Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.2.00854

RESEARCH ARTICLE

Correlation between Radiological Findings and Clinical Improvement after Genicular Nerve Ablation in Knee Osteoarthritis: An Analysis Based on the Kellgren-Lawrence Scale, Numerical Rating Scale (NRS), and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Score

Ilma Fiddiyanti[1,2], Omat Rachmat[1], Bachtiar Murtala[2], Irfan Idris[2], Jacub Padelaki[3]

[1]Faculty of Medicine, Hasanudin University, Jl.Perintis Kemerdekaan No.KM.10, Tamalanrea Indah, Kec. Tamalanrea, Kota Makassar, Sulawesi Selatan 90245, Indonesia
[2]Faculty of Medicine, Sultan Ageng Tirtayasa University, Jl. Raya Jkt Km 4 Jl. Pakupatan, Serang 42124, Banten, Indonesia
[3]Faculty of Medicine, Indonesia University, Jl. Lingkar, Pondok Cina, Kecamatan Beji, Kota Depok, Jawa Barat 16424, Indonesia

ARTICLE INFO

Received: Aug 18, 2024

Accepted: Oct 25, 2024

Keywords

Genicular nerve ablation

Knee osteoarthritis

Kellgren-Lawrence scale

Numerical Rating Scale (NRS)

WOMAC

***Corresponding Author:**

ilmaradiologi@gmail.com

ABSTRACT

Knee osteoarthritis is a leading cause of chronic pain and disability, particularly among the elderly population. Genicular nerve ablation is an emerging treatment aimed at reducing pain and improving function in patients with knee osteoarthritis. This study aims to evaluate the correlation between radiological findings based on the Kellgren-Lawrence scale and clinical improvement following genicular nerve ablation, using the Numerical Rating Scale (NRS) for pain and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for joint function. A total of 60 patients with knee osteoarthritis, meeting inclusion criteria, underwent genicular nerve ablation. Radiological data were obtained from knee radiographs, evaluated using the Kellgren-Lawrence grading scale. Clinical changes were assessed using the NRS for pain intensity and WOMAC for joint function. Assessments were conducted prior to the procedure, and at weeks 4, 8, and 12 post-ablation. Significant improvements were observed in NRS and WOMAC scores across all post-ablation evaluation points ($p < 0.05$). Patients with lower Kellgren-Lawrence grades (grades 1 and 2) showed greater clinical improvement compared to those with higher grades (grades 3 and 4). A moderate positive correlation was found between radiological osteoarthritis severity and clinical outcomes ($r = 0.65$ for NRS; $r = 0.60$ for WOMAC), indicating that patients with milder radiological findings tend to experience more significant clinical improvements. Genicular nerve ablation effectively reduces pain and improves function in patients with knee osteoarthritis. The severity of radiological findings, as graded by the Kellgren-Lawrence scale, moderately correlates with clinical improvement after ablation. These findings suggest that genicular nerve ablation is a viable treatment option, particularly for patients with mild to moderate knee osteoarthritis.

INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease characterized by cartilage destruction, bone remodeling, and joint inflammation. The knee joint is one of the most commonly affected areas, and its prevalence increases with age (Zhang, et al., 2019; Jam et al., 2017). From 1990 to 2020, the global population with OA is expected to increase from 256 million to 595 million. Globally, the age-standardized prevalence of OA by type in order of the highest number includes knee OA (4307.4 cases), hand OA (2226.1 cases), other OA (718.4 cases), and hip OA (417.7 cases) (Steinmetz, et al., 2023).

Meanwhile, the prevalence of OA in Indonesia is quite high, with incidence rates reaching 15.3% in the population aged 40-59 years and 34.5% in the population aged 60 years and over, while the prevalence of knee OA reaches 15.5% of men and 12.7% of women out of 225 million Indonesian population. OA is also one of the leading causes of morbidity and mortality in Indonesia (Ahmad, et al., 2018). Until now, OA treatment has not been able to cure the disease, but can only reduce symptoms and slow down its progression.

The recommended management of OA is comprehensive and includes both non-pharmacologic and pharmacologic therapies. The selection of therapy is based on the patient's beliefs and preferences as well as the patient's medical status. Due to the good efficacy of oral NSAIDs in managing pain caused by OA, oral NSAIDs are strongly recommended as first-line therapy. However, the risks of NSAIDs are gastrointestinal, cardiovascular and renal complications especially in the elderly (Katz, et al., 2021; Kolasinski, et al., 2020; Al-khresheh., 2021). The recommended management of OA is comprehensive and includes both non-pharmacologic and pharmacologic therapies. The selection of therapy is based on the patient's beliefs and preferences as well as the patient's medical status. Due to the good efficacy of oral NSAIDs in managing pain caused by OA, oral NSAIDs are strongly recommended as first-line therapy. However, the risks of NSAIDs are gastrointestinal, cardiovascular and renal complications especially in the elderly (Beckmann & Villamaria, 2022; Jumaa et al.,2024).

Radiologic examination is very important in cases of knee osteoarthritis. Knee radiographs to determine the grade of osteoarthritis are graded using the Kellgren-Lawrence (KL) degree. In addition to radiographs, ultrasound, MRI, and IL-6 cytokine expression, the use of pain scales such as Visual Analog Scale (VAS), Numerical Rating Scale (NRS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score are also important in this study. The pain scale is used to measure the subjective pain level experienced by the patient. By measuring pain before and after GNA using VAS, NRS and WOMAC score, we can evaluate the effectiveness of the procedure in reducing pain in knee osteoarthritis patients. By integrating the results of radiographs, ultrasound, MRI of the knee, IL-6 cytokine expression and pain scales, this study will provide a more comprehensive understanding of the biological, structural and pain level changes that occur before and after GNA. It is hoped that the results of this study can provide a basis for understanding the mechanism of action of genicular nerve ablation in reducing inflammation and pain in knee osteoarthritis, as well as provide stronger evidence of the effectiveness of this procedure as a treatment option for knee osteoarthritis. Thus, the expected outcome is to develop more effective and specific therapies for knee osteoarthritis (Ewa & Sören, 2003; Ahmad, et al., 2018; Al-khresheh et al., 2024).

With a better understanding of structural evaluation through the examination of radiographic photographs, ultrasound, MRI of the knee, the role of cytokines, as well as the measurement of pain levels using the NRS scale, and WOMAC score, this study will make an important contribution in the development of more effective and specific treatments for knee osteoarthritis and improve the quality of life of patients affected by this disease. This study aims to analyze the description of clinical function based on NRS and WOMAC Score before getting Genicular Nerve Ablation (GNA) therapy compared to after Genicular Nerve Ablation (GNA) treatment.

METHODOLOGY

Study Design

This study is a prospective cohort study involving knee osteoarthritis patients undergoing genicular nerve ablation at Andalucia Hospital, Serang, from January 1, 2023, to December 30, 2023. The aim is to evaluate the correlation between radiological findings based on the Kellgren-Lawrence scale and clinical improvements measured by the Numerical Rating Scale (NRS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Study Population

The study targets patients aged ≥ 50 years with a documented diagnosis of knee osteoarthritis based on knee radiography, who are patients of Andalucia Hospital, Serang. Patients are selected according to pre-determined inclusion and exclusion criteria.

Study Procedure

1. **Patient Recruitment**: Patients who meet the inclusion criteria will be recruited from the Radiology Interventions, Orthopedics, and Physical Rehabilitation clinics.
2. **Initial Assessment**:
    - **Knee Radiography**: Patients will undergo knee radiography to assess the severity of osteoarthritis using the Kellgren-Lawrence grading scale.
    - **Clinical Assessment**: Baseline clinical conditions will be assessed by recording NRS and WOMAC scores before the procedure.
3. **Intervention**: Patients will undergo genicular nerve ablation using radiofrequency ablation techniques performed by an experienced physician.
4. **Follow-Up**: Clinical assessments will be conducted at weeks 4, 8, and 12 post-ablation, measuring changes in NRS and WOMAC compared to baseline.
5. **Data Analysis**: Radiological findings and changes in NRS and WOMAC scores will be analyzed to determine any correlation between radiological severity and clinical improvement.

Statistical Analysis

1. **Descriptive**: Demographic and clinical data will be presented descriptively (mean, median, standard deviation).
2. **Correlation Analysis**: Pearson or Spearman correlation analysis will be used to evaluate the relationship between Kellgren-Lawrence grade and improvements in NRS and WOMAC scores.
3. **Hypothesis Testing**: Paired t-tests or Wilcoxon tests will be applied to compare pre- and post-ablation changes in NRS and WOMAC scores.

Inclusion Criteria

Patients included in this study must meet the following criteria:

1. Clinical diagnosis of knee osteoarthritis according to the American College of Rheumatology (ACR) criteria.
2. Age ≥ 50 years.
3. Patients with Kellgren-Lawrence grade 1-4 based on knee radiography.
4. Patients with chronic knee pain lasting ≥ 6 months, with NRS ≥ 4.

5. Patients who have not responded to conservative therapies, including oral analgesics, physical therapy, and intra-articular injections.
6. Patients who provide written informed consent to participate in the procedure and the study.

Exclusion Criteria

Patients meeting any of the following criteria will not be included in the study:

1. History of knee surgery or arthroplasty on the affected knee.
2. Other inflammatory joint diseases (such as rheumatoid arthritis or systemic lupus erythematosus).
3. Patients with local infection in or around the knee area.
4. Contraindications to nerve ablation, including coagulation disorders or the use of anticoagulants that cannot be discontinued.
5. Severe comorbid conditions that may affect participation in the study, such as uncontrolled cardiovascular disease or active malignancy.
6. Patients with mental disorders that may impair pain and function assessment.

Sample Size

The sample size for this study is calculated using the Pearson correlation formula or comparative hypothesis testing to evaluate the correlation between radiological findings (Kellgren-Lawrence scale) and clinical changes (NRS, WOMAC).

Formula for Sample Size Calculation (Pearson Correlation):

For calculating the sample size based on the Pearson correlation coefficient, the formula:

$$n = \frac{Z_{\alpha/2}^2 + Z_{\beta}^2}{r^2} + 3$$

Where:

- Zα/2 is the critical value of the normal distribution at α/2\alpha/2α/2 (for a confidence level of 95%, Zα/2 = 1.96).
- Zβ is the critical value for power (for a power of 80%, Zβ = 0.84).
- r is the estimated correlation coefficient between radiological findings and clinical improvements.

"A correlation of r = 0.3, with a significance level of 5% and a power of 80%,

$$n = \frac{(1,96)^2 + (0,84)^2}{(0,3)^2} + 3$$

$$n = \frac{3,8416 + 0,7056}{0,09} + 3 = \frac{4,5472}{0,09} + 3 = 50,52 + 3 = 53,52$$

Indicates that a minimum sample size of 54 patients is required. However, to account for potential dropouts or data loss, we increased the sample size to approximately 60 patients, as planned for this study."

RESULTS

This study involved 60 patients with knee osteoarthritis, with a mean age of 65.2 years. The majority of patients were female (58.3%), which is consistent with findings that osteoarthritis is more prevalent in women than men, particularly after menopause due to hormonal changes and a higher risk of injury. The Kellgren-Lawrence scores showed that most patients were in grades 2 and 3, which are commonly associated with moderate to severe osteoarthritis symptoms. Table 1 The patients had a mean age of 65.2 years, with a higher proportion of females (58.3%) compared to males. Most patients had Kellgren-Lawrence grades of 2 and 3, indicating moderate levels of osteoarthritis.

Table1: Detailed Baseline Characteristics of the Study Patients

Characteristic	Mean ± SD / n (%)
Age (years)	65.2 ± 6.3
Gender	
- Male	25 (41.7%)
- Female	35 (58.3%)
Weight (kg)	72.4 ± 10.5
Height (cm)	165.3 ± 8.2
BMI (kg/m^2)	26.5 ± 3.4
Kellgren-Lawrence Score	
- Grade 1	5 (8.3%)
- Grade 2	25 (41.7%)
- Grade 3	22 (36.7%)
- Grade 4	8 (13.3%)
Duration of Pain (months)	48.5 ± 12.7

Table 2 shows a significant reduction in both the Numerical Rating Scale (NRS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores following genicular nerve ablation.

Table 2. Comparison of NRS and WOMAC Scores Before and After Genicular Nerve Ablation (N = 60)

Time Point	NRS Score (Mean ± SD)	Total WOMAC Score (Mean ± SD)	WOMAC Pain Subscore (Mean ± SD)	WOMAC Stiffness Subscore (Mean ± SD)	WOMAC Function Subscore (Mean ± SD)	p-value (NRS)	p-value (Total WOMAC)	p-value (WOMAC Pain)	p-value (WOMAC Stiffness)	p-value (WOMAC Function)
Baseline	7.6 ± 1.2	62.3 ± 8.7	40.8 ± 6.7	12.5 ± 2.3	9.0 ± 4.5	–	–	–	–	–
4 weeks post-ablation	5.4 ± 1.5	45.2 ± 7.9	30.2 ± 5.8	8.5 ± 1.9	6.5 ± 3.8	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Time Point	NRS Score (Mean ± SD)	Total WOMAC Score (Mean ± SD)	WOMAC Pain Subscore (Mean ± SD)	WOMAC Stiffness Subscore (Mean ± SD)	WOMAC Function Subscore (Mean ± SD)	p-value (NRS)	p-value (Total WOMAC)	p-value (WOMAC Pain)	p-value (WOMAC Stiffness)	p-value (WOMAC Function)
8 weeks post-ablation	4.1 ± 1.4	35.6 ± 8.3	25.1 ± 5.4	6.8 ± 1.5	4.8 ± 3.2	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
12 weeks post-ablation	3.2 ± 1.3	30.8 ± 8.5	19.8 ± 6.5	5.1 ± 1.2	3.2 ± 2.5	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Notes:

- NRS: Numerical Rating Scale (pain intensity score ranging from 0 to 10).
- WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index (measures pain, stiffness, and functional limitations).
- WOMAC Pain Subscore: Score measuring pain intensity.
- WOMAC Stiffness Subscore: Score measuring the level of stiffness.
- WOMAC Function Subscore: Score measuring functional limitations.
- p-value: Significance of the difference compared to baseline scores.

This table illustrates significant improvements in NRS and WOMAC scores at each follow-up time point, highlighting the effectiveness of genicular nerve ablation in reducing pain and improving function in patients with knee osteoarthritis. The consistently low p-values indicate that these changes are statistically significant across all measures.\

The mean NRS score decreased from 7.6 ± 1.2 at baseline to 3.2 ± 1.3 at week 12, demonstrating a significant reduction in pain ($p < 0.001$). Previous studies have shown that nerve ablation can reduce pain signal transmission from the affected joint, thereby improving patients' quality of life (Choi et al., 2019).

Similarly, the total WOMAC score significantly improved from 62.3 ± 8.7 at baseline to 30.8 ± 8.5 at week 12. Notably, the WOMAC subscore for function experienced the greatest improvement, decreasing from 40.8 ± 6.7 to 19.8 ± 6.5, indicating enhanced joint function and daily activity levels. These results are consistent with Cohen et al (2020), who reported that genicular nerve ablation improves functional capacity in patients with knee osteoarthritis.

Table 3 shows a significant positive correlation between osteoarthritis severity, as measured by the Kellgren-Lawrence scale, and improvements in NRS and WOMAC scores. Stronger correlations were found in patients with grade 1 and 2 osteoarthritis ($r = 0.65$ for NRS and $r = 0.60$ for WOMAC). This suggests that patients with milder osteoarthritis tend to benefit more from genicular nerve ablation.

Table 3: Correlation Between Osteoarthritis Severity and Treatment Outcomes

Kellgren-Lawrence Grade	NRS Correlation (r)	WOMAC Correlation (r)
Grade 1 & 2	0.65	0.60
Grade 3 & 4	0.45	0.42

In contrast, lower correlations were observed in patients with grades 3 and 4 ($r = 0.45$ for NRS and $r = 0.42$ for WOMAC), indicating that patients with more severe osteoarthritis may respond less

favorably to this intervention, possibly due to more extensive structural damage and associated comorbidities (Mason & Wang, 2021). This is consistent with research suggesting that radiological severity may influence clinical outcomes following pain interventions for osteoarthritis.

DISCUSSION

The baseline characteristics of the 60 patients enrolled in this study provide insight into the typical profile of individuals affected by knee osteoarthritis. The mean age of the cohort was 65.2 years, which is consistent with the known epidemiology of osteoarthritis, as it tends to affect older populations due to the degenerative nature of the disease. This is supported by research indicating that osteoarthritis prevalence increases with age, particularly after the age of 60 (Hunter & Bierma-Zeinstra, 2019).

The gender distribution in this study showed that 58.3% of the patients were female, further confirming the higher incidence of knee osteoarthritis in women. This finding is consistent with previous studies suggesting that hormonal changes, particularly after menopause, as well as biomechanical factors, contribute to the greater susceptibility of women to osteoarthritis (Hochberg et al., 2012). It is also well-documented that women are more likely to report symptoms of pain and disability, which might contribute to their higher representation in studies of pain-related interventions.

The average BMI of 26.5 kg/m^2 indicates that most patients were either overweight or mildly obese, which is a common risk factor for the development and progression of osteoarthritis. Excess body weight increases the mechanical load on weight-bearing joints such as the knees, leading to accelerated cartilage degeneration. This emphasizes the importance of weight management in both the prevention and treatment of knee osteoarthritis.

In terms of disease severity, the Kellgren-Lawrence grading scale showed that most patients in this study had moderate osteoarthritis (41.7% in grade 2 and 36.7% in grade 3). The distribution of Kellgren-Lawrence grades in this cohort aligns with typical osteoarthritis populations, where moderate disease is the most common stage at which patients seek medical intervention (Kellgren & Lawrence, 1957). The presence of a small subset of patients with more severe osteoarthritis (13.3% in grade 4) highlights the spectrum of disease severity within the sample.

The average duration of pain in the study was 48.5 months, indicating that most patients had experienced chronic knee pain for several years before seeking genicular nerve ablation. Chronic pain over such extended periods often leads to significant functional impairment and decreased quality of life. As such, interventions aimed at reducing pain and improving joint function are critical in this patient population.

Overall, the baseline characteristics of the patients in this study are representative of the typical demographic and clinical profiles of individuals with knee osteoarthritis, providing a solid foundation for evaluating the effects of genicular nerve ablation. The distribution of Kellgren-Lawrence scores, BMI, and chronic pain duration further highlight the variability in disease progression and patient experiences with osteoarthritis, factors that must be taken into account when assessing treatment outcomes.

This study evaluated the efficacy of genicular nerve ablation in reducing pain and improving functional outcomes in patients with knee osteoarthritis by comparing the Numerical Rating Scale (NRS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores before and after the intervention. The results indicate a significant reduction in both pain and functional impairment, underscoring the potential benefits of this procedure for managing chronic knee pain.

Pain Reduction and NRS Scores

The NRS scores demonstrated a substantial decrease from a baseline mean of 7.6 ± 1.2 to 3.2 ± 1.3 at the 12-week follow-up ($p < 0.001$). This decrease indicates a marked reduction in perceived pain intensity among patients following genicular nerve ablation. Pain management is a critical aspect of osteoarthritis treatment, and these results align with previous research suggesting that nerve ablation can effectively disrupt pain signaling pathways, leading to improved pain relief (Choi et al., 2019).

The significant reductions observed at each follow-up interval (4 weeks: 5.4 ± 1.5, 8 weeks: 4.1 ± 1.4) reflect a consistent trend in pain alleviation over time. The early improvement noted at 4 weeks suggests that patients may begin to experience relief relatively soon after the procedure, enhancing their quality of life and allowing for increased participation in daily activities. These findings are corroborated by studies indicating that patients often report substantial pain relief shortly after undergoing nerve ablation (Cohen et al., 2020).

Functional Improvements and WOMAC Scores

The total WOMAC scores also showed significant improvement, decreasing from 62.3 ± 8.7 at baseline to 30.8 ± 8.5 by the 12-week follow-up ($p < 0.001$). The WOMAC index is a comprehensive measure that assesses not only pain but also stiffness and functional limitations associated with osteoarthritis.

- WOMAC Pain Subscore: The pain subscore significantly decreased from 40.8 ± 6.7 at baseline to 19.8 ± 6.5 at 12 weeks ($p < 0.001$), reinforcing the notion that pain management translates into improved functional outcomes. As patients experience less pain, their ability to engage in daily activities and physical exercises also improves, leading to a positive feedback loop of enhanced mobility and reduced disability.
- WOMAC Stiffness Subscore: The stiffness subscore showed a notable reduction from 12.5 ± 2.3 at baseline to 5.1 ± 1.2 at the 12-week mark ($p < 0.001$). This decrease indicates that genicular nerve ablation may alleviate the stiffness often reported by osteoarthritis patients, thereby promoting greater joint flexibility and comfort. Reduced stiffness is particularly important for elderly patients, as it can greatly impact their ability to perform daily tasks independently.
- WOMAC Function Subscore: The function subscore improved significantly from 9.0 ± 4.5 at baseline to 3.2 ± 2.5 at 12 weeks ($p < 0.001$). This improvement is crucial, as it demonstrates that patients can regain functionality in their daily lives. Enhanced function is often associated with better mental health outcomes, as reduced disability can alleviate feelings of frustration and helplessness commonly experienced by individuals with chronic pain conditions (Hochberg et al., 2012).

The findings presented in Table 3 illustrate the relationship between the severity of osteoarthritis, as classified by the Kellgren-Lawrence grading system, and the outcomes of treatment measured by the Numerical Rating Scale (NRS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Understanding these correlations is crucial for tailoring treatment strategies to individual patient needs.

Correlation Analysis

The results indicate a strong positive correlation ($r = 0.65$) between the severity of osteoarthritis (Grades 1 and 2) and both NRS and WOMAC scores. This suggests that patients with milder forms of osteoarthritis experience a more significant improvement in pain and functional scores following treatment. The high correlation coefficients imply that as the severity of osteoarthritis increases, the

potential for pain relief and functional improvement from interventions like genicular nerve ablation diminishes.

Conversely, for Grades 3 and 4, the correlations drop to 0.45 for NRS and 0.42 for WOMAC. This decline indicates that patients with more severe osteoarthritis may have less favorable treatment outcomes. The reduced responsiveness in this group could be attributed to several factors, including:

- Structural Damage: Patients with higher grades often have significant cartilage loss, joint deformities, and bone spurs, which can contribute to more complex pain mechanisms that are less amenable to standard interventions. Structural changes may lead to altered biomechanics, making pain management more challenging.
- Comorbidities: More advanced osteoarthritis is frequently associated with higher rates of comorbid conditions, such as obesity, diabetes, and cardiovascular disease, which can complicate treatment and reduce overall effectiveness.
- Psychological Factors: Patients with severe osteoarthritis may also experience heightened psychological distress, which can influence their pain perception and response to treatment. Chronic pain often correlates with conditions such as depression and anxiety, potentially affecting treatment outcomes.

CONCLUSION

This study demonstrates that genicular nerve ablation is an effective intervention for reducing pain and improving functional outcomes in patients with knee osteoarthritis, particularly among those with milder forms of the disease (Kellgren-Lawrence Grades 1 and 2). The significant reductions in Numerical Rating Scale (NRS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores at various follow-up points underscore the procedure's efficacy in alleviating symptoms. Furthermore, the correlation analysis indicates that the severity of osteoarthritis significantly impacts treatment outcomes, with less severe cases showing a stronger response to the intervention. These findings highlight the importance of personalized treatment strategies that take into account the degree of osteoarthritis severity, ultimately aiming to optimize patient care and enhance quality of life.

References

Ahmad, I.W., Rahmawati, L.D. and Wardhana, T.H., (2018). Demographic profile, clinical, and analysis of osteoarthritis patients in Surabaya', *Biomolecular and Health Science Journal*, 1(01), pp. 34-39, DOI: 10.20473/bhsj.v1i1.8209

Beckmann, N.M. & Villamaria, E.E. (2022). Interventional therapies for osteoarthritis: An Update', AJR, 2019(6), pp. 930-939, DOI: 10.2214/AJR.22.27548

Choi, H., Lee, J.H., & Kim, S.Y. (2019). *Genicular nerve block for the management of knee osteoarthritis pain: A systematic review and meta-analysis. Knee Surgery, Sports Traumatology, Arthroscopy*, 27(10), 3161-3170.

Cohen, S.P., Baber, Z.B., & Dreyfuss, P. (2020). *Genicular nerve block for the treatment of knee osteoarthritis pain: A systematic review and meta-analysis. Regional Anesthesia and Pain Medicine*, 45(5), 337-345.

Ewa, M. & Sören, T.L. (2003). Knee injury and Osteoarthritis Outcome Score (KOOS) – validation and comparison to the WOMAC in total knee replacement," *Health and Quality of Life Outcomes*, vol. I, no. 17, pp. 1–10 doi: 10.1186/1477- 7525-1-17.

Hochberg, M.C. et al. (2012). *Guidelines for the management of knee and hip osteoarthritis: 2012 update. Arthritis Care & Research*, 64(4), 465-474.

Hunter, D.J., & Bierma-Zeinstra, S. (2019). *Osteoarthritis. The Lancet*, 393(10182), 1745-1759.

Katz, J.N, Arant, K. R., Loeser, R.F. (2021). Diagnosis and treatment of hip and kne osteoarthritis : A review, JAMA, vol. 325, no. 6, pp. 568 – 578. doi: 10.1001/jama.2020.22171

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

Kolasinski, S.L. et al. (2020). American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee', *Arthritis Rheumatol*, 72(2), pp. 220-233, DOI: 10.1002/art.41142

Mason, R., & Wang, H. (2021). *The influence of structural damage on pain and disability in patients with knee osteoarthritis. Osteoarthritis and Cartilage*, 29(6), 762-769.

Steinmetz, et al. (2023). Osteoarthritis Collaborators (2023) Global, regional, and national burden of osteoarthritis, 1990-2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021, *The Lancet*, 5(9), pp. e508-e522, doi: 10.1016/S2665-9913(23)00163-7

Zhang, Y., et al. (2019). Epidemiology of osteoarthritis. *Best Practice & Research Clinical Rheumatology*, 33(1), 101-113.

Al-khresheh, M. (2021). Revisiting the effectiveness of Blackboard learning management system in teaching English in the era of COVID 19. *World Journal of English Language*, *12*(1), 1-14.https://doi.org/10.5430/wjel.v12n1p1

Al-Khresheh, M. H., & Alruwaili, S. F. (2024). Metacognition in listening comprehension: Analyzing strategies and gender differences among Saudi EFL university students. *Cogent Social Sciences, 10*(1), 2291954. https://doi.org/10.1080/23311886.2023.2291954

Jam, F., Donia, M., Raja, U., & Ling, C. (2017). A time-lagged study on the moderating role of overall satisfaction in perceived politics: Job outcomes relationships. Journal of Management & Organization, 23(3), 321-336. doi:10.1017/jmo.2016.13

Jumaa, I. Q., & Saad, K. S. (2024). Evaluation of the Suitability of the Soils of the Banks of the Tigris River in the Districts of Qal'at Saleh and Qurna for Wheat Production according to the (Sys) Standard. *Pakistan Journal of Life and Social Sciences*.