (20%). The 51–60 age group was the most represented, aligning with the typical age of significant OA symptoms. The mean age was 52.52 ± 8.98, indicating a predominance of middle-aged and older adults (Table 1-2), the primary demographic for conservative osteoarthritis treatments like PRP. According to the data most of the Females are more prone to osteoarthritis than Males because of the hormonal imbalance and obesity problems. Distribution of patients based on their occupation. Out of 60 patients, 19(31.7%) working as coolie,6(10%) farmers,13(21.7%) house wives, 9(15%) Tailor, 6(10%) Teacher,7(11.6%) Others.

Table 1. Gender wise Distribution

Gender	Frequency	Percentage
Female	37	61.7%
Male	23	38.3%

Table 2. Age-wise distribution.

Age Group	Frequency	Percentage
< 40 years	6	10%
41–50 years	18	30%
51–60 years	24	40%
> 60 years	12	20%

Table 3. Distribution based on occupation.

Occupation	Frequency	Percentage
Coolie	19	31.7%
Housewife	13	21.7%
Tailor	9	15%
Teacher	6	10%
Farmer	6	10%
Others	7	11.6%

Table 4. Distribution of Comorbidities among Study Participants.

Comorbidity	Frequency	Percentage
Hypertension	13	21.7%
Asthma	7	11.7%
Pancreatitis	4	6.7%
Pneumonia	3	5.0%
None	33	55.0%

Table 5. Kellgren Lawrence Radiographic Grading of Knee Osteoarthritis.

Grade	Frequency	Percentage
1	12	20%
2	48	80%

Table 6. Side of Knee Involvement.

Side	Frequency	Percentage
Left	31	51.7%
Right	29	48.3%

Table 7. Overall Difference Between Womac Score at Different Time Intervals.

Time Point	Pain Score	Stiffness Score	Physical Function Score	Total WOMAC
Baseline	13.82 ± 3.37	4.63 ± 1.50	35.12 ± 7.17	53.15 ± 9.49
10 Days Post PRP	11.52 ± 3.21	3.83 ± 1.30	31.67 ± 7.01	47.07 ± 10.02
3 Weeks Post PRP	10.33 ± 3.08	3.41 ± 1.30	29.80 ± 7.27	43.65 ± 9.81
6 Weeks Post PRP	9.18 ± 2.90	3.05 ± 1.18	28.23 ± 6.92	40.65 ± 9.07

Table 8. VAS Score Mean at Different Time Intervals.

VAS grade	Before	10 days	3rd week	6th week	Chi=Square P value
Mild pain	6 (10)	7 (11.7)	34 (56.7)	40 (66.7)	68.425
Moderate pain	54 (90)	53 (88.3)	26 (43.3)	20 (33.3)	
Total	60	60	60	60	<0.001

Table 9. Changes in VAS Score in Different Time Intervals.

Time Point	VAS Mean Score
Baseline	4.48
10 Days Post PRP	4.47
3 Weeks Post PRP	3.47
6 Weeks Post PRP	3.22

Comorbidities among the 60 study participants revealed that 55% (n=33) had no underlying health conditions at the time of enrollment. Among those with comorbidities, hypertension was the most commonly reported, affecting 21.7% (n=13) of individuals, followed by asthma in 11.7% (n=7), pancreatitis in 6.7% (n=4), and pneumonia in 5% (n=3) of the participants. Radiological assessment of the 60 patients with knee osteoarthritis revealed that the majority were classified as Grade 2, with 48 patients (80%) falling into this category. In contrast, Grade 1 changes were observed in 12 patients (20%). Among the 60 patients enrolled in the study, knee osteoarthritis involvement was observed to be nearly evenly distributed between both sides. Specifically, the left knee was affected in 51.7% (n=31) of participants, while the right knee was involved in 48.3% (n=29). Baseline (Before Treatment): The average score was 53.15 with a standard deviation of 9.487. This indicates a relatively high level of symptom severity at the beginning. After 10 Days: The mean score dropped to 47.07 (SD = 10.023), reflecting an initial improvement in the patient condition. At 3rd Week: The mean further decreased to 43.65 (SD = 9.806), continuing the trend of symptom reduction. At 6th Week: The score reached 40.65 (SD = 9.068), representing the lowest recorded value and suggesting further sustained improvement. In this study, the mean Visual Analogue Scale (VAS) scores were recorded before and after platelet-rich plasma (PRP) injections in knee osteoarthritis patients. Initially, the mean pain score was 4.48, indicating moderate pain. After 10 days of the injection, the score remained nearly unchanged at 4.47, suggesting minimal short-term improvement. However, by the 3rd week, the mean score dropped significantly to 3.47, and by the 6th week, it further reduced to 3.22. This gradual decline in pain scores shows that PRP treatment becomes more effective with time. The statistical analysis (ANOVA) resulted in a p-value of less

than 0.001, indicating that the changes observed were statistically significant (Table 3-4). Overall, the graph clearly demonstrates a consistent improvement in pain reduction from the 3rd week onward. Before starting PRP treatment, 90% of patients had moderate pain and only 10% had mild pain. But after 10 days, mild pain slightly increased to 11.7%, and moderate pain reduced to 88.3%. By the 3rd week, there was a noticeable shift-56.7% of patients reported mild pain, and only 43.3% had moderate pain. At the end of 6 weeks, this improvement continued, with 66.7% having mild pain and just 33.3% with moderate pain (Table 5-6)**.**

DISCUSSION

This prospective observational study assessed the effectiveness of intra-articular Platelet-Rich Plasma (PRP) therapy in patients with knee osteoarthritis (OA), with a focus on pain relief, reduction in joint stiffness, and improvement in physical function. The findings support PRP as a beneficial intervention for early to moderate OA. In our study, most of the patients who received PRP therapy were women (61.7%), with findings by Pasupuleti Archana Babu et al., who also reported a female predominance. Osteoarthritis is more common in postmenopausal women, likely due to estrogen deficiency and the biomechanical load from routine household tasks. The age distribution showed that the highest proportion of patients (40%) were in the 51–60-year range, with a mean age of 52.52 years, comparable to the study by Rompilli Joshua et al., who also reported a concentration in the 50–65 age group. These results support the well-established understanding that OA primarily affects middle-aged and older adults (Mascarenhas, 2015). Radiologically, 80% of the patients had Grade 2 OA based on the Kellgren–Lawrence scale, which indicates moderate degeneration. This stage is ideal for PRP treatment, as cartilage still has some potential for regeneration. Similar recommendations were noted in studies by Deepak Rai et al. and Zhengchao Wang et al., who supported PRP use at this stage for optimal benefit. Pain relief outcomes showed a statistically significant improvement. The mean WOMAC pain score dropped from 13.82 at baseline to 9.18 after six weeks. While the change at 10 days was modest, more pronounced improvements were observed at the third and sixth weeks, indicating that PRP may take time to reach full therapeutic effect. This trend aligns with results from Kon, Filardo, and Gormeli, who also reported delayed but sustained symptomatic relief following PRP therapy (Murphy L, 2008). Our findings echo those of D. Ravi Prakash et al., who observed sustained symptom relief for up to 12 months, and Ashok Kumar et al., who noted positive short-term results with three PRP injections. Joint stiffness improved notably as well, with scores dropping from 4.63 to 3.05. This supports the study by Cerza et al., which emphasized PRP's ability to improve joint flexibility and reduce synovial inflammation. Physical function showed a similar trend, with the mean score decreasing from 35.12 to 28.23 over six weeks. The total WOMAC score improved from 53.15 to 40.65, representing significant overall symptomatic improvement. Similar outcomes were reported by Sanchez and Halpern, especially in patients with moderate OA, which was also the dominant grade in our study population (Kevy, 2004). When compared to conventional treatments like hyaluronic acid injections and NSAIDs, as discussed by Pourcho et al., PRP offers a biologically active, regenerative option with fewer side effects and better tolerability. Its mechanism—rich in growth factors and cytokines promotes tissue healing, modulates inflammation, and enhances joint lubrication (Phillips M, 2021). While the results are encouraging, the study has limitations. It lacked a control group and did not investigate long-term outcomes or repeated PRP injections. Patient variables such as body mass index (BMI), activity level, or concurrent treatments were not stratified. Future studies should address these variables and include a randomized control group with extended follow-up durations (Lippi G, 2006).

CONCLUSION

The present study concludes that intraarticular injection of platelet-rich plasma (PRP) provides significant improvements in pain relief, joint function, and overall quality of life for patients with knee osteoarthritis especially in early to moderate stages (Grade 1 and Grade 2). PRP appears to exert its therapeutic effects by delivering growth factors that support cartilage repair, reduce inflammation, and enhance joint lubrication. Overall, PRP is a safe and effective adjunct in the management of knee osteoarthritis and may offer a promising approach to slow disease progression.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

REFERENCES

Sellam, J., & Berenbaum, F. (2013). Is osteoarthritis a metabolic disease? *Joint Bone Spine, 80*(6), 568–573.

World Health Organization Scientific Group on the Burden of Musculoskeletal Conditions at the Start of the New Millennium. (2003). *The burden of musculoskeletal conditions at the start of the new millennium* (WHO Technical Report Series No. 919). Geneva, Switzerland: World Health Organization.

Jang, S. J., Kim, J. D., & Cha, S. S. (2013). Platelet-rich plasma (PRP) injections as an effective treatment for early osteoarthritis. *European Journal of Orthopaedic Surgery & Traumatology, 23*(5), 573–580.

Kellgren, J. H., & Lawrence, J. S. (1957). Radiological assessment of osteo-arthrosis. *Annals of the Rheumatic Diseases, 16*(4), 494–502.

Pourcho, A. M., Smith, J., Wisniewski, S. J., & Sellon, J. L. (2014). Intra-articular platelet-rich plasma injection in the treatment of knee osteoarthritis: Review and recommendations. *American Journal of Physical Medicine & Rehabilitation, 93*(11 Suppl. 3), S108–S121.

Gobbi, A., Lad, D., & Karnatzikos, G. (2015). The effects of repeated intra-articular PRP injections on clinical outcomes of early osteoarthritis of the knee. *Knee Surgery, Sports Traumatology, Arthroscopy, 23*(8), 2170–2177.

Di Martino, A., Di Matteo, B., Papio, T., Tentoni, F., Selleri, F., Cenacchi, A., Kon, E., & Filardo, G. (2019). Platelet-rich plasma versus hyaluronic acid injections for the treatment of knee osteoarthritis: Results at 5 years of a double-blind, randomized controlled trial. *The American Journal of Sports Medicine, 47*(2), 347–354.

Sampson, S., Reed, M., Silvers, H., Meng, M., & Mandelbaum, B. (2010). Injection of platelet-rich plasma in patients with primary and secondary knee osteoarthritis: A pilot study. *American Journal of Physical Medicine & Rehabilitation, 89*(12), 961–969.

van Buul, G. M., Koevoet, W. L., Kops, N., Bos, P. K., Verhaar, J. A., Weinans, H., Bernsen, M. R., & van Osch, G. J. (2011). Platelet-rich plasma releasate inhibits inflammatory processes in osteoarthritic chondrocytes. *The American Journal of Sports Medicine, 39*(11), 2362–2370.

Nakagawa, K., Sasho, T., Arai, M., Kitahara, S., Ogino, S., Wada, Y., et al. (2007, October). Effects of autologous platelet-rich plasma on the metabolism of human articular chondrocytes. Electronic poster presentation, Chiba and Ichihara, Japan.

Patel, S., Dhillon, M. S., Aggarwal, S., Marwaha, N., & Jain, A. (2013). Treatment with platelet-rich plasma is more effective than placebo for knee osteoarthritis: A prospective, double-blind, randomized trial. *The American Journal of Sports Medicine, 41*(2), 356–364.

Mascarenhas, R., Saltzman, B. M., Fortier, L. A., & Cole, B. J. (2015). Role of platelet-rich plasma in articular cartilage injury and disease. *The Journal of Knee Surgery, 28*(1), 3–10.

Murphy, L., Schwartz, T. A., Helmick, C. G., Renner, J. B., Tudor, G., Koch, G., et al. (2008). Lifetime risk of symptomatic knee osteoarthritis. *Arthritis & Rheumatism, 59*(9), 1207–1213.

Kevy, S. V., & Jacobson, M. S. (2004). Comparison of methods for point-of-care preparation of autologous platelet gel. *Journal of Extra-Corporeal Technology, 36*(1), 28–35.

Phillips, M., Bhandari, M., Grant, J., Bedi, A., Trojian, T., Johnson, A., & Schemitsch, E. (2021). A systematic review of current clinical practice guidelines on intra-articular hyaluronic acid, corticosteroid, and platelet-rich plasma injection for knee osteoarthritis. *Orthopaedic Journal of Sports Medicine, 9*(8), 23259671211030272.

Lippi, G., Salvagno, G. L., Montagnana, M., Poli, G., & Guidi, G. C. (2006). Influence of the needle bore size on platelet count and routine coagulation testing. *Blood Coagulation & Fibrinolysis, 17*(7), 557–561.

Park, Y. B., Kim, J. H., Ha, C. W., & Lee, D. H. (2021). Clinical efficacy of platelet-rich plasma injection and its association with growth factors in the treatment of mild to moderate knee osteoarthritis: A randomized double-blind controlled clinical trial as compared with hyaluronic acid. *The American Journal of Sports Medicine, 49*(2), 487–496.

Trojian, T. H., Concoff, A. L., Joy, S. M., Hatzenbuehler, J. R., Saulsberry, W. J., & Coleman, C. I. (2016). AMSSM scientific statement concerning viscosupplementation injections for knee osteoarthritis: Importance for individual patient outcomes. *British Journal of Sports Medicine, 50*(2), 84–92.

Lai, L. P., Stitik, T. P., Foye, P. M., Georgy, J. S., Patibanda, V., & Chen, B. (2015). Use of platelet-rich plasma in intra-articular knee injections for osteoarthritis: A systematic review. *PM&R, 7*(6), 637–648.

Shen, L., Yuan, T., Chen, S., Xie, X., & Zhang, C. (2017). The temporal effect of platelet-rich plasma on pain and physical function in the treatment of knee osteoarthritis: Systematic review and meta-analysis of randomized controlled trials. *Journal of Orthopaedic Surgery and Research, 12*(1), 16.

Gibbs, N., Diamond, R., Sekyere, E. O., & Thomas, W. D. (2015). Management of knee osteoarthritis by combined stromal vascular fraction cell therapy, platelet-rich plasma, and musculoskeletal exercises: A case series. *Journal of Pain Research, 8*, 799–806.

Fawzy, R. M., Hashaad, N. I., & Mansour, A. I. (2017). Decrease of serum biomarker of type II collagen degradation (Coll2-1) by intra-articular injection of autologous platelet-rich plasma in patients with unilateral primary knee osteoarthritis. *European Journal of Rheumatology, 4*(2), 93–97.

Oudelaar, B. W., Peerbooms, J. C., Huis In 't Veld, R., & Vochteloo, A. J. H. (2019). Concentrations of blood components in commercial platelet-rich plasma separation systems: A review of the literature. *The American Journal of Sports Medicine, 47*(2), 479–487.

Li, M., Zhang, C., Ai, Z., Yuan, T., Feng, Y., & Jia, W. (2011). [Article in Chinese]. *Chinese Journal of Reparative and Reconstructive Surgery, 25*(10), 1192–1196.

Cross, M., Smith, E., Hoy, D., Nolte, S., Ackerman, I., Fransen, M., et al. (2014). The global burden of hip and knee osteoarthritis: Estimates from the global burden of disease 2010 study. *Annals of the Rheumatic Diseases, 73*(7), 1323–1330.

Hamood, R., Tirosh, M., Fallach, N., Chodick, G., Eisenberg, E., & Lubovsky, O. (2021). Prevalence and incidence of osteoarthritis: A population-based retrospective cohort study. *Journal of Clinical Medicine, 10*(18), 4282.

Coaccioli, S., Sarzi-Puttini, P., Zis, P., Rinonapoli, G., & Varrassi, G. (2022). Osteoarthritis: New insight on its pathophysiology. *Journal of Clinical Medicine, 11*(20), 6013.

Yu, H., Huang, T., Lu, W. W., Tong, L., & Chen, D. (2022). Osteoarthritis pain. *International Journal of Molecular Sciences, 23*(9), 4642.

Rai, D., Singh, J., Somashekharappa, T., & Singh, A. (2021). Platelet-rich plasma as an effective biological therapy in early-stage knee osteoarthritis: One-year follow-up. *SICOT-J, 7*, 6.

Bansal, H., Leon, J., Pont, J. L., Wilson, D. A., Bansal, A., Agarwal, D., & Preoteasa, I. (2021). Platelet-rich plasma (PRP) in osteoarthritis knee: Correct dose critical for long-term clinical efficacy. *Scientific Reports, 11*(1), 3971.