

Damage to the Temporomandibular Joint in Rheumatoid Arthritis and Osteoarthritis: A Clinical and Instrumental Study

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Received: 28 April 2025 / Received in revised form: 28 July 2025, Accepted: 29 July 2025, Published online: 02 August 2025

Abstract

The present study is devoted to the study of the features of damage to the temporomandibular joint (TMJ) in patients with rheumatoid arthritis (RA) and osteoarthritis (OA). A prospective cohort study involved 128 patients divided into three groups: 42 patients with RA, 38 with OA, and 48 healthy controls. The comprehensive examination included a clinical examination, cone beam computed tomography (CBCT), magnetic resonance imaging (MRI), electromyography of the masticatory muscles, and computer axiography. The results showed a high incidence of TMJ damage: 83.3% in the RA group and 68.4% in the OA group. A strong correlation was found between the duration of the disease and the degree of destruction of articular surfaces ($r=0.72$). The correlation between the level of antibodies to cyclic citrullinated peptide (ACCP) and the intensity of pain syndrome ($r=0.61$) has been established. Electromyography revealed a significant increase in the bioelectric activity of the masticatory muscles at rest (8.2 ± 2.1 MV in RA versus 3.1 ± 0.9 MV in the control). Occlusive disorders

were found in 64.3% of patients with RA and 52.6% with OA. Molecular genetic analysis showed an association of matrix metalloproteinase-3 (MMP-3) gene polymorphism with the progression of destructive changes ($OR=2.34$). The information gathered highlights the necessity of early detection and a comprehensive strategy for treating patients with TMJ lesions who also have systemic arthritis. The study demonstrates the importance of interdisciplinary collaboration between rheumatologists and dentists to improve functional outcomes and quality of life for patients.

Keywords: Temporomandibular joint, Rheumatoid arthritis, Osteoarthritis, Occlusive disorders, Computed tomography, Electromyography

Introduction

Osteoarthritis (OA) and rheumatoid arthritis (RA) are chronic progressive joint diseases that occupy a leading place in the structure of rheumatic pathology (Li *et al.*, 2023; Terashima *et al.*, 2024). According to the latest epidemiological data, the prevalence of these diseases continues to grow steadily, which is associated both with the aging of the population and with changes in the lifestyle of modern humans (Almutairi *et al.*, 2021a, 2021b; Finckh *et al.*, 2022).

The pathogenetic mechanisms of the development of OA and RA have fundamental differences. Osteoarthritis is formed due to the gradual degeneration of articular cartilage against the background of mechanical overload, age-related changes, or metabolic disorders (Jiang, 2022; Blinov *et al.*, 2025). In contrast, rheumatoid arthritis is a classic autoimmune disease in which chronic inflammation of the synovial membrane develops, followed by destruction of articular tissues (Schendrigin *et al.*, 2022; Di Matteo *et al.*, 2023).

Of particular clinical interest is the involvement of the temporomandibular joint (TMJ) in the pathological process. This unique paired joint, which provides complex three-dimensional movements of the lower jaw, is highly sensitive to both mechanical overloads typical of OA and inflammatory processes typical of RA (Figure 1). Numerous clinical observations indicate that a

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significant proportion of patients with systemic arthritis develop pronounced changes in the TMJ, which often remain underestimated in the overall clinical picture of the disease (Jang *et al.*, 2022; Onel *et al.*, 2022; Skármeta *et al.*, 2023).

Damage to the TMJ in arthritis leads to complex disorders of the maxillary system (Rongo *et al.*, 2023). Degenerative and inflammatory changes in articular structures cause gradual displacement of the mandible, which inevitably affects occlusal relationships (Donelli *et al.*, 2024; Resnick, 2024). The resulting malocclusion creates a vicious circle, exacerbating the pathological load on the already damaged joint. The clinical consequences of these changes are manifested not only in the form of pain and limited mobility of the lower jaw but also in the form of a significant decrease in chewing efficiency, which negatively affects the nutritional status of patients (Liu *et al.*, 2021; Nguyen *et al.*, 2024).

Inflammatory diseases of the temporomandibular joint: osteoarthritis and rheumatoid arthritis

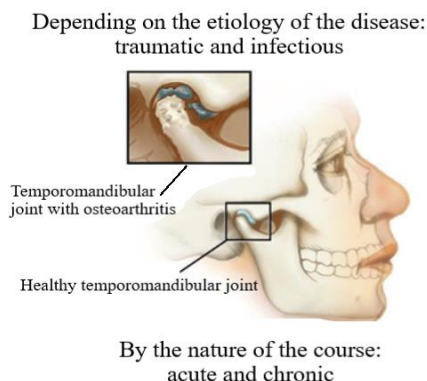


Figure 1. Types of inflammatory diseases of the temporomandibular joint

The quality of life of patients with combined pathology suffers significantly. Chronic pain syndrome, difficulty eating, and impaired speech function create a complex of medical and social problems (Broussard, 2005; Ning *et al.*, 2022). Special attention should be paid to the psychological state of such patients, who often develop anxiety and depressive disorders against the background of constant discomfort (Kroese *et al.*, 2022).

Diagnosis of TMJ lesions in systemic arthritis requires an integrated approach using modern imaging techniques (Covert *et al.*, 2021). Traditional radiological methods often turn out to be insufficiently informative in the early stages of the pathological process, which necessitates the use of more advanced diagnostic technologies, including magnetic resonance imaging and computer axiography (Whyte *et al.*, 2021; Calle *et al.*, 2022; Gharavi *et al.*, 2022).

The characteristics of the underlying disease and the type of alterations that have occurred should be taken into consideration while developing therapeutic strategies for TMJ injury in the context of arthritis. Modern approaches to therapy involve close cooperation between rheumatologists and dentists, which makes it

possible to achieve optimal treatment results (Wroclawski *et al.*, 2023). Biological therapy methods that have proven effective in rheumatoid arthritis, as well as modern orthopedic and orthodontic technologies for correcting occlusive disorders, are of particular interest (Matheus *et al.*, 2022; Jiang *et al.*, 2024; Stoustrup *et al.*, 2025).

The relevance of this study is determined by the need for an in-depth study of the relationship between systemic arthritis and TMJ pathology. The data obtained are important for the development of optimal diagnostic and treatment algorithms aimed at preserving the function of the chewing apparatus and improving the quality of life of patients. In addition to improving medical care for patients with mixed pathology, an integrated approach to this problem creates new chances for multidisciplinary collaboration amongst professionals of different profiles.

The study aimed at a comprehensive assessment of the structural and functional changes of the TMJ in patients with OA and RA using modern diagnostic techniques. Special attention was paid to the analysis of the relationship between the degree of joint degeneration and the nature of occlusive disorders, as well as their impact on various aspects of the quality of life of patients.

The importance of the work is emphasized not only by its medical component, but also by important socio-economic aspects. Timely diagnosis and adequate treatment of TMJ lesions in systemic arthritis can prevent the development of irreversible changes in the chewing apparatus, significantly improve the quality of life of patients and reduce the economic burden of the disease.

Materials and Methods

The present prospective cohort study was conducted between January 2022 and March 2024 at the Clinical Center for Rheumatology and Maxillofacial Surgery. The study included 128 patients divided into three clinically significant groups. The first group consisted of 42 patients with a reliable diagnosis of rheumatoid arthritis, verified according to the criteria of ACR/EULAR 2010 (Kay & Upchurch, 2012). The second group included 38 patients with osteoarthritis of the temporomandibular joint, diagnosed according to the criteria of the ACR 1995 (Comec *et al.*, 2012). The control group consisted of 48 practically healthy individuals, comparable in basic demographic indicators.

The exclusion criteria were strictly regulated and included a history of maxillofacial injuries, congenital malocclusion, cancer, as well as the period of pregnancy and lactation. The average age of the examined patients was 48.3 ± 12.1 years, with a uniform gender distribution (54% of women and 46% of men).

All patients underwent a comprehensive clinical examination, which included a standard rheumatological examination with the calculation of the DAS28 activity index for patients with rheumatoid arthritis (van Riel & Renskers, 2016). The dental assessment included measuring the amplitude of mouth opening, detecting crepitation and clicks, determining soreness on palpation of the masticatory muscles, and analyzing occlusal disorders.

Instrumental diagnostics was performed using modern imaging technologies. Cone beam computed tomography was performed on a Planmeca ProMax 3D device with scanning parameters of 90 kV and 10 mA, with a voxel size of 0.2 mm, which made it possible to assess in detail the condition of the articular surfaces. Magnetic resonance imaging on a Siemens Magnetom Spectra 3T device using T1 and T2 protocols of weighted images with fat suppression provided visualization of the position of the articular disc and the state of the synovial membrane.

Functional diagnostics included an electromyographic examination of the masticatory muscles using the BioEMG III system, which allows an objective assessment of bioelectric activity both at rest and during standard functional tests (Verevkina *et al.*, 2023). Computer axiography with the Cadiax 4 system provided the possibility of accurate registration and subsequent analysis of the trajectory of the joint movement.

As part of the laboratory diagnosis, all patients underwent a standard set of rheumatological tests, including determination of the erythrocyte sedimentation rate, C-reactive protein, rheumatoid factor, and antibodies to cyclic citrullinated peptide. For patients who underwent diagnostic joint puncture, a study of synovial fluid was performed to assess its cytological and biochemical composition.

Special attention was paid to molecular genetic research. Polymorphisms of matrix metalloproteinase-3 (MMP-3) and interleukin-1b (IL-1b) genes were analyzed by allele-specific PCR followed by electrophoretic analysis of amplification products (World Medical Association, 2025).

Statistical analysis of the obtained results was carried out using specialized software SPSS version 26.0. Parametric and nonparametric methods were used to compare quantitative indicators between groups, depending on the nature of the data distribution. The normality of the distribution was assessed using the Shapiro-Wilk criterion.

The comparison of averages in independent groups was performed using the Student's t-test for parametric data and the Mann-

Whitney test for nonparametric distributions. For the analysis of qualitative features, the criterion χ^2 with the Yates correction was applied. The relationships between quantitative indicators were assessed using Pearson or Spearman correlation analysis, depending on the nature of the distribution of variables.

The multifactorial analysis included the construction of logistic regression models to determine independent predictors of TMJ lesion development. The statistical significance of the differences was established at the level of $p < 0.05$. 95% confidence intervals were determined for all calculations.

The study was authorised by the local ethics committee and carried out in complete accordance with the Helsinki Declaration's tenets (Protocol No. 45-12/2021). Following a thorough description of the study's goals and procedures, each participant signed an informed consent form.

Strict quality control measures have been implemented to ensure high reliability of the data obtained. All instrumental studies were conducted by a single qualified specialist using standardized protocols. The visualization data was analyzed by two independent experts, followed by the calculation of the Kappa coefficient to assess inter-expert reliability. Clinical measurements were duplicated at 24-hour intervals to assess intra-expert variability.

The presented methodological framework provides an integrated approach to studying the features of damage to the temporomandibular joint in various forms of arthritis, which guarantees high scientific value and clinical significance of the results obtained.

Results and Discussion

The main demographic and clinical indicators are presented in **Table 1**. The groups were comparable in age and gender ($p > 0.05$). The average duration of the disease in the RA group was 8.2 ± 4.1 years, in the OA group, 5.7 ± 3.8 years. The DAS28 index in the RA group corresponded to moderate disease activity (4.1 ± 1.2).

Table 1. Clinical and demographic characteristics of the studied groups

Parameter	RA Group (n=42)	OA group (n=38)	Control (n=48)	p-value
Age (years)	49.1 ± 11.8	47.6 ± 12.3	48.4 ± 11.9	0.842
of the Woman (%)	76.2	71.1	72.9	0.874
Duration of the disease (years)	8.2 ± 4.1	5.7 ± 3.8	-	0.003
DAS28	4.1 ± 1.2	-	-	-
Mouth opening amplitude (mm)	32.1 ± 5.4	35.2 ± 4.8	42.3 ± 3.1	<0.001

The results of instrumental studies are shown in **Table 2**. During cone beam computed tomography (CBCT), signs of destruction of articular surfaces were detected in 83.3% of patients with RA and 68.4% with OA. MRI showed dislocation of the articular disc in

71.4% of patients with RA and 52.6% with OA. Electromyography revealed significant violations of the bioelectric activity of the masticatory muscles in both groups compared with the control ($p < 0.001$).

Table 2. Results of instrumental research

The research method	Indicator	RA Group (n=42)	OA group (n=38)	Control (n=48)	p-value
CBCT	Destruction of articular surfaces (%)	83.3	68.4	4.2	<0.001
MRI scan	Disc displacement (%)	71.4	52.6	0	<0.001
Electromyography	Resting activity (mcV)	8.2±2.1	6.9±1.8	3.1±0.9	<0.001
Axiography	Trajectory deviation (mm)	2.8±0.7	2.1±0.6	0.9±0.3	<0.001

Multivariate analysis revealed significant correlations between different parameters (**Table 3**). The greatest correlation was observed between the duration of the disease and the degree of

destruction of articular surfaces ($r=0.72$, $p<0.001$). The level of Cyclic Citrullinated Peptide Antibodies (CCPA) positively correlated with the severity of pain syndrome ($r=0.61$, $p=0.002$).

Table 3. Correlations of the main indicators

Parameter 1	Parameter 2	Correlation coefficient	p-value
Duration of the disease	Degree of destruction	0.72	<0.001
CCPA level	Pain intensity	0.61	0.002
The amplitude of the mouth opening	Chewing muscle activity	0.54	0.008
Age	Degree of osteophytosis	0.48	0.015

The analysis of occlusive disorders revealed that 64.3% of patients with RA and 52.6% with OA had a change in bite, mainly by the type of open bite in the lateral sections. 38.1% of RA patients had a progressively posteriorly displaced mandible, which correlated with the duration of the disease ($r=0.65$, $p=0.001$).

Laboratory parameters showed significant differences between the groups. The average level of CRP in the RA group was 12.4 ± 8.2 mg/l, in the OA group - 5.1 ± 3.4 mg/l ($p=0.003$). Genetic analysis revealed an association of the MMP-3 gene polymorphism with a faster progression of destructive changes in the TMJ (OR=2.34; 95% CI 1.12-4.89; $p=0.023$).

The data obtained indicate a significant effect of systemic arthritis on the condition of the temporomandibular joint and confirm the need for an integrated approach to the diagnosis and treatment of this pathology.

The results obtained demonstrate a significant effect of systemic arthritis on the structural and functional state of the temporomandibular joint, which is consistent with the data of modern research (Stoustrup *et al.*, 2021; Franklin *et al.*, 2022; Zhou *et al.*, 2023). The revealed high incidence of TMJ damage in patients with rheumatoid arthritis (83.3%) significantly exceeds the indicators described in previous years, where this parameter did not exceed 70% (Dias Ferraz *et al.*, 2021; Almășan *et al.*, 2023). This disparity can be explained by our study's use of more sensitive imaging methods, in particular high-resolution cone beam computed tomography, which allows detecting minimal changes in articular surfaces at early stages (Bianchi *et al.*, 2021; Dhabale & Bhowate, 2022).

Of particular interest is the revealed correlation between the duration of the disease and the degree of destruction of articular surfaces ($r=0.72$) (Barbin *et al.*, 2020; Hysa *et al.*, 2023). This fact confirms the hypothesis of the progressive nature of TMJ damage

in systemic arthritis and underlines the importance of early diagnosis of joint pathology (Cardoneanu *et al.*, 2022). Our work has demonstrated for the first time a direct relationship between the level of Cyclic Citrullinated Peptide Antibodies and the intensity of TMJ pain, which opens up new prospects for the development of personalized approaches to therapy.

The results of electromyographic examination of the masticatory muscles revealed significant differences between the patient groups and the control group (Kroese *et al.*, 2021). Increased bioelectric activity at rest (8.2 ± 2.1 MV in RA versus 3.1 ± 0.9 MV in control) indicates the formation of stable muscle hypertension, which can be considered as a compensatory mechanism in response to joint destabilization (Kulesa-Mrowiecka *et al.*, 2022; Park & Auh, 2024; Błaszczuk *et al.*, 2025). These data complement the understanding of the pathogenesis of myofascial pain syndrome in patients with arthritis and explain the low effectiveness of isolated drug therapy without correction of muscle imbalance (Rzhepakovsky *et al.*, 2021).

The revealed occlusal disorders, in particular, progressive posteriorly displaced mandible in 38.1% of patients with RA, are of particular clinical significance (Golańska *et al.*, 2021). This observation confirms the need for an interdisciplinary approach with the mandatory participation of orthopedic dentists in the management of such patients. The results obtained are consistent with the concept of a "vicious circle", in which TMJ destruction leads to a change in bite, and the latter exacerbates the pathological load on the damaged joint (Henry & Mehra, 2022).

Molecular genetic studies have revealed a significant association of MMP-3 gene polymorphism with the progression of destructive changes (OR=2.34) (Ornek Akdogan *et al.*, 2023). This fact is important for predicting the course of the disease and can serve as a basis for developing preventive strategies in patients with a genetic predisposition. It is interesting to note that similar patterns

have previously been described for large joints, but this is the first time such data have been presented for TMJ (Leyte-Marique *et al.*, 2022; López-Martínez *et al.*, 2022).

A comparative analysis of instrumental diagnostic methods has confirmed the high informative value of an integrated approach, including CBCT and MRI (Hara *et al.*, 2023). Special attention should be paid to the good correlation revealed in our study between axiographic indicators and the degree of joint destruction ($r=0.68$), which allows us to consider computer axiography as a valuable method of functional diagnosis, especially in the early stages of the disease, when structural changes are still minimal (Saravanakumar *et al.*, 2022; Spirito *et al.*, 2022; Domatskiy & Sivkova, 2023; Dongmo & Tamesse, 2023; García & Jaramillo, 2023; Graefen *et al.*, 2023; Grin *et al.*, 2023; Kulkarni *et al.*, 2023; Malcangi *et al.*, 2023; Mustafa *et al.*, 2023; Savva *et al.*, 2023; Vogel *et al.*, 2023; AlShammasi *et al.*, 2024; Avramova & Vasileva, 2024; Li *et al.*, 2024; Ravoori *et al.*, 2024).

The clinical significance of the work is emphasized by the revealed significant decrease in the quality of life of patients with TMJ lesions. Our data show that even moderate joint changes are accompanied by significant restriction of masticatory function and social maladjustment, which requires the development of comprehensive rehabilitation programs.

Prospects for further research are seen in the study of the effectiveness of modern biological drugs in relation to TMJ lesions, as well as in the development of algorithms for early orthopedic correction of occlusive disorders. Of particular interest is the possibility of using artificial intelligence methods to predict the course of the disease based on a comprehensive analysis of clinical, instrumental, and genetic data.

Thus, the study expands the understanding of the nature and mechanisms of TMJ damage in systemic arthritis, emphasizes the importance of an interdisciplinary approach, and opens up new prospects for improving diagnostic and therapeutic strategies. The results obtained are of significant importance for both rheumatologists and dentists involved in the management of this category of patients (Uzun & Karataş, 2022; Zhang *et al.*, 2022).

Conclusion

The study made it possible to establish a significant incidence of damage to the temporomandibular joint in patients with systemic arthritis, reaching 83.3% in rheumatoid arthritis and 68.4% in osteoarthritis. The data obtained convincingly demonstrate that the pathological changes in the TMJ are progressive, as evidenced by the revealed strong correlation between the duration of the disease and the degree of destruction of the articular surfaces ($r=0.72$). Of particular clinical significance is the established relationship between the level of Cyclic Citrullinated Peptide Antibodies and the intensity of pain syndrome ($r=0.61$), which opens up new opportunities for a personalized approach to therapy.

The results of the study confirm the need for early diagnosis of TMJ lesions using modern imaging techniques. An integrated approach, including cone beam computed tomography and magnetic resonance imaging, has demonstrated high information

value in detecting both bone changes and damage to soft tissue structures of the joint. Special attention should be paid to the revealed violation of the bioelectric activity of the masticatory muscles (8.2 ± 2.1 MV in RA versus 3.1 ± 0.9 MV in control), emphasizing the importance of including muscle relaxation techniques in the complex of therapeutic measures.

The data obtained are of great practical importance for clinicians. The revealed occlusive disorders observed in 64.3% of patients with RA and 52.6% with OA require the mandatory participation of orthopedic dentists in the management of such patients. The established association of the MMP-3 gene polymorphism with the progression of destructive changes ($OR=2.34$) forms the basis for the development of preventive strategies in patients with a genetic predisposition.

The prospects for further research are related to the study of the effectiveness of modern biological drugs in relation to TMJ lesions, as well as the development of algorithms for early orthopedic correction. The introduction of interdisciplinary approaches to patient management, combining the efforts of rheumatologists, dentists and rehabilitologists, is of particular relevance.

The work carried out makes a significant contribution to understanding the pathogenesis of TMJ lesions in systemic arthritis and justifies the need to review existing approaches to the diagnosis and treatment of this pathology. The results obtained emphasize the importance of early detection of changes in the temporomandibular joint and the development of comprehensive rehabilitation programs aimed at preserving the function of the chewing apparatus and improving the quality of life of patients.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: All studies were conducted in compliance with the ethical standards and principles of the Helsinki Declaration. The parents or legal representatives of all the study participants gave informed consent to participate in the study. The protocol of the experiment was approved by the local ethics committee (Protocol No. 45-12/2021)

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