



Clinical Outcomes of Patients with a History of Rheumatoid Arthritis Undergoing Lumbar Spine Surgery

Nasrin Bazgir¹, Sahar Heidari², Masoud Hatefi^{3*}

¹Non-Communicable Diseases Research Center, Razi Hospital, School of Medicine, Ilam University of Medical Sciences, Ilam, Iran.

²Department of Medical Surgical Nursing, School of Nursing and Midwifery, Mazandaran University of Medical Sciences, Mazandaran, Iran.

³Non-Communicable Diseases Research Center, Department of Neurosurgery, Emam Khomeini Hospital, School of Medicine, Ilam University of Medical Sciences, Ilam, Iran.

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ABSTRACT

Background: Rheumatoid arthritis (RA) negatively affects various aspects of patients' lives and is characterized by mild to severe joint inflammation. This study aimed to evaluate the clinical outcomes of patients with a history of rheumatoid arthritis undergoing lumbar spine surgery.

Methods: In this retrospective case-control study, medical records of patients hospitalized in Ilam hospitals who underwent surgery for LSS during 2024–2025 were reviewed. Data were collected using a demographic information form, a checklist of disease-related complications, and the Visual Analogue Scale (VAS) for assessing back and leg pain, which rates pain intensity from 0 to 10. Data analysis was performed using SPSS version 16, employing an independent samples t-test, chi-square/Fisher's exact tests, and descriptive statistics (mean $\pm$ SD, N%), with a significance level of less than 0.05.

Results: The results showed that the mean leg pain score at baseline was higher in the RA group compared with the non-RA group (9.45 ± 0.81 vs. 8.82 ± 0.93), with a statistically significant difference ($P=0.002$). Leg pain markedly decreased in both groups during follow-up, reaching 2.35 ± 0.62 in the RA group and 1.17 ± 1.05 in the non-RA group at 6 months after surgery ($P<0.001$). After 12 months, the mean leg pain scores further decreased to 0.92 ± 0.23 in the RA group and 0.67 ± 0.43 in the non-RA group, and the difference between the groups remained statistically significant ($P<0.01$).

Conclusion: Based on the findings, both back pain and leg pain significantly decreased in the RA and non-RA groups during the 12-month follow-up after surgery. Although patients with RA had higher baseline pain scores and continued to report slightly higher pain levels during follow-up, substantial improvement was observed in both groups over time. Overall, the results suggest that the surgical intervention was effective in reducing postoperative back and leg pain in both RA and non-RA patients.

The authors declare no conflicts of interest.

*Corresponding author.

E-mail address: masoudhatefi46@gmail.com

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Introduction

Chronic diseases are a group of illnesses that, due to their persistent nature, leave irreversible complications for patients. These complications can include physical and psychological effects that impact all dimensions of a patient's health. Chronic diseases encompass various types, such as cancer, patients undergoing hemodialysis, cardiovascular patients, patients with diabetes, patients with neurological disorders, and rheumatoid arthritis (RA), among others [1-2]. Rheumatoid arthritis (RA) is a chronic systemic disease with a notable prevalence. Disease-modifying antirheumatic drugs (DMARDs) have been widely used in these patients, and various new drugs have been employed recently. RA is one of the most common autoimmune diseases and a chronic systemic inflammatory disease affecting the joints, leading to their destruction, deformity, or reduced function [3-5]. RA, as a chronic illness, impacts patients' functional status and reduces life expectancy, potentially causing significant social and relational problems. Although the exact causes of RA are not fully understood, endocrine, metabolic, genetic factors, occupation, nutrition, geographical location, and psychosocial differences are recognized as contributing factors in its development. RA occurs across all races, geographical regions, and age groups, with its prevalence increasing with age. While present at various ages, RA is reported to be most prevalent between the ages of 40 and 60 [6-8].

Rheumatoid arthritis negatively affects the lives of affected individuals and is characterized by mild to severe joint inflammation. RA can be accompanied by pain, stiffness, joint destruction, physical deformity, and disability [9-10].

Chronic pain is a prevalent symptom and a major source of stress in rheumatoid arthritis (RA). RA-related pain is not only an unpleasant physical experience but is also unpredictable and uncontrollable due to its perceived intensity and duration. Patients with chronic pain often have negative and maladaptive evaluations of their condition and their ability to manage it. Patients with RA frequently use non-steroidal anti-inflammatory drugs (NSAIDs) at full doses to reduce pain and inflammation. However, this class of drugs carries various side effects, including renal complications, gastrointestinal bleeding, wound irritation, and increased mortality [11-14]. RA leaves many direct and indirect complications for patients. Among these complications are negative impacts on the outcomes of neurological and neurosurgical patients. For example, in patients with spinal stenosis, due to the changes RA causes in quality of life and patient disability, these alterations may also affect the prognosis and outcome of surgery. RA can affect the spine with various abnormalities, including gait

disturbances and hip and knee disorders [9,14-15]. In fact, RA can manifest as spinal stenosis, spondylolisthesis, and low back pain. Furthermore, patients with RA suffer from complications such as surgical site infections, vertebral fractures, and the need for corrective surgeries after spinal procedures [16-18]. Considering the above, this study aimed to evaluate the clinical outcomes of patients with a history of rheumatoid arthritis undergoing lumbar spine surgery.

Methods

Study design

This retrospective case-control study (Ethical Code in Research: IR.MEDILAM.REC.1404.150) reviewed the records of patients admitted to hospitals in Ilam City who underwent lumbar spine surgery for lumbar spinal stenosis (LSS) during 2024–2025.

Sample size justification

A post-hoc power analysis indicated that a sample size of 40 patients per group would provide approximately 80% power to detect a moderate effect size ($d=0.6$) in pain score differences between groups at a significance level of 0.05.

Inclusion criteria

Inclusion criteria for the study included the completeness of the patient's clinical record according to the information requested in the researcher-made checklist; performance of lumbar spine surgery for all patients; patient's availability for phone contact; at least one-day hospitalization in the ICU; the patient's full awareness and consciousness of the pain intensity status before and after surgery; presence of patients with a history of RA (case group) and patients without a history of RA (control group); and age over 20 years.

Exclusion criteria

Exclusion criteria included incomplete patient information and patients' inability to recall their exact pain intensity at the times investigated by the researchers.

Variables

The data used included information from the demographic information form (which contained details on age, sex, current smoker status, diabetes mellitus, RA disease, history of heart disease, history of total knee arthroplasty, osteoporosis, and complications). Complications included information on adverse events such as wound infection, urinary tract infection, pulmonary embolism, pneumonia, and deep venous thrombosis. Furthermore, to assess back pain and leg pain, the VAS (Visual Analogue Scale) pain assessment tool was used, which measures pain intensity from 0 to 10.

Ethics in Research

To adhere to research ethics, all patient information was kept confidential, and patients made voluntary decisions regarding their participation in the study. Other ethical considerations included obtaining permission from the relevant authorities of Ilam University of Medical Sciences and acquiring the research ethics code from the university.

Statistical Analysis

For data analysis, SPSS version 16 software was used, and statistical tests such as independent samples t-test, chi-square/Fisher's exact, mean $\pm$ SD, and N (%) were applied at a significance level of less than 0.05.

Results

The results showed that the mean age of patients was similar between the RA and non-RA groups, and the difference was not statistically significant ($P = 0.24$). In addition, no significant difference was observed between

the groups regarding gender distribution ($P = 0.16$). However, the prevalence of current smoking was significantly higher in the RA group compared with the non-RA group (40% vs. 17.5%, $P = 0.02$). Furthermore, the rate of total knee arthroplasty (TKA) did not differ significantly between the two groups ($P = 0.37$). The incidence of complications within three months after discharge was also low and showed no statistically significant difference between the groups ($P = 0.15$), including wound infection, urinary tract infection, and pulmonary embolism (Table 1).

The findings showed that the mean back pain score was higher in the RA group than in the non-RA group at baseline (9.32 ± 0.88 vs. 8.62 ± 0.95), with a statistically significant difference ($P=0.001$). Back pain significantly decreased in both groups during follow-up, and at 6 months, the mean scores reached 2.27 ± 0.59 in the RA group and 0.75 ± 0.45 in the non-RA group ($P<0.001$). After 12 months, back pain further decreased to 0.87 ± 0.55 in the RA group and 0.37 ± 0.34 in the non-RA group, while the difference between the two groups remained statistically significant ($P=0.001$). (Table 2).

Table 1- Demographic and clinical characteristics of patients

Variable	RA (n=40)	Non-RA (n=40)	P value
Age, mean (SD)	59.40 (9.68)	56.75 (10.32)	0.24
Gender, n (%)			0.16
• Male	17 (42.5)	11 (27.5)	
• Female	23 (57.5)	29 (72.5)	
Current smoker, n (%)			0.02
• Yes	16 (40)	7 (17.5)	
• No	24 (60)	33 (82.5)	
Diabetes mellitus, n (%)			0.17
• Yes	10 (25)	11 (27.5)	
• No	30 (75)	29 (72.5)	
History of heart disease, n (%)			0.01
• Yes	10 (25)	21 (52.5)	
• No	30 (75)	19 (47.5)	
TKA, n (%)			0.37
• Yes	5 (12.5)	8 (20)	
• No	35 (87.5)	32 (80)	
Osteoporosis, n (%)			0.63
• Yes	21 (52.5)	13 (32.5)	
• No	19 (47.5)	27 (67.5)	
Complications within 3 months after discharge, n (%)			0.15
• Wound infection	3 (7.5)	1 (2.5)	
• Urinary tract infection	2 (5)	1 (2.5)	
• Pulmonary embolism	1 (2.5)	0 (0)	
• Pneumonia	0 (0)	0 (0)	
• Deep venous thrombosis	0 (0)	0 (0)	

Table 2- Comparison of postoperative back pain between RA and non-RA groups.

Variable	RA Mean (SD)	Non-RA Mean (SD)	P value
Baseline	9.32 (0.88)	8.62 (0.95)	0.001
After 6 months	2.27 (0.59)	0.75 (0.45)	<0.001
After 12 months	0.87 (0.55)	0.37 (0.34)	0.001

The results showed that the mean leg pain score at baseline was higher in the RA group compared with the non-RA group (9.45 ± 0.81 vs. 8.82 ± 0.93), with a statistically significant difference ($P=0.002$). Leg pain markedly decreased in both groups during follow-up, reaching 2.35 ± 0.62 in the RA group and 1.17 ± 1.05 in the non-RA group at 6 months after surgery ($P<0.001$). At 12 months after surgery, the mean leg pain score remained significantly higher in the RA group than in the non-RA group (0.92 ± 0.23 vs. 0.67 ± 0.43 , $P = 0.007$). (Table 3). To account for baseline differences, multivariable regression analysis was performed, adjusting for a history of heart disease and other relevant covariates. After adjustment, RA status remained independently associated with higher postoperative pain scores. In the multivariable regression model, a history of cardiovascular disease was associated with a slight increase in 12-month leg pain, but this relationship was not statistically significant ($B = 0.292$, $p = 0.130$).

Thus, the differences in pain levels cannot be explained solely by cardiovascular comorbidities. Other factors, including RA-related characteristics and clinical variables, appear to play a more important role in determining long-term pain intensity (Table 4). In the multivariable regression analysis for 12-month back pain, none of the evaluated variables—including age, gender, diabetes, and history of cardiovascular disease—showed

a statistically significant association (all $p > 0.05$). Although TKA and osteoporosis demonstrated a trend toward association, they did not reach statistical significance. Therefore, no independent predictors of long-term postoperative back pain were identified in this model (Table 5).

Discussion

Pain as a key postoperative and disease-related outcome

Lumbar spine disorders and their surgical treatment may be associated with several postoperative consequences. Patients may experience persistent pain in the back, legs, and knees, along with reduced physical functioning and emotional distress. In addition, these conditions can affect social and marital relationships and impose economic burdens due to treatment costs and work limitations, leading patients to adopt various coping strategies such as pain acceptance and passive adaptation [19]. Pain is one of the main symptoms in patients with spinal injuries. In the study by Weber et al., among 202 patients, the severity of spinal canal stenosis ranged from mild to very severe, but this severity was not associated with the level of pain or disability before surgery or one year after the operation [20].

Table 3- Comparison of postoperative leg pain between RA and non-RA groups.

Variable	RA Mean (SD)	Non-RA Mean (SD)	P value
Baseline	9.45 (0.81)	8.82 (0.93)	0.002
After 6 months	2.35 (0.62)	1.17 (1.05)	<0.001
After 12 months	0.92 (0.23)	0.67 (0.43)	0.007

Table 4- Predictors of postoperative leg pain at 12 months – multivariable regression analysis.

Variable	B	Sig	95.0% Confidence Interval for B	
			Lower Bound	Upper Bound
Age	0.006	0.538	-0.013	0.024
Gender	-0.164	0.435	-0.579	0.252
Current smoker	-0.806	0.000	-1.237	-0.375
Diabetes mellitus	-0.438	0.080	-0.930	0.054
History of heart disease	0.292	0.130	-0.088	0.671
TKA	0.412	0.092	-0.069	0.894
Osteoporosis	-0.405	0.004	-0.678	-0.133
Complications	-0.145	0.038	-0.281	-0.009

Table 5- Predictors of postoperative back pain at 12 months – multivariable regression analysis.

Variable	B	Sig	95.0% Confidence Interval for B	
			Lower Bound	Upper Bound
Age	-0.010	0.218	-0.026	0.006
Gender	-0.109	0.557	-0.479	0.260
Current smoker	-0.182	0.345	-0.565	0.200
Diabetes mellitus	0.095	0.668	-0.343	0.532
History of heart disease	0.139	0.413	-0.198	0.477
TKA	0.364	0.094	-0.064	0.792
Osteoporosis	-0.218	0.076	-0.460	0.023
Complications	0.018	0.763	-0.103	0.139

In the study by Verma et al., patients with leg pain initially had greater disability, and although they showed a greater reduction in leg pain after surgery, they still experienced more pain and disability compared with the group without leg pain. Overall, ASD patients with radiculopathy experience higher levels of pain and disability before surgery and continue to do so even after surgical correction [21]. The findings of this study are consistent with the results of the aforementioned studies regarding the presence of pain in patients with LSS.

In the study by Gulati et al., lumbar spinal stenosis-related surgical outcomes were investigated among patients with RA. A total of 1,130 individuals were assigned to the control group and 29 to the RA group. Eighteen RA patients (48.6%) had other health problems, such as cardiovascular disease in nine (24.3%), cerebrovascular disease in one (2.7%), chronic lung disease in two (5.4%), hypertension in nine (24.3%), cancer in two (5.4%), diabetes in two (5.4%), and other endocrine disorders in one (2.7%). Regarding back pain, the mean baseline pain score in the control group was 6.6, decreasing to 3.8 after one year. In the RA group, the baseline mean was 7.3, which decreased to 4 after one year. The mean change in pain score was 3.8 in the control group and 3.5 in the RA group ($P=0.19$). For leg pain, the mean baseline pain score in the control group was 6.6, decreasing to 3.6 after one year. In the RA group, the baseline mean was 7.3, decreasing to 4.3 after one year. The mean change in leg pain was 3.1 in the control group and 3.0 in the RA group ($P=0.92$) [22]. These data suggest that although RA patients start with higher pain, the rate of postoperative improvement is similar, but their “final pain level” remains higher, which is of clinical importance.

RA and postoperative course

In the study by Joo and colleagues, which systematically reviewed articles indexed in PubMed, the findings showed that patients with RA reported higher rates of postoperative complications after lumbar spine surgery as well as an increased incidence of vertebral fractures [23].

Sugita et al. also conducted an observational cohort study in which 103 patients with RA were evaluated between 2003 and 2011. The findings showed that RA patients who required cervical spine surgery had higher disease activity, a greater number of tender joints, and higher CRP levels compared with other RA patients [24]. Pain is one of the complications of LSS disease, and appropriate interventions should be implemented to reduce it [25].

Our study also indicated that RA patients have a similar pattern in terms of pain intensity. This is consistent with the pattern of Gulati and Joo's studies, which suggests that RA is more associated with a higher initial pain burden and a higher risk of complications. The higher

baseline pain observed in patients with rheumatoid arthritis (RA) can be attributed to the interaction between systemic inflammation and alterations in neural pain processing, particularly central sensitization. Additionally, the consequences of concomitant joint involvement and increased spinal vulnerability to osteoporotic vertebral fractures are recognized as key factors contributing to the persistence and exacerbation of pain in this population [26-27].

For rheumatologists and spine surgeons, it is essential that future research explores the impact of disease activity control, specific pharmacological treatments (including DMARDs and biologics), and the duration of rheumatoid arthritis on outcomes following lumbar and leg pain surgeries. Conducting multicenter, large-scale studies with long-term follow-up is critical to maximizing therapeutic strategies and minimizing postoperative complications. Collaborative efforts across specialized centers will facilitate a more profound understanding of these factors, ultimately supporting the development of evidence-based, personalized treatment protocols.

Study limitations and recommendations for future research

- Retrospective design (potential selection bias, missing data)

Future studies with prospective designs are recommended to minimize selection bias and allow more complete and standardized data collection.

- Small sample size (40 patients per group)

To increase statistical power and improve the reliability of the findings, larger multicenter studies with greater sample sizes are necessary.

- Single-center study (limited generalizability)

Conducting multicenter studies across different institutions would improve the generalizability of the results.

- Lack of RA disease activity markers

Future studies should include RA disease activity indicators such as DAS28, CRP, and ESR to better evaluate the impact of disease severity on surgical outcomes.

- Lack of functional outcome measures

Incorporating validated functional outcome measures and quality-of-life assessments would provide a more comprehensive evaluation of postoperative recovery.

- Short follow-up period (only 12 months)

Longer follow-up periods are recommended to evaluate long-term outcomes, complications, and potential need for reoperation.

Conclusion

Based on the findings, both back pain and leg pain significantly decreased in the RA and non-RA groups

during the 12-month follow-up after surgery. Although patients with RA had higher baseline pain scores and continued to report slightly higher pain levels during follow-up, substantial improvement was observed in both groups over time. Overall, the results suggest that the surgical intervention was effective in reducing postoperative back and leg pain in both RA and non-RA patients.

References

- [1] Aghamiri SH, Erfani A, Borji M. Investigating the Prevalence of Headache and Its Influencing Factors in the Intensive Care Unit. *Arch Anesth & Crit Care*. 2024; 11(2):150-154.
- [2] Sadeghi S, Dehghani-Ghorbi M, Kharazmi AB, Sheikholeslami SA, Delkash P. Survival in the Intensive Care Unit: A Prognosis Patient with Rheumatoid Diseases. *Arch Anesth & Crit Care*. 2025; 11(3):319-324.
- [3] Xie W, Chen T, Chen Y, Zhang Z, Xiao S. Associated lifestyle factors and comorbidities of difficult-to-treat rheumatoid arthritis: a systematic review and meta-analysis. *Lancet Rheumatol*. 2026; 8(6):e425-e437.
- [4] Wang F, Zhang H, Zhou D, Tang X, Wang J, et al. High-Efficiency Targeted Mitochondrial Transfer and AUTAC4-Enhanced Dual Renewal Strategy for Rheumatoid Arthritis. *Adv Mater*. 2026; 38(32):e14070.
- [5] Coghi P, Chen Z, Leong KF, Yu X, Hosmane NS, et al. Metal coordination-based nanomaterials: Novel drug delivery system for treatment of rheumatoid arthritis. *Coord Chem Rev*. 2026; 546:217049.
- [6] Sonomoto K, Nakayamada S, Fujino Y, Miyata H, Kubo S, et al. Biological/targeted synthetic DMARDs do not arrest bone loss in patients with rheumatoid arthritis: a multicenter prospective observational study. *Rheumatology (Oxford)*. 2024; 63(8):2239-2248.
- [7] Uke P, Maharaj A, Adebajo A. A review on the epidemiology of rheumatoid arthritis: An update and trends from current literature. *Best Pract Res Clin Rheumatol*. 2025; 39(1):102036.
- [8] Togashi T, Ishihara R, Watanabe R, Shiomi M, Yano Y, et al. Rheumatoid Factor: Diagnostic and Prognostic Performance and Therapeutic Implications in Rheumatoid Arthritis. *J Clin Med*. 2025; 14(5):1529.
- [9] Onobun DE, Hussain R, Lim G, Ojo EO, Orji C, et al. Evaluating Surgical Strategies for Adolescent Idiopathic Scoliosis: A Meta-Analysis of Posterior Spinal Fusion and Vertebral Body Tethering. *Cureus*. 2025; 17(8):e90739.
- [10] Zimba O, Baimukhamedov C, Kocyigit BF. Late-onset rheumatoid arthritis: clinical features, diagnostic challenges, and treatment approaches. *Rheumatol Int*. 2025; 45(6):152.
- [11] Kupczyk D, Bilski R, Szeleszczuk Ł, Mądra-Gackowska K, et al. The Role of Diet in Modulating Inflammation and Oxidative Stress in Rheumatoid Arthritis, Ankylosing Spondylitis, and Psoriatic Arthritis. *Nutrients*. 2025; 17(9):1603.
- [12] Sahin D, Di Matteo A, Emery P. Biomarkers in the diagnosis, prognosis and management of rheumatoid arthritis: A comprehensive review. *Ann Clin Biochem*. 2025; 62(1):3-21.
- [13] Wadström H, Askling J, Gedeberg R, Feltelius N, Hellgren K. Non-steroidal anti-inflammatory drugs and risk of kidney cancer: A Swedish nationwide cohort study in the general and high-use populations. *J Intern Med*. 2025; 297(5):505-517.
- [14] Makino T, Kaito T, Fujiwara H, Yonenobu K. Lumbar scoliosis in rheumatoid arthritis: epidemiological research with a DXA cohort. *Spine (Phila Pa 1976)*. 2013; 38(6):E339-43.
- [15] Jain H, Zakieh O, Zeoli T, Chanbour H, Paulson A, et al. Is rheumatoid arthritis associated with worse outcomes following adult spinal deformity surgery? *Clin Neurol Neurosurg*. 2025; 255:108967.
- [16] Crawford CH 3rd, Carreon LY, Djurasovic M, Glassman SD. Lumbar fusion outcomes in patients with rheumatoid arthritis. *Eur Spine J*. 2008; 17(6):822-5.
- [17] Park JS, Shim KD, Song YS, Park YS. Risk factor analysis of adjacent segment disease requiring surgery after short lumbar fusion: the influence of rheumatoid arthritis. *Spine J*. 2018; 18(9):1578-1583.
- [18] Seki S, Hirano N, Matsushita I, Kawaguchi Y, Nakano M, et al. Lumbar spine surgery in patients with rheumatoid arthritis (RA): what affects the outcomes? *Spine J*. 2018; 18(1):99-106.
- [19] Babae Z, Dehghani M, Babakhani B, Najafi MS. Lived Experiences of Patients who Suffer from Chronic Low Back Pain. *Iran J Nurs Res*. 2020; 15(4):44-57.
- [20] Weber C, Giannadakis C, Rao V, Jakola AS, Nerland U, et al. Is There an Association Between Radiological Severity of Lumbar Spinal Stenosis and Disability, Pain, or Surgical Outcome?: A Multicenter Observational Study. *Spine (Phila Pa 1976)*. 2016; 41(2):E78-83.
- [21] Verma R, Lafage R, Scheer J, Smith J, Passias P, et al. Improvement in Back and Leg Pain and Disability Following Adult Spinal Deformity Surgery: Study of 324 Patients With 2-year Follow-up and the Impact of Surgery on Patient-reported Outcomes. *Spine (Phila Pa 1976)*. 2019; 44(4):263-269.
- [22] Gulati A, Solberg T, Giannadakis C, Hoff M, Haugeberg G, et al. Surgery for lumbar spinal stenosis in patients with rheumatoid arthritis: A multicenter observational study. *Eur J Rheumatol*. 2016; 3(2):56-60.
- [23] Joo P, Ge L, Mesfin A. Surgical Management of the Lumbar Spine in Rheumatoid Arthritis. *Global Spine J*. 2020; 10(6):767-774.

- [24] Sugita S, Chikuda H, Kadono Y, Ohtsu H, Takeshita K, et al. Clinical characteristics of rheumatoid arthritis patients undergoing cervical spine surgery: an analysis of National Database of Rheumatic Diseases in Japan. *BMC Musculoskelet Disord.* 2014; 15:203.
- [25] Heine P, Hunter R, Booth A, Lamb SE, Williamson E, et al. The effectiveness of prehabilitation on post-operative recovery from lumbar spinal stenosis surgery - A systematic review and intervention component analysis. *Clin Rehabil.* 2026; 40(7):906-923.
- [26] Hladkykh FV, Liadova TI, Matvieienko MS, Komorovsky R, Smiyan S, et al. Central Sensitization and Nociceptive Pain: Shared Mechanisms in Fibromyalgia, Osteoarthritis, and Inflammatory Arthritis. *J Pain Res.* 2026; 19:571311.
- [27] Wang D, Li T, Wang W, Ruan Y, Cai J, et al. Pain mechanism and management strategy of rheumatoid arthritis. *Front Pain Res (Lausanne).* 2025; 6:1693399.