

ORIGINAL RESEARCH ARTICLE

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ASSOCIATION BETWEEN TEMPOROMANDIBULAR JOINT DISORDERS AND CERVICAL SPINE PARAMETERS

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Abstract

The craniocervical mandibular system includes the temporomandibular joint, the atlanto-occipital joint, the hyoid bone, the masticatory muscles, and any muscle or ligament connecting the head to the neck. Because of the functional unit structure of the system and its biomechanical interaction, scientists are examining whether temporomandibular joint disorders are associated with changes in cervical spine parameters. To compensate for pathological changes in this system, it is necessary to adjust the position of the hyoid bone, neck posture, and head. This study aims to evaluate whether there is an association between temporomandibular joint disorders and cervical spine parameters. This is a descriptive cross-sectional study that included 24 patients aged 25–65 years with temporomandibular joint disorders diagnosed by an orthodontist and a maxillofacial surgeon. Each patient underwent cervical radiographs in two projections, and we assessed cervical parameters. Joint arthritis, malocclusions, tooth loss, congenital asymmetry, and trauma were the main causes of temporomandibular joint disorders in our cases. Regardless of the cause, all of them had at least one change in cervical spine parameters. Cervical tilting, C2–C7 cervical lordosis (CL), and C2–C7 sagittal vertical alignment (C2–C7 SVA) were the cervical parameters that experienced the biggest changes. A forward head position, cervical lordosis loss, and scoliosis were common observations. Temporomandibular joint disorders were associated with cervical spine parameter changes in all cases. Cervical tilting, C2–C7 cervical lordosis, and C2–C7 SVA were the cervical parameters that experienced the most changes.

Keywords: temporomandibular joint disorders, cervical spine parameters.

1. Introduction

The craniocervical-mandibular region can be regarded as an integrated functional system because its anatomical components are closely connected biomechanically. This system includes the temporomandibular joints, atlanto-occipital joint, hyoid bone, tongue, muscles of mastication, and the muscles and ligaments that provide connections between the head and cervical region. Alterations affecting one component may be accompanied by adaptive changes in other structures in an effort to maintain functional balance and head posture. Consequently, increasing attention has been directed toward the functional relationship between craniofacial structures and the cervical spine. [1–3] Previous investigations have reported an association between temporomandibular joint disorders and alterations in cervical posture and alignment. Individuals with temporomandibular joint disorders may also experience cervical symptoms or postural abnormalities, suggesting that assessment of the cervical region

may provide additional information during their clinical evaluation. Cervical alignment is commonly assessed using radiographs obtained in a neutral position, with measurements performed primarily on the lateral projection. Several radiographic parameters can be used to characterize cervical sagittal alignment and the relationship between the cervical spine and the head. [4–6]

Temporomandibular disorders comprise a heterogeneous group of conditions involving either the joint structures or the muscles responsible for mastication. Joint involvement may occur in association with autoimmune diseases such as rheumatoid arthritis, internal derangements involving the articular disc, or degenerative processes. Muscular involvement may present predominantly with myofascial pain. In addition, temporomandibular dysfunction may occur in association with tooth loss, malocclusion, unilateral biting habits, previous facial trauma, or congenital abnormalities. The underlying cause therefore determines the specialist or combination of specialists involved in management. [7, 8] For example, temporomandibular joint involvement secondary to rheumatoid arthritis requires management of the underlying inflammatory disease, whereas disc-related disorders may require orthodontic or maxillofacial assessment. Congenital abnormalities may require multidisciplinary management, while traumatic injuries may be managed by maxillofacial and orthopaedic specialists. Degenerative disorders may require conservative medical treatment, and dental abnormalities such as malocclusion or unreplaced tooth loss are generally managed through dental and orthodontic care. Cervical spine disorders may similarly require evaluation by rheumatologists, neurologists, orthopaedic surgeons, or neurosurgeons, depending on the clinical condition. These considerations emphasize the potential value of a multidisciplinary approach when temporomandibular and cervical abnormalities coexist. [9, 10] The relationship between mandibular asymmetry and spinal posture has also been investigated. Alterations in dental occlusion and mandibular position may influence the activity of the masticatory and postural muscles and may be associated with changes in head and neck position. Such adaptations may extend beyond the cervical region and involve the alignment of the trunk and other segments of the vertebral column. Previous reports have described associations between mandibular deviation, scoliosis, and trunk imbalance, supporting the concept that craniofacial asymmetry may coexist with changes in global posture. [11–14]

Cervical alignment represents a dynamic component of overall sagittal balance. The position of the cervical spine is influenced not only by local vertebral morphology but also by the orientation of the head, thoracic spine, and upper trunk. Several radiographic measurements can therefore be considered when evaluating cervical alignment. The C2–C7 Cobb angle is commonly used to quantify cervical lordosis, whereas the C2–C7 sagittal vertical axis provides information regarding the anterior-posterior position of the cervical spine. Additional parameters, including T1 slope, thoracic inlet angle, neck tilt, and cervical tilt, provide complementary information regarding the orientation of the cervical spine and the mechanisms involved in maintaining head balance and horizontal gaze. Interpretation of these parameters as an integrated system may therefore provide a more comprehensive description of cervical alignment than assessment of an individual measurement alone. [15–17]

Changes in cervical alignment may represent structural abnormalities, postural adaptations, or variations related to individual anatomy and positioning during radiographic examination. In patients with temporomandibular disorders, altered mandibular position, pain, restricted mandibular movement, or changes in masticatory muscle activity may potentially influence head and neck posture. Conversely, altered cervical posture may affect the mechanical and neuromuscular environment of the

craniomandibular region. The relationship should therefore be considered potentially bidirectional rather than assuming that cervical alterations are a direct consequence of temporomandibular pathology. Importantly, the presence of a radiographic alteration does not necessarily indicate clinically significant cervical disease or instability. Despite increasing interest in the interaction between the temporomandibular and cervical regions, the clinical significance of cervical alignment changes in patients with temporomandibular disorders remains incompletely defined. The available literature includes patients with different temporomandibular conditions and uses heterogeneous clinical and radiographic assessment methods. Furthermore, cervical alignment may be influenced by age, posture, thoracic alignment, muscular activity, and other individual characteristics. Describing the distribution of cervical alignment parameters in patients with temporomandibular disorders may therefore provide useful preliminary information and help identify patterns that warrant further investigation using larger samples and appropriate control groups. [15–17]

From a clinical perspective, recognition of possible cervical involvement may be relevant when evaluating patients with temporomandibular disorders, particularly those presenting with cervical discomfort, restricted neck mobility, or altered head posture. A better understanding of the relationship between these anatomical regions may also facilitate communication among dental, orthodontic, maxillofacial, physiotherapeutic, and medical specialists. However, because a descriptive observational study cannot establish causality, cervical alterations should be interpreted as associated findings rather than direct consequences of temporomandibular joint pathology. Based on these anatomical and biomechanical relationships, the present study was designed to assess cervical spine alignment parameters in patients with temporomandibular joint disorders and to describe the cervical postural changes observed in this population.

2. Materials and Methods

This study was designed as a descriptive cross-sectional observational investigation. Because the study population did not include a control or comparison group, no inferential statistical analysis was performed. The analysis focused on describing the cervical spine alignment findings observed among patients diagnosed with temporomandibular joint disorders. The study population consisted of 24 patients between 25 and 65 years of age who had been diagnosed with temporomandibular joint disorders by orthodontists and maxillofacial surgeons. Diagnosis was established using the clinical and imaging examinations considered appropriate for each patient, including cephalometric assessment, panoramic radiography, and magnetic resonance imaging of the temporomandibular joint. The study population included patients with different types of temporomandibular pathology, including joint arthritis associated with autoimmune rheumatic disease, degenerative joint changes, articular disc disorders, trauma-related conditions, malocclusion, tooth loss, and congenital abnormalities. Patients with congenital or traumatic cervical spine pathology were excluded. Pediatric patients, pregnant women, and breastfeeding women were also excluded.

A detailed medical history was obtained from each participant, including information concerning possible cervical spine complaints and general health status. During the clinical examination, cervical mobility was assessed, with particular attention to restriction and pain. Preservation of physiological cervical lordosis was also evaluated using a goniometer. Each participant underwent cervical spine radiography in a neutral standing position using two projections. Cervical alignment measurements were obtained from the lateral

radiograph. The parameters evaluated were C2–C7 cervical lordosis (CL), T1 slope (T1S), thoracic inlet angle (TIA), neck tilt (NT), C2–C7 sagittal vertical axis (C2–C7 SVA), cervical tilt, and cranial tilt. The recorded measurements were subsequently reviewed descriptively to identify the cervical alignment parameters most frequently altered in the study population. (18, 19, 20) For interpretation of the measurements, the following reference ranges were used: approximately 10–30° for C2–C7 cervical lordosis, less than 40 mm for C2–C7 SVA, approximately 20–30° for T1 slope, approximately 70–85° for TIA, approximately 45–55° for neck tilt, approximately 10–20° for cervical tilt, and 0–5° for cranial tilt. [20–23]

Cervical lordosis was determined using the C2–C7 Cobb angle, calculated from the lines corresponding to the inferior endplates of C2 and C7. The angle between the perpendiculars to these reference lines was used to quantify cervical curvature. T1 slope was measured as the angle between the horizontal reference and a line parallel to the superior endplate of T1. Thoracic inlet angle was defined by the relationship between the superior endplate of T1, the upper endplate center, and the superior aspect of the manubrium. Neck tilt was determined from the angle formed between a vertical reference through the manubrium and the line connecting the center of the superior endplate of T1 with the manubrium. C2–C7 SVA was assessed as the horizontal distance between the posterosuperior corner of C7 and a vertical plumb line originating from the centroid of C2. Cervical tilt was measured as the angle between a line perpendicular to the superior endplate of T1 and the line extending from the center of the T1 superior endplate to the tip of the dens. Cranial tilt was determined from the angle between this line connecting T1 with the dens and a true vertical reference line. [20–23]

Ethical approval for the study was obtained from the Ethics Council of the University of Medicine, Tirana, Department of Morphology, Faculty of Medicine, Anatomy Section. Written informed consent was obtained from all participants. Patients were informed about the purpose of the study, the clinical relevance of the radiological examination, and the voluntary nature of participation. They were also informed that refusal to participate would not affect their medical care. The confidentiality and anonymity of participants were maintained throughout the study. Information regarding previous radiological examinations and concomitant medical conditions was obtained before imaging. Female participants were specifically asked about pregnancy and breastfeeding. Radiographic examinations were performed in accordance with radiation-protection principles and only when considered clinically appropriate. Patients were informed about the purpose and potential effects of ionizing radiation before the examination.

3. Results

The study included 24 patients aged 25–65 years; the female: male ratio was 2:1. Of the cases included in the study, two were diagnosed with temporomandibular joint arthritis in the setting of rheumatoid arthritis. Four patients were treated for malocclusion by an orthodontist. Five patients presented with temporomandibular joint problems as a result of tooth loss and failure to replace them in time. Six patients were treated for articular disc displacement. Four patients were diagnosed with degenerative changes in the temporomandibular joints. Two patients had a history of trauma from facial impact, and one patient had a congenital atypical joint space. After performing cervical radiography in a neutral position and in two projections, in the lateral projection, cervical parameters were measured such as: CL or C2–C7 Cobb angle (cervical lordosis), T1S (T1 slope), TIA (thoracic inlet angle), NT (neck tilt), C2–C7 SVA (C2–C7 sagittal vertical axis), cervical tilting, and cranial tilting.

All patients had at least one altered cervical parameter. About 79.16% of cases had limitation of neck mobility, mainly in lateral flexion. About 70.83% of cases had limitation of neck mobility in extension. Forward head posture was found in 62.5% of cases. In cases with forward head posture, an increase in the C2-C7 sagittal vertical axis parameter, a decrease in the C2-C7 Cobb angle, an increase in T1 slope, a decrease in NT and cervical tilting, and an increase in cranial tilting were found. An increase in the C2-C7 SVA parameter was observed in 83.3% of cases, a decrease in the C2-C7 Cobb angle in 75% of cases, about 58.33% of cases had a decrease in cervical tilting, 50% of cases had an increase in T1 slope, about 45.83% of cases had a decrease in NT, and about 50% of cases had an increase in cranial tilting. The changes in these parameters were not at a stage that created instability, nor did they require neurosurgical intervention. The temporomandibular joint disorders in these patients were associated with alterations in cervical parameters that objectify postural changes. TIA is the sum of the T1 slope and NT parameters, which showed minimal changes since the increase in T1 slope was compensated by the decrease in neck tilting. Cervical tilting, C2-C7 cervical lordosis, and C2-C7 SVA were the cervical parameters that experienced the most changes.

4. Discussion

The present study demonstrated that alterations in cervical spine alignment and postural parameters were frequently observed in patients with temporomandibular joint disorders. All patients had at least one altered cervical parameter, while limitations in neck mobility and forward head posture were also frequently observed. The most commonly altered radiographic parameters were the C2-C7 sagittal vertical axis (SVA), C2-C7 Cobb angle, and cervical tilt. These findings suggest that cervical postural alterations are frequently present in patients with temporomandibular disorders and support the concept of a functional relationship between the stomatognathic and cervical regions. The high prevalence of forward head posture in the present sample is of particular interest. Forward head posture is characterized by anterior displacement of the head relative to the trunk and may be accompanied by compensatory changes in cervical alignment. In the present study, patients with forward head posture demonstrated an increased C2-C7 SVA and a reduced C2-C7 Cobb angle, indicating a tendency toward anterior translation of the head and reduced cervical lordosis. Increased T1 slope and cranial tilt, together with decreased neck and cervical tilt, were also observed. Although the present study cannot establish a causal relationship, this pattern suggests that changes in one component of the craniocervical alignment may be accompanied by compensatory changes in other cervical and cranial parameters.

The findings are consistent with previous literature describing an interaction between the temporomandibular, craniofacial, and cervical regions. The craniocervical region is anatomically and functionally interconnected with the stomatognathic system through muscles, fascia, and neural pathways. Changes in head and neck posture may therefore influence mandibular position and masticatory muscle activity, while painful or dysfunctional temporomandibular conditions may modify head and neck posture through protective or compensatory mechanisms. Previous studies have reported relationships between temporomandibular disorders, neck disability, and cervical posture, supporting the relevance of evaluating the cervical region in patients presenting with temporomandibular complaints. [11-14] However, the direction and clinical significance of these relationships remain uncertain. The C2-C7 SVA was the most frequently increased parameter in the present study, being altered in 83.3% of patients. This finding is compatible with the frequent observation of forward head posture in the sample.

An increased C2-C7 SVA reflects greater anterior translation of the cervical spine and is commonly considered an important parameter of sagittal cervical alignment. The reduced C2-C7 Cobb angle observed in 75% of patients further suggests a tendency toward reduced cervical lordosis in this population. These findings should, however, be interpreted cautiously because cervical alignment is influenced by age, posture during radiography, thoracic alignment, and individual anatomical characteristics. Cervical tilt was also frequently altered, with a decrease observed in 58.33% of patients. Cervical tilt reflects the orientation of the cervical spine relative to the horizontal reference and may change as part of the compensatory mechanisms involved in maintaining horizontal gaze and overall head balance. The simultaneous alterations observed in C2-C7 SVA, cervical lordosis, and cervical tilt may therefore represent different components of a broader postural adaptation rather than isolated abnormalities. TIA showed comparatively limited changes in the present study. This may be explained by the relationship between its components, T1 slope and neck tilt. Approximately half of the patients demonstrated an increased T1 slope, whereas 45.83% showed a decreased NT. Because TIA is determined by the relationship between these parameters, changes in opposite directions may partially compensate for one another, resulting in relatively preserved TIA values. This finding illustrates the importance of interpreting cervical alignment parameters as an integrated system rather than considering each measurement independently.

Although several cervical parameters were frequently altered, none of the observed changes suggested clinically significant cervical instability or required neurosurgical intervention. Therefore, the presence of radiographic alterations should not necessarily be interpreted as evidence of clinically significant cervical pathology. Rather, these findings may reflect postural adaptations or variations in cervical alignment that coexist with temporomandibular disorders. From a clinical perspective, the findings support the importance of considering the cervical region when evaluating patients with temporomandibular joint disorders, particularly those presenting with restricted neck mobility or forward head posture. A multidisciplinary approach involving dental, orthodontic, physiotherapeutic, and medical assessment may be useful in selected patients. However, the present findings should not be interpreted as evidence that treatment of cervical alignment would necessarily improve temporomandibular symptoms.

This study has several limitations. First, the sample size was relatively small and consisted exclusively of patients with temporomandibular disorders. The absence of a healthy control group prevents determination of whether the observed cervical alterations are more prevalent than in the general population. Second, the descriptive observational design does not allow causal relationships to be established between temporomandibular disorders and cervical alignment. Third, the sample included patients with different temporomandibular conditions and clinical backgrounds, including rheumatoid arthritis, disc displacement, degenerative changes, tooth loss, trauma, and congenital joint abnormalities. This clinical heterogeneity may have contributed to variability in cervical findings. Finally, the study did not assess longitudinal changes or determine whether the severity of temporomandibular dysfunction was related to the magnitude of cervical alignment alterations. Despite these limitations, the present study provides a descriptive overview of cervical alignment patterns in patients with temporomandibular disorders. The frequent alterations in C2-C7 SVA, C2-C7 Cobb angle, and cervical tilt, together with the high prevalence of forward head posture, warrant further investigation. Future studies should include larger samples, healthy control groups, standardized assessment of temporomandibular disorder severity, and correlation analyses between temporomandibular and cervical parameters. Such studies may help

clarify whether the observed cervical alterations represent a clinically meaningful association, a compensatory postural response, or coincidental findings. [20, 21]

5. Conclusion

Patients with temporomandibular joint disorders frequently demonstrated alterations in cervical spine alignment and postural parameters. The most frequently observed changes involved the C2–C7 sagittal vertical axis, C2–C7 Cobb angle, and cervical tilt, with forward head posture also commonly observed. These findings suggest that temporomandibular joint disorders may coexist with alterations in cervical alignment and posture, particularly in the sagittal plane. However, the observed changes did not indicate clinically significant cervical instability or a need for neurosurgical intervention. Further studies with larger samples, appropriate control groups, and analytical assessment of the relationships between temporomandibular joint disorders and cervical parameters are needed to clarify the clinical significance of these findings and determine whether a meaningful association exists.

Author Contributions: J. Hankollari conceptualized the study, collected and analyzed the data, interpreted the findings and drafted the manuscript; N. Leka reviewed and approved the final version of the manuscript; E.Plaku collected the data too.

Data Availability Statement: The data generated and/or analyzed during the current study are not publicly available due to patient privacy and confidentiality considerations but may be available from the corresponding author upon reasonable request, subject to appropriate ethical and institutional requirements

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