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Clinical, Instrumental, And Biochemical Assessment of Osteoarthritis and Arthritis in Women of Reproductive Age: The Role of Electronic Axiography In Personalized Treatment Abstract

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Abstract

The aim of this study was to improve the diagnostic accuracy and treatment efficacy of temporomandibular joint (TMJ) dysfunction in women of reproductive age through the integration of instrumental biomarkers of mandibular movement and systemic biochemical parameters. A clinical and functional assessment was performed using electronic axiography (HCN parameters, Bennett angle, ISS, and displacement angles), occlusal analysis, and cephalometry. Morphological verification was based on cone-beam computed tomography (CBCT) and

magnetic resonance imaging (MRI). In addition, systemic markers of stress-related metabolic alterations were investigated, including sodium (Na), calcium (Ca), total protein, glucose, ATP, histamine, adrenaline, cortisol, parathyroid hormone (PTH), and vitamin D. The findings showed that, in most patients, the pain phenotype was predominantly associated with myogenic mechanisms, whereas confirmed structural changes in the joint accounted for a limited proportion of cases. Electronic axiography demonstrated high diagnostic value in identifying movement patterns associated with the stage of the chronic process and helped reduce the risk of overdiagnosing intra-articular pathology when symptom-based classification systems were used in isolation. The biochemical profile reflected the 'stress signature' of the pain syndrome and enhanced the prognostic value of the functional and morphological findings. Based on the integration of clinical, axiographic, cephalometric, and biochemical parameters, a practice-oriented stage-based stratification system was proposed, directly linking disease stages to clinical management decisions. Implementation of a standardized algorithm (clinical assessment → axiography → imaging when indicated → biomarker panel) improves treatment targeting, facilitates patient adaptation, and reduces the frequency of unnecessary interventions.

Keywords: Temporomandibular joint; temporomandibular joint dysfunction; electronic axiography; gnathography; cephalometry; occlusal analysis; T-Scan; myogenic pain; biochemical biomarkers; cortisol; histamine; parathyroid hormone; women of reproductive age; personalized dentistry; stage-based stratification.

1. Introduction

Temporomandibular joint (TMJ) dysfunctions are multifactorial disorders characterized by a combination of morphological changes in the joint components, functional discoordination of the musculoskeletal complex, and specific biomechanical characteristics of mandibular movements. Modern diagnostic approaches require the integration of imaging, functional, and biomechanical methods: magnetic resonance imaging (MRI) for soft tissue assessment, cone-beam computed tomography (CBCT) for the evaluation of bony structures, and axiography and electromyography (EMG) for the analysis of mandibular movements and muscle activity. This multiparametric approach improves the accuracy of identifying the underlying causes of functional disorders and enhances treatment planning, particularly in women of reproductive age, in whom hormonal and stress-related modulation of the pain phenotype may frequently occur.

In this context, increasing attention is being paid to "instrumental biomarkers," which comprise electronic axiographic, cephalometric, and systemic biochemical parameters. These indicators facilitate the differential diagnosis of the stages of chronic dysfunction and help predict treatment response. The integration of clinical, instrumental, and laboratory data is considered a foundation for developing personalized patient management strategies.

Objective

To improve the effectiveness of diagnosing and treating TMJ osteoarthritis and arthritis in women of reproductive age through comprehensive stratification incorporating electronic axiographic parameters, cephalometric measurements, and systemic biochemical markers.

2. Methods

The study was based on the clinical and functional assessment of the TMJ, standardized recording of axiographic parameters—including angular and linear characteristics of condylar movement tracings and derived parameters such as HCN, the Bennett angle, ISS, and displacement angles, as detailed in the study protocol—as well as morphological verification using CBCT and MRI and the analysis of systemic biomarkers. The analytical framework was based on an approach in which clinical findings and instrumental axiographic and cephalometric features were interpreted as predictors (biomarkers) of disease stage. This approach enabled the identification of risk factors, assessment of risk levels, and optimization of therapeutic strategies.

Systemic biochemical parameters were additionally assessed as markers of stress-induced and catabolic processes. These included electrolytes (sodium [Na] and calcium [Ca]), general metabolic indicators (protein and glucose), energy-related markers (adenosine triphosphate [ATP]), mediators (histamine, adrenaline, and cortisol), and calcium-regulating hormones (parathyroid hormone [PTH] and vitamin D). These parameters were considered indicators of clinical severity and of the involvement of neuroendocrine and metabolic mechanisms in the pathogenesis of TMJ-associated pain.

Currently used diagnostic classification systems, particularly the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), were critically evaluated in relation to clinical practice. Particular attention was paid to the risk of overdiagnosing intra-articular lesions in cases in which the myogenic component of pain predominates.

Clarify the study design and participants Define all technical abbreviations and parameters.

3. Results

The analysis of clinical complaints and objective findings showed that, in the majority of patients presenting with muscle spasms and tenderness, the pain syndrome was predominantly myogenic in origin. Despite the high frequency of bone compression detected during forceful functional tests, structural changes in the joint were instrumentally confirmed in only a small proportion of cases. This discrepancy between clinical manifestations and morphological findings demonstrates the considerable functional tolerance of the masticatory and speech apparatus to mechanical overload and highlights the predominant role of musculoskeletal dysfunction in the absence of evident organic pathology.

At the level of systemic biomarkers, women of reproductive age with painful forms of TMJ dysfunction exhibited signs of stress-related metabolic alterations. These included increased serum sodium [Na] levels, accompanied by a trend toward decreased calcium (Ca), protein, and glucose levels; elevated ATP levels, reflecting the energy demands associated with chronic muscle hypertonicity; increased histamine, adrenaline, and cortisol levels, corresponding to the psychoemotional modulation of pain; and compensatory elevation of parathyroid hormone (PTH) in the presence of calcium and vitamin D levels remaining within the reference ranges. This combination of changes is proposed as a set of systemic biochemical markers reflecting disease severity and the "stress signature" of TMJ dysfunction.

Electronic axiography demonstrated high diagnostic value in identifying movement patterns characteristic of different stages of the chronic disease process. Systematization of axiographic parameters in conjunction with clinician-oriented and patient-centered assessment tools, including R. Slavicek's subjectivization index, improved the accuracy of stage-based stratification and enhanced the interpretation of mixed myogenous-articular disorders. In such cases, the isolated application of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) may lead to the overdiagnosis of intra-articular pathology.

Taken together, the findings provided the basis for a clinical classification of the stages of chronic dysfunction affecting the maxillofacial region, in which axiographic, cephalometric, and biochemical parameters serve as objective markers of risk and disease progression. Compared with symptom-list-based approaches, this classification demonstrated better clinical and prognostic concordance and facilitated more consistent therapeutic decision-making.

4. Discussion

The principal clinical finding—the predominance of the myogenic component of pain despite the limited proportion of confirmed structural lesions—supports a shift toward function-oriented diagnostic and therapeutic approaches. From a practical perspective, this highlights the need for early integration of instrumental biomarkers of mandibular movement and muscle tone. Electronic axiography serves as a diagnostic "window" into joint biomechanics and helps guide treatment selection, including occlusal adjustment, muscle relaxation protocols, behavioral interventions, and, where supported by morphological evidence, targeted orthopedic or surgical treatment.

Systemic biochemical alterations confirm that painful forms of TMJ dysfunction in women of reproductive age extend beyond the boundaries of a localized joint disorder, reflecting neuroendocrine and metabolic pathways associated with stress and energy demands. Incorporating a basic biomarker panel—including Na, Ca, protein, glucose, ATP, histamine, adrenaline, cortisol, PTH, and vitamin D—makes the patient management model genuinely multidimensional. Clinical manifestations, movement kinematics, joint morphology, and systemic mediators are assessed collectively, strengthening the prognostic validity of stratification and helping explain the phenomenon of "severe pain despite minimal morphological changes."

From a methodological perspective, the proposed clinical classification of disease stages has practical value because it links risk markers and disease stage to treatment selection, thereby reducing the likelihood of overdiagnosing intra-articular disorders and performing unnecessary invasive interventions. This approach is consistent with the broader trend in evidence-based dentistry toward moving beyond syndrome-based descriptions to risk-stratified management guided by objective predictors.

5. Conclusion

In women of reproductive age, the pain phenotype associated with TMJ dysfunction is predominantly driven by myogenic mechanisms, while confirmed structural changes account for a limited proportion of cases. This finding supports the adoption of a function-oriented diagnostic and therapeutic pathway.

Electronic axiography is a key tool for disease stratification. When combined with cephalometry and subjectivization indices, its parameters improve the accuracy of stage-based diagnosis and reduce the risk of overdiagnosis associated with the isolated use of clinical symptom-based scales.

Systemic biochemical markers reflect the stress-related metabolic "signature" of the pain process and complement functional and morphological findings in the personalization of treatment.

A comprehensive classification of the stages of chronic dysfunction affecting the maxillofacial region, based on the integration of axiographic, cephalometric, and biochemical data, demonstrates greater prognostic value and practical utility for treatment planning than traditional symptom-list-based approaches.

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