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TEMPOROMANDIBULAR DISORDERS AND CERVICAL SPINE PATHOLOGY: A NARRATIVE REVIEW ON FUNCTIONAL INTERRELATIONS AND ORAL HEALTH IMPLICATIONS

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ABSTRACT

Background: Temporomandibular disorders (TMDs) and cervical spine pathologies, including disc herniation and musculoskeletal imbalance, often coexist and may share pathophysiological mechanisms. Their potential interrelation has implications not only for diagnosis and treatment but also for oral health status and rehabilitation outcomes. **Objective:** This narrative review aims to explore the functional and anatomical links between TMDs and cervical spine disorders, emphasizing their mutual influence on pain, posture, neuromuscular coordination, and oral function. The review also assesses how these interactions impact oral health, particularly in relation to mastication, occlusion, and temporomandibular joint (TMJ) stability. **Methods:** A literature search was conducted using PubMed, Scopus, and Web of Science for studies published between 2000 and 2024. Eligible articles included clinical trials, observational studies, systematic reviews, and relevant anatomical or physiological investigations focusing on TMDs and cervical spine pathology. **Results:** Evidence suggests a bidirectional relationship between cervical dysfunction and TMDs, mediated by shared neural pathways, muscular co-activation, and biomechanical interdependence. Patients with cervical disc pathology often present with TMJ dysfunction, while TMD symptoms may exacerbate cervical musculoskeletal disorders. These interrelations can influence oral health through altered mandibular movement, parafunctions (e.g., bruxism), and reduced access to effective hygiene due to pain or restricted mobility. **Conclusions:** Understanding the cervico-mandibular relationship is essential for accurate diagnosis, effective management, and long-term prevention of chronic orofacial conditions. Interdisciplinary approaches involving dentistry, physical therapy, and neurology are recommended to optimize both TMJ function and cervical spine health in the context of oral health maintenance

Key words: Temporomandibular disorders, cervical spine, disc herniation, orofacial pain, musculoskeletal dysfunction, postural imbalance, TMJ, etc

1.INTRODUCTION

Temporomandibular disorders (TMDs) represent a heterogeneous group of musculoskeletal and neuromuscular conditions affecting the temporomandibular joint (TMJ), masticatory muscles, and associated structures. They are among the most prevalent causes of non-dental orofacial pain and functional limitation, affecting up to

10–15% of the adult population worldwide [1]. Clinical manifestations may include joint sounds, restricted mandibular movements, pain in the jaw and surrounding areas, and impaired mastication.

Parallel to the increase in TMD prevalence, cervical spine pathologies—particularly cervical disc herniation and cervical muscle imbalance—have emerged as frequent comorbidities. Cervical spine dysfunctions may present with neck pain, reduced mobility, and postural deviations, but are also frequently associated with referred pain to the craniofacial region, dizziness, and altered occlusal dynamics [2]. Anatomical and neurophysiological continuity between the craniofacial and cervical regions suggests a functional interdependence that may influence both diagnosis and therapeutic strategies [3].

Studies have shown that individuals with cervical musculoskeletal disorders are more likely to develop TMD symptoms, and vice versa [4].

The biomechanical and neuroanatomical linkage between the cervical spine and the TMJ is mediated by muscular chains (e.g., sternocleidomastoid, trapezius, suprahyoid and infrahyoid muscles) and shared innervation via the trigemino-cervical complex—a convergence zone of nociceptive input from the cranial and upper cervical nerves [5].

This interrelation also has implications for oral health. Pain and dysfunction in either the TMJ or cervical spine may alter masticatory patterns, reduce oral hygiene efficiency, and exacerbate parafunctional behaviors such as bruxism. Furthermore, malocclusion, loss of posterior support, or occlusal instability can act as contributing or perpetuating factors for both TMD and cervical tension syndromes [6].

Given the multifactorial etiology and overlapping symptomatology, there is a growing need for interdisciplinary assessment and management of patients presenting with signs of TMD and cervical spine disorders. Dentists, physical therapists, neurologists, and other healthcare professionals must be aware of these interconnections to ensure comprehensive and effective care.

This narrative review aims to explore the functional and clinical interactions between TMDs and cervical spine pathology, with a particular focus on their impact on oral health parameters, diagnosis, and treatment strategies.

2.LITERATURE REVIEW

The intricate relationship between temporomandibular disorders (TMDs) and cervical spine dysfunction has been the subject of increasing scientific attention in the last two decades. Numerous clinical and experimental studies have sought to understand the anatomical, biomechanical, and neurophysiological links that may explain the frequent co-occurrence of temporomandibular joint (TMJ) dysfunction and cervical musculoskeletal disorders. This section synthesizes the current evidence on their functional interdependence, with particular focus on the implications for oral health, pain management, posture, and interdisciplinary care.

- **Anatomical and Neurophysiological Connections Between the TMJ and Cervical Spine**

The anatomical and neurophysiological interplay between the temporomandibular joint (TMJ) and the cervical spine is well-documented, especially in the context of pain referral patterns, muscular coordination, and postural control. The cranio-cervico-mandibular region functions as an integrated biomechanical and neuromuscular unit, supported by both muscular continuity and central nervous system convergence.

At the muscular level, there is significant interdependence between the masticatory and cervical muscles. The sternocleidomastoid (SCM), trapezius, and deep suboccipital

muscles form chains of coordinated activity with the masseter, temporalis, and pterygoid muscles, particularly during mandibular movements and head stabilization. The suprahyoid and infrahyoid muscles, involved in jaw depression and tongue function, also connect mandibular action to cervical posture [7].

The central structure in this interrelationship is the trigeminocervical complex (TCC), located in the upper cervical spinal cord and brainstem. This area integrates afferent nociceptive input from both the trigeminal nerve (cranial nerve V) and the upper cervical spinal nerves (C1–C3). As a result, pain signals originating from the TMJ, masseter, or masticatory muscles can be referred to the neck, and vice versa [8]. This convergence of sensory input explains why patients with cervical disc herniation or cervical facet dysfunction may report orofacial pain, even in the absence of primary dental pathology [9].

Moreover, the atlanto-occipital and atlanto-axial joints play a key role in maintaining the spatial orientation of the head and jaw. Dysfunction or instability in these upper cervical segments may alter head position, influence mandibular rest posture, and affect TMJ loading. Several imaging studies have shown positional changes in the condylar position and articular disc in patients with cervical spine deviations or forward head posture [10].

From a developmental and functional perspective, the cervical spine and TMJ are also closely related in terms of motor control. Electromyographic (EMG) studies have demonstrated co-activation patterns between cervical and jaw muscles during tasks such as clenching, head tilting, and swallowing, further supporting their neuromuscular interdependence [11].

Understanding these anatomical and neurological connections is essential for clinicians when evaluating orofacial pain or dysfunction. A localized symptom in the TMJ may reflect a more global postural or cervical imbalance, which should be addressed as part of a comprehensive treatment strategy.

- **Temporomandibular Disorders: Clinical Overview**

Temporomandibular disorders (TMDs) represent a prevalent and multifactorial group of conditions affecting the temporomandibular joint (TMJ), the masticatory muscles, and associated structures. These disorders often manifest through pain, restricted mandibular movement, and joint sounds, and are considered a leading cause of non-dental orofacial pain.

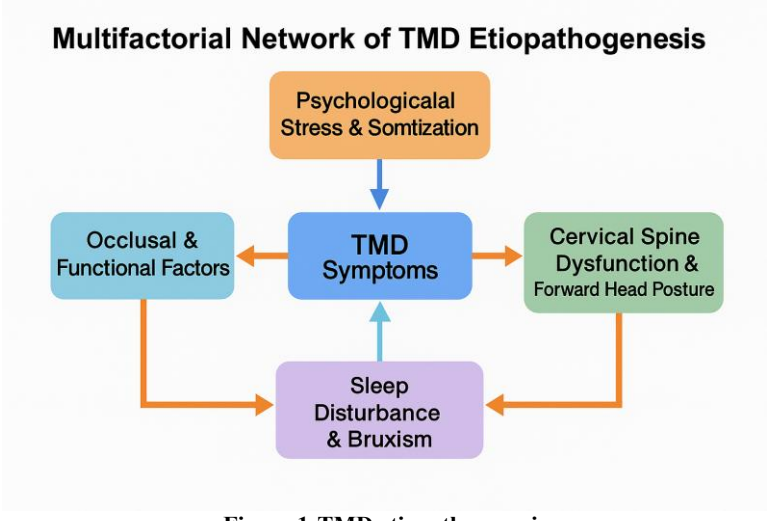

Figure 1-TMD etiopathogenesis

Current epidemiological data suggest that TMD symptoms affect approximately 10–15% of the adult population, with a higher incidence among women and individuals aged between 20 and 40 years. In a systematic review by Manfredini et al. (2011), signs of TMD were found in up to 31% of examined individuals, though only

about 13% reported pain as a primary complaint [11].

The clinical presentation is typically heterogeneous. Patients frequently report facial pain localized in the preauricular area, temple, or along the jaw. This discomfort may radiate the neck or shoulder region, particularly in chronic presentations. Joint sounds such as clicking or crepitus are common and may indicate internal joint derangements, although they are not always correlated with pain or dysfunction. Limited or asymmetric jaw opening, deviation during movement, and muscular fatigue are also common findings.

Psychosocial and behavioral factors appear to play a pivotal role in the onset and perpetuation of TMD. A study revealed that psychological distress, sleep disturbances, and increased somatic awareness significantly predicted the development of persistent TMD pain [12]. These findings support the integration of the biopsychosocial model in the understanding and management of orofacial pain disorders.

Additionally, TMD has been linked to postural and cervical spine dysfunctions. Evidence from clinical and EMG studies shows altered head posture and cervical muscle co-activation in individuals with TMD.

A systematic review by Costa et al. found a strong association between TMD and neck pain, with cervical dysfunction being more prevalent in TMD patients compared to control groups [13]. These interrelations suggest a bidirectional influence between the craniofacial and cervical systems, likely mediated by shared neural pathways and muscular chains[14].

Several studies confirm that pain from TMD extends beyond the TMJ region. In a clinical study by Wiesinger et al. (2009), over 50% of TMD patients also reported concomitant neck pain, and up to 40% reported headache and shoulder discomfort [15]. This aligns with neuroanatomical findings showing sensory convergence in the trigeminocervical complex, allowing cervical dysfunctions to influence orofacial perception.

Table 1- Key Findings from Contemporary Literature on Temporomandibular Disorders

Study / Source	***Key Findings***
Bueno et al. (2018)	TMD global prevalence ~31%; pain-related ~10%
Slade et al. (2013)	Psychological and sensory predictors of chronic TMD
Wiesinger et al. (2009)	>50% of TMD patients report neck pain
Costa et al. (2017)	Cervical spine dysfunction strongly associated with TMD
De Laat et al. (2012)	TMD pain often coexists with myofascial and cervical muscle hypersensitivity

Moreover, muscle tenderness and myofascial trigger points in the masseter and temporalis muscles have been shown to coexist with hyperactivity in upper trapezius and sternocleidomastoid muscles, particularly in patients with postural alterations [16].

Importantly, while occlusal factors were historically emphasized in TMD etiology, contemporary research points to a more complex interaction of biomechanical, neuromuscular, and psychosocial influences. Interdisciplinary approaches are now considered essential, particularly for chronic cases with comorbid cervical or psychological symptoms [17].

Recognition of TMD as a multifaceted condition with overlapping domains of dysfunction is critical for timely diagnosis and comprehensive management. Clinicians must consider that orofacial pain complaints might reflect broader musculoskeletal or systemic imbalances rather than isolated joint pathology [16].

- **Cervical Spine Pathology: Clinical Overview**

Cervical spine dysfunctions, particularly in the upper cervical region (C0–C3), have increasingly been implicated in the pathogenesis of temporomandibular disorders (TMD), especially in chronic pain cases. While traditionally viewed as an isolated musculoskeletal entity, current evidence supports a functional and neurophysiological overlap between cervical spine pathologies and orofacial conditions.

Chronic cervical pain affects up to 30–50% of adults at some point in their life, with a high recurrence rate and significant impact on quality of life [18]. In TMD populations, the prevalence of concomitant neck pain is significantly higher. A large cross-sectional study by Wiesinger et al. (2009) demonstrated that more than half of individuals with TMD reported persistent neck pain, and over 40% exhibited reduced cervical mobility compared to controls [19].

One of the key interfaces connecting cervical and craniofacial regions is the trigeminocervical complex (TCC), which integrates nociceptive input from both trigeminal (cranial nerve V) and upper cervical (C1–C3) afferents. This convergence explains why cervical joint dysfunction or muscular hypertonia may refer pain to the temporomandibular area, or vice versa [20].

Electromyographic (EMG) studies have shown co-activation patterns between cervical stabilizers (e.g., sternocleidomastoid, upper trapezius) and masticatory muscles during tasks such as clenching, head rotation, and swallowing [21]. This supports the concept of a functional muscular synergy rather than separate motor compartments.

Postural deviation, particularly forward head posture (FHP), alters the biomechanical load on the cervical spine and TMJ. FHP increases tension in the suboccipital and masticatory muscles and changes the resting position of the mandible. A study by Fernández-de-Las-Peñas et al. (2010) found that individuals with FHP exhibited increased pain sensitivity in the masseter and temporalis muscles, as well as reduced cervical mobility [22].

In MRI-based investigations, cervical kyphosis or atlanto-occipital joint dysfunction has been correlated with positional changes in the TMJ disc and condyle, suggesting that cervical alignment can directly influence intra-articular dynamics [23].

Recognizing cervical spine dysfunction as a contributing factor in orofacial pain is critical for accurate diagnosis and management. Studies such as that by Olivo et al. (2010) emphasize the diagnostic value of cervical screening in TMD patients, recommending that all orofacial pain assessments include cervical palpation, mobility testing, and postural evaluation [24].

Furthermore, manual therapy targeting the cervical region has shown clinically significant improvements in TMD symptoms, particularly in reducing pain and improving mandibular function [25]. These outcomes support a bidirectional therapeutic model, where cervical intervention benefits craniofacial outcomes and vice versa.

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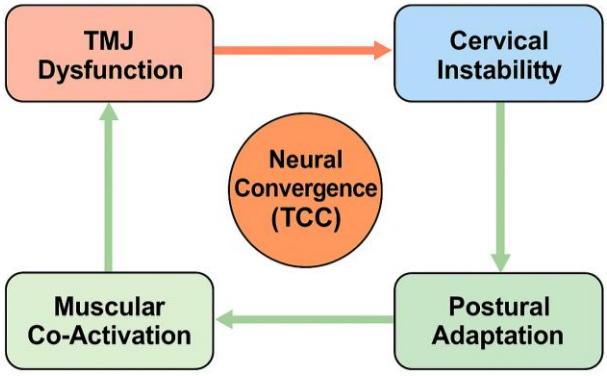

Figure 2- Functional Interactions Between the Cervical Spine and Temporomandibular Joint

- **Pathophysiological and Biomechanical Interrelations**

The functional interplay between the temporomandibular joint (TMJ) and cervical spine extends beyond anatomical proximity, representing a complex interface of shared neuromuscular control, convergent nociceptive pathways, and dynamic postural adaptation. Multiple studies have demonstrated that dysfunction in one region can perpetuate or even generate maladaptive responses in the other, supporting a bidirectional pathophysiological model.

One of the most significant mechanisms linking these structures is the convergence of afferent input within the trigeminocervical complex (TCC). This brainstem region receives sensory input from both the trigeminal nerve and the upper cervical spinal nerves (C1–C3), explaining how pain originating in the neck can be perceived in the face, jaw, or temple, and vice versa.

Bogduk and Govind (2009) describe this convergence as the primary neurophysiological basis for referred orofacial pain in cervical pathology, particularly in cases of cervicogenic headache and atlantoaxial joint irritation [25]. Functional MRI studies have further confirmed overlapping activation zones in chronic TMD and cervical pain patients, implicating central sensitization as a shared feature [26].

From a biomechanical perspective, several studies have highlighted how cervical spine posture, especially forward head posture (FHP), affects the spatial orientation of the jaw and the biomechanical load on the TMJ. Fernández-de-las-Peñas et al. (2007) showed that individuals with FHP presented significantly higher pressure-pain sensitivity in the masseter and temporalis muscles, alongside reduced cervical rotation and extension. Notably, the same population demonstrated increased electromyographic activity in cervical flexors during mandibular tasks, suggesting altered neuromuscular control and compensation patterns [27].

Moreover, Uritani et al. (2014) used MRI to demonstrate positional changes in the mandibular condyle and articular disc among patients with upper cervical instability, providing structural evidence of cervical influence on TMJ loading dynamics [28]. These findings support clinical observations where TMD symptoms persist or worsen in the presence of cervical dysfunction, even after local occlusal or intraarticular interventions.

On the muscular level, co-activation between deep cervical flexors, sternocleidomastoid, and masticatory muscles has been observed in both healthy individuals and those with TMD. A study by Armijo-Olivo et al. (2011) confirmed altered muscle recruitment patterns in TMD patients during head posture corrections, indicating that compensatory activation in cervical stabilizers may contribute to overload and pain maintenance [29].

Importantly, clinical trials evaluating conservative cervical interventions have shown tangible benefits in TMD populations. Kalamir et al. (2013) conducted a randomized controlled trial demonstrating that manual therapy targeting the cervical spine significantly reduced TMJ-related pain and improved function over a 6-week period. These outcomes remained stable at follow-up, suggesting a sustained neuromuscular normalization effect [30].

Taking together, these data emphasize that the TMJ and cervical spine do not function as independent systems but as integrated units within a common postural and neuromuscular framework. This interdependence is clinically relevant, particularly in chronic or treatment-resistant TMD cases, where isolated local management often yields suboptimal results. Understanding the pathophysiological and biomechanical synergy between these regions is therefore crucial for designing comprehensive, patient-centered therapeutic strategies [31,32].

Diagnostic Considerations

Accurate diagnosis of temporomandibular disorders (TMD) in the context of cervical spine involvement requires a multidimensional clinical approach. Increasing evidence supports the idea that

orofacial symptoms often reflect not only local dysfunction at the temporomandibular joint (TMJ) but also regional or systemic alterations, especially those involving the cervical spine and neuromuscular control.

Standard diagnostic models such as the DC/TMD (Diagnostic Criteria for Temporomandibular Disorders) have substantially improved diagnostic validity by integrating clinical and psychosocial domains. However, these criteria do not routinely account for cervical contributions, despite data indicating that up to 70% of patients with chronic TMD report concurrent cervical discomfort, altered neck mobility, or tenderness to palpation [33]. This underlines the importance of extending routine diagnostic protocols to include cervical spine screening.

Clinical examination should assess the presence of TMJ pain on palpation, mandibular movement limitations, joint sounds (clicking or crepitus), and muscle tenderness. In addition, a structured cervical assessment is recommended, including range of motion testing, palpation of cervical paraspinal and suboccipital muscles, and evaluation of head posture. Studies like that of Olivo et al. (2010) emphasize that postural alterations such as forward head posture (FHP) are significantly more frequent in TMD patients than in controls and may correlate with pain intensity and chronicity [34].

Instrumental tools such as surface electromyography (sEMG), pressure pain threshold (PPT) mapping, and computerized mandibular scanning (CMS) have been used to quantify neuromuscular dysfunction. While not always necessary in routine clinical practice, they provide objective evidence of altered muscle recruitment and jaw-neck motor coordination patterns. For example, increased co-activation between the sternocleidomastoid and masseter muscles during clenching has been documented in TMD patients with cervical symptoms [35].

Advanced imaging is reserved for cases where structural pathology is suspected—e.g., internal derangement, osteoarthritis, or upper cervical instability. MRI remains the gold standard for evaluating intra-articular TMJ structures and disc position, while CBCT offers valuable insights into bony alterations. In the cervical region, dynamic flexion-extension radiographs or MRI may be indicated if neurological symptoms or instability are present.

Beyond musculoskeletal assessment, psychosocial evaluation is a crucial diagnostic pillar. The OPPERA study demonstrated that psychological factors—such as anxiety, pain catastrophizing, and somatization—are strong predictors not only of TMD onset but also of symptom persistence [36]. Validated screening tools like the Pain Catastrophizing Scale (PCS) or the Hospital Anxiety and Depression Scale (HADS) can be easily integrated into the diagnostic pathway.

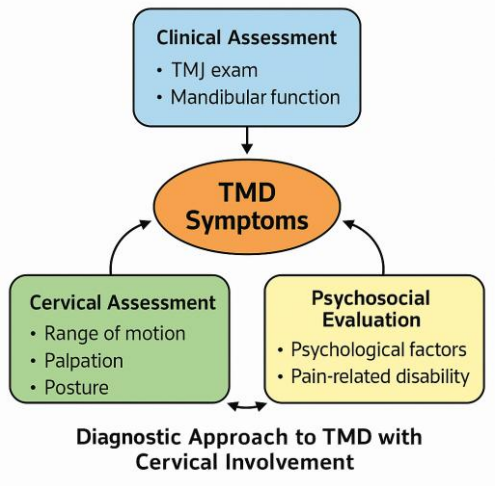

Figure 3-Diagnostic approach to TMD

Taken together, the diagnostic approach to TMD with possible cervical involvement should evolve from a purely structural paradigm to a functional, systems-based model, where neuromuscular, postural, and psychosocial dimensions are simultaneously considered. This ensures not only more accurate classification but also informs more individualized and effective treatment strategies.

- **Therapeutic Implications and Interdisciplinary Management**

The effective treatment of temporomandibular disorders (TMD),

particularly in patients with associated cervical spine dysfunction, necessitates a multimodal and interdisciplinary approach. Monodisciplinary interventions—whether dental, physiotherapeutic, or pharmacologic—are often insufficient in addressing the complex neuromuscular, biomechanical, and psychosocial components that sustain chronic orofacial pain.

Evidence from randomized clinical trials and meta-analyses strongly supports the integration of cervical spine rehabilitation into TMD management. Kalamir et al. (2013) demonstrated that manual therapy applied to the upper cervical spine produced significant improvements in pain intensity and mandibular function in TMD patients compared to sham treatment, with benefits persisting at 3-month follow-up [20]. These results are echoed by Armijo-Olivo et al. (2016), who reported that cervical mobilization and stabilization exercises reduced disability scores in patients with combined TMD and neck pain [21].

Physiotherapy plays a central role, focusing on postural correction, joint mobilization, trigger point release, and neuromuscular re-education. Several studies have found that forward head posture correction reduces electromyographic hyperactivity in both cervical and masticatory muscles, suggesting a mechanistic basis for combined treatment strategies [37]. Additionally, therapeutic exercises targeting deep cervical flexors and scapular stabilizers have been shown to normalize muscle coordination during jaw movement tasks, further reinforcing the interdependence of these regions.

In parallel, dental interventions such as occlusal splints (e.g., stabilization splints or anterior bite appliances) are used to reduce muscular hyperactivity and intra-articular stress. However, their efficacy appears to be enhanced when combined with cervical treatment and behavioral strategies. According to a systematic review by Al-Ani et al. (2016), splint therapy alone was less effective in reducing long-term pain when not integrated with supportive care [38].

Cognitive-behavioral therapy (CBT), patient education, and stress management techniques are also vital. The OPPERA study highlighted that patients with high psychosocial risk profiles benefited significantly more from integrative therapy models compared to mechanical approaches alone [39]. Clinicians are therefore encouraged to include psychological screening in the therapeutic pathway and, where indicated, to refer patients for appropriate mental health support.

Interdisciplinary collaboration between dentists, physiotherapists, manual therapists, neurologists, and psychologists is the emerging gold standard in complex TMD cases. A coordinated care model ensures that cervical dysfunction, psychological distress, and orofacial symptoms are addressed simultaneously, reducing recurrence risk and promoting long-term functional stability.

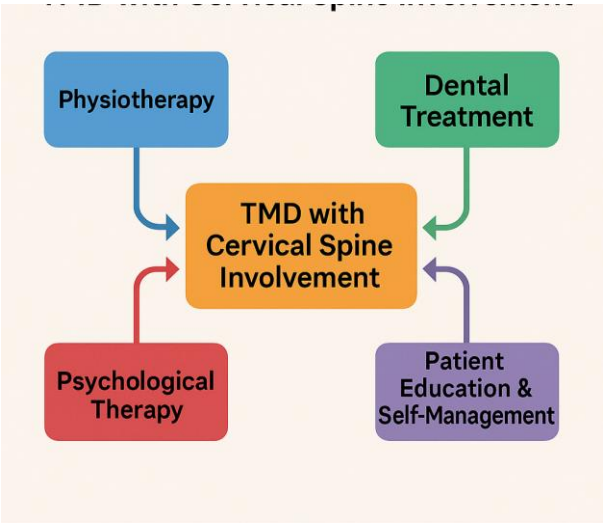

Figure 3-Interdisciplinary management of TMD

- **Oral Health Implications and Quality of Life**

Temporomandibular disorders (TMDs), particularly when compounded by cervical spine dysfunction, extend their clinical impact well beyond joint mechanics, influencing multiple aspects of oral health and patient well-being. The chronicity, multisystem involvement, and pain-related disability associated with these conditions have measurable consequences on mastication, dentition, periodontal stability, and quality of life (QoL).

One of the most evident consequences of TMD is masticatory dysfunction, characterized by reduced bite force, impaired

chewing efficiency, and fatigue of the masticatory muscles. In a study by Poluha et al. (2021), patients with moderate-to-severe TMD reported a significant decrease in masticatory ability and food consistency tolerance, which correlated with increased self-reported disability and social withdrawal [40]. This is further exacerbated in individuals with coexisting neck pain, as the biomechanical synergy between cervical and mandibular function becomes compromised.

Dental wear—including attrition, abrasion, and enamel cracks—is frequently observed in TMD patients, particularly those with parafunctional habits such as bruxism. Bruxism prevalence in TMD populations has been estimated between 40–70%, with nocturnal episodes contributing to accelerated occlusal degradation [41]. Cervical dysfunction may indirectly influence bruxism patterns by altering proprioceptive input and contributing to sustained muscle hyperactivity.

From a periodontal perspective, chronic clenching and abnormal loading can lead to increased occlusal trauma, gingival recession, and loss of attachment. A controlled study by Pereira et al. (2012) found a higher rate of localized periodontal breakdown in TMD patients with hypertonic masseter activity, independent of plaque indices, suggesting a biomechanical contribution to periodontal disease [42].

Psychosocial burden also plays a critical role in the oral health trajectory of these patients. Chronic pain is associated with diminished oral health-related quality of life (OHRQoL), affecting emotional well-being, self-image, and social interaction. Using the OHIP-14 index, Oliveira et al. (2020) demonstrated that TMD patients scored significantly higher in domains such as physical pain, psychological discomfort, and handicap, compared to controls [43].

Moreover, patients often adapt maladaptive behaviors—such as unilateral chewing, reduced oral hygiene due to pain, or avoidance of dental care—further perpetuating oral deterioration. In elderly or polymorbid individuals, TMD symptoms combined with cervical stiffness may contribute to oropharyngeal dysphagia, reduced tongue coordination, and compromised prosthetic rehabilitation [44].

Importantly, these oral health impairments contribute to a vicious cycle: pain and dysfunction lead to poor oral hygiene, dietary restrictions, and psychosocial stress, which in turn exacerbate
the musculoskeletal condition

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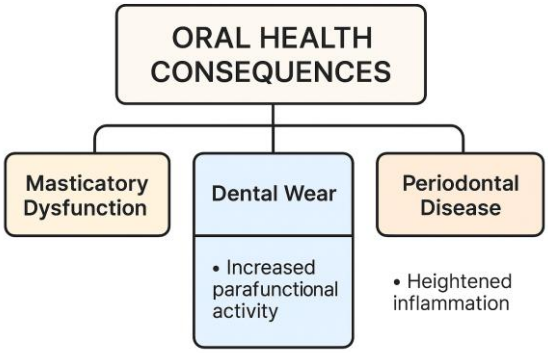

Figure 4-Interrelation with oral health

As such, a patient-centered, holistic approach must include oral health monitoring, prosthetic and occlusal management, behavioral guidance, and functional rehabilitation as part of integrated care.

3. RESEARCH GAPS AND FUTURE DIRECTIONS

Despite growing recognition of the interplay between temporomandibular disorders (TMD) and cervical spine dysfunction, current research remains fragmented and limited by methodological constraints. Much of the available evidence is cross-sectional or based on small, heterogeneous samples, which impairs the ability to draw causal inferences or to standardize diagnostic and therapeutic approaches.

One of the most pressing gaps in the literature is the lack of high-quality longitudinal studies that follow the natural course of TMD in relation to cervical spine pathology. Most clinical trials focus on short-term outcomes, and very few have examined whether early cervical dysfunction predicts persistent orofacial pain. Furthermore, there is a shortage of robust data exploring the role of

neuromuscular coordination and central sensitization mechanisms across the cranio-cervical axis in chronic TMD populations.

Diagnostic inconsistency remains another major obstacle. Although the DC/TMD provides a validated framework for assessing temporomandibular disorders, no universal diagnostic model integrates cervical spine assessment in the context of orofacial pain. Clinical and imaging parameters used to define cervical dysfunction vary significantly between studies, making comparison and synthesis difficult. There is also a need for validated functional tests that can assess cervical–mandibular interdependence in real time, ideally combining electromyographic, kinematic, and pain data.

On the therapeutic front, while interdisciplinary treatment is widely advocated, standardized care pathways are virtually nonexistent. Very few randomized controlled trials have directly compared isolated dental or physiotherapeutic approaches with combined interventions, and even fewer have included psychological or behavioral components as active arms. As a result, clinicians often rely on empirical experience or extrapolate from unrelated musculoskeletal models.

Technological advancement presents an opportunity for future exploration. Digital occlusal analysis systems, 3D kinematic tracking, wearable EMG sensors, and AI-assisted imaging interpretation could provide more objective and individualized diagnostics. However, these tools are underutilized in both clinical and research settings. Integrating such technologies into larger, multicenter trials could provide meaningful insights into the biomechanics and neurophysiology of TMD–cervical interactions.

From a public health perspective, research is also needed to evaluate the economic and societal impact of chronic TMD with cervical comorbidity, including work absenteeism, healthcare utilization, and effects on daily function. These data would support the development of preventive strategies and better resource allocation.

Finally, future directions must prioritize interdisciplinary collaboration in research design, ensuring that dental professionals, physiotherapists, neurologists, psychologists, and pain specialists contribute to study protocols. Cross-disciplinary training and shared terminology will be essential to overcome the fragmentation that currently impedes knowledge integration.

In summary, the field requires a paradigm shift toward integrated, patient-centered, and evidence-driven frameworks, grounded in longitudinal data, objective assessment, and real-world applicability. Addressing these research gaps will be fundamental in improving both diagnostic precision and therapeutic outcomes for individuals affected by complex temporomandibular and cervical dysfunctions.

4.CONCLUSIONS

- The functional and pathophysiological interconnection between temporomandibular disorders (TMD) and cervical spine pathology reflects a complex interplay of anatomical continuity, neuromuscular coordination, and central nervous system convergence. Far from being isolated regional conditions, TMD and cervical dysfunction frequently coexist and potentiate one another, contributing to chronicity, functional impairment, and reduced quality of life.
- Current evidence supports the view that cervical spine disorders—particularly upper cervical instability, muscular imbalance, and altered posture—can influence TMJ function through shared neural pathways (notably the trigeminocervical complex) and biomechanical mechanisms. Conversely, longstanding TMD may contribute to cervical dysfunction via compensatory muscular overuse and altered proprioception.

- From a clinical perspective, this bidirectional relationship necessitates a shift away from reductionist models of orofacial pain toward **integrated diagnostic and therapeutic frameworks**. Comprehensive assessment should include cervical screening, postural evaluation, and psychosocial profiling, especially in chronic or treatment-resistant cases. Multimodal interventions—combining physiotherapy, occlusal therapy, behavioral support, and patient education—have shown greater efficacy than isolated treatments, underscoring the importance of interdisciplinary care.
- Despite increasing scientific interest, significant gaps remain in understanding the natural history, shared pathomechanisms, and optimal management strategies for patients presenting with overlapping TMD and cervical symptoms. Future research must prioritize longitudinal designs, standardized diagnostic tools, and cross-disciplinary collaboration to clarify causality and inform evidence-based care pathways.
- Ultimately, recognizing the TMJ and cervical spine as parts of a unified cranio-cervical system offers clinicians a more comprehensive lens through which to understand orofacial pain and dysfunction. A paradigm grounded in neuromuscular interdependence, postural dynamics, and patient-centered management holds the promise of more effective and sustainable outcomes for individuals affected by these often-intertwined conditions.

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