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FROM JAW TO SPINE: A NARRATIVE REVIEW ON ORAL HEALTH, TMJ FUNCTION, AND POSTURAL REHABILITATION STRATEGIES

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ABSTRACT

This narrative review explores the intricate interrelationship between oral health, temporomandibular joint (TMJ) function, and cervical spine dynamics, highlighting the importance of an integrative, multidisciplinary approach to diagnosis and rehabilitation. Anatomical and neurophysiological links between the TMJ and cervical spine-mediated through the trigeminocervical complex-underscore how dysfunction in one area can influence the other, resulting in pain, postural imbalances, and reduced quality of life. Systemic factors, such as chronic inflammation, periodontal disease, and autoimmune conditions, further contribute to this complexity. The review emphasizes the therapeutic potential of physiotherapy and postural rehabilitation techniques, including manual therapy, neuromuscular re-education, and cervical stabilization, in improving both TMJ and cervical symptoms. Current literature supports the efficacy of interdisciplinary management strategies that integrate dental, physiotherapeutic, and neurological care. Future directions point toward personalized treatment protocols, digital health tools, and preventive education to better address the growing burden of temporomandibular and spinal dysfunctions.

Key words: Temporomandibular joint, cervical spine, postural rehabilitation, oral health, physiotherapy, trigeminocervical complex

1.INTRODUCTION

The human body functions as a complex, interconnected system in which dysfunctions in one anatomical region can significantly impact others. In recent decades, growing evidence has drawn attention to the intricate relationships between oral health, temporomandibular joint (TMJ) function, and cervical spine integrity [1,2].

These relationships are particularly relevant in the context of chronic musculoskeletal conditions, such as temporomandibular disorders (TMDs) and cervical disc herniation, which often present with overlapping symptoms, including pain, limited mobility, and altered posture [3].

Oral health extends beyond the teeth and gums, encompassing the functionality and alignment of the jaws, occlusion, and associated muscular activity. Disruptions in these components may contribute not only to local discomfort, but also to biomechanical imbalances involving the cervical spine and shoulder girdle [4].

The TMJ, being anatomically and functionally connected to the cervical spine through muscular and neural pathways, plays a pivotal role in maintaining postural equilibrium [5,6].

In parallel, physiotherapeutic approaches targeting the cervical region—ranging from

manual therapy and postural correction to myofascial release and neuromuscular re-education—have shown promise in alleviating symptoms of TMDs and enhancing orofacial function [7,8]. Likewise, emerging integrative strategies involving dentistry, physiotherapy, and neuroscience are opening new avenues in managing complex cases that span orofacial and cervical involvement [9].

This narrative review aims to synthesize current knowledge on the bidirectional links between oral health, TMJ function, and cervical spine disorders. Particular attention is given to the role of postural rehabilitation in multidisciplinary care, with the goal of informing both clinical practice and future research directions [10].

2.LITERATURE REVIEW

To explore the complex interface between oral health, TMJ function, and cervical spine dynamics, we performed a narrative review of the scientific literature published in the last two decades. Key articles were identified through electronic databases (PubMed, Scopus, and Web of Science) using combinations of terms such as "temporomandibular disorders," "oral health," "occlusion," "cervical spine," and "physiotherapy." Selection criteria prioritized studies with clinical relevance, anatomical insight, and interdisciplinary scope. Based on this foundation, we begin by examining the core components of orofacial health and the functional role of the temporomandibular. joint.

- *Oral Health and Temporomandibular Joint Function*

The temporomandibular joint (TMJ) is a synovial articulation between the mandibular condyle and the glenoid fossa of the temporal bone, with a fibrocartilaginous disc that divides the joint into superior and inferior compartments. Its unique structure enables both hinge-like rotation and gliding movements, allowing for the complex motions of mastication, speech, and swallowing [11]. The TMJ is innervated primarily by the auriculotemporal branch of the mandibular nerve (CN V3) and receives vascular supply from branches of the superficial temporal and maxillary arteries [12].

Temporomandibular disorders represent a heterogeneous group of conditions affecting the masticatory muscles, TMJ structures, and associated tissues. According to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), TMDs are classified into muscular, articular, and combined disorders, with symptoms ranging from joint noises and restricted mouth opening to myofascial pain and headaches [13]. Etiological factors include parafunctional habits, malocclusion, psychological stress, and trauma [14].

Malocclusion and bruxism (parafunctional activity) can significantly influence TMJ loading and muscular fatigue, predisposing individuals to dysfunction. Imbalanced occlusal contacts may lead to asymmetric mandibular movements and overactivation of the masticatory muscles, contributing to pain and inflammation [15]. Moreover, poor oral health, including periodontal disease or missing teeth, can further disrupt occlusal harmony and mandibular stability [16].

Recent studies have increasingly explored the systemic dimensions of temporomandibular disorders (TMDs), emphasizing their interaction with chronic inflammatory processes and multisystemic conditions. Periodontal disease, a prevalent chronic oral condition, has been linked to elevated systemic levels of pro-inflammatory cytokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and C-reactive protein (CRP) [17,18]. These biomarkers are also found to be elevated in synovial fluid and blood samples of patients with internal derangement of the TMJ and degenerative joint disease, suggesting shared inflammatory pathways [19].

In particular, TNF-α has been shown to mediate cartilage degradation and bone resorption in both periodontitis and temporomandibular osteoarthritis, while IL-6 may contribute to central sensitization and

chronic pain syndromes [20]. A study by Maixner et al. found that individuals with TMDs exhibit higher systemic inflammatory load compared to matched controls, with potential implications for comorbidities such as cardiovascular and autoimmune diseases [21].

Systemic rheumatic diseases, particularly rheumatoid arthritis (RA), often manifest TMJ involvement in their early stages. TMJ arthritis can lead to progressive cartilage erosion, reduced mandibular mobility, and occlusal changes, affecting both masticatory function and quality of life [22]. Imaging studies confirm that nearly 50% of RA patients may present radiographic signs of TMJ degeneration, even in the absence of overt symptoms [23].

Similarly, fibromyalgia—a chronic pain disorder characterized by widespread musculoskeletal pain and central sensitization—is frequently associated with TMD. A systematic review by Costa et al. reported that up to 75% of patients with fibromyalgia also experience TMJ pain, suggesting a high rate of comorbidity and overlapping mechanisms such as altered pain modulation and autonomic dysfunction [24].

These findings underscore the necessity of an integrated diagnostic and therapeutic approach that considers the TMJ not as an isolated entity, but as part of a systemic inflammatory and neuromuscular network. Clinicians across disciplines—including dentistry, rheumatology, and physiotherapy—should be vigilant for orofacial signs that may indicate broader systemic dysregulation.

➢ *TMJ and Cervical Spine Interactions*

The anatomical and functional interplay between the temporomandibular joint (TMJ) and the cervical spine is increasingly recognized in the context of musculoskeletal and postural dysfunction. Several studies have demonstrated that alterations in cervical posture and spinal alignment can affect masticatory muscle activity and TMJ biomechanics, and vice versa. This bidirectional relationship is mediated through shared neuromuscular pathways, muscular continuities, and central mechanisms involved in pain processing.

The TMJ and cervical spine are closely connected via the trigeminocervical complex (TCC), a convergence zone in the upper cervical spinal cord where sensory input from the trigeminal nerve (CN V) and upper cervical nerves (C1–C3) is integrated [25]. This anatomical and neurophysiological cross-talk explains why nociceptive stimuli originating from the TMJ, masticatory muscles, or even the teeth can be perceived in cervical areas and vice versa.

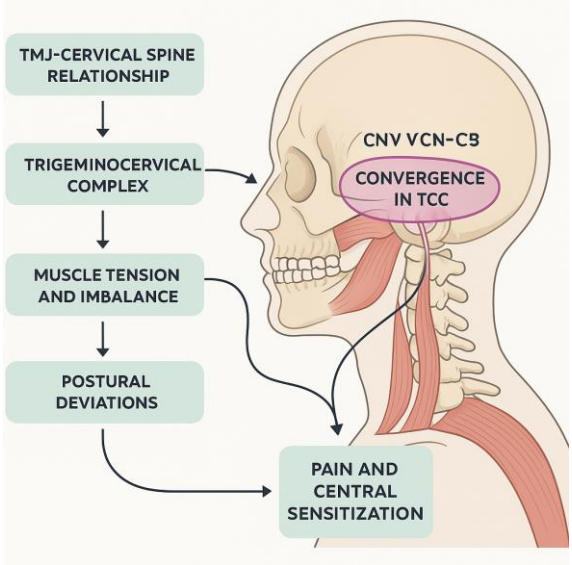

Figure 1- Functional Connectivity Between TMJ and Cervical Spine in Postural and Pain Disorders

For instance, studies using electromyography and imaging have shown that patients with TMJ dysfunction often present with increased tension or asymmetry in the cervical musculature, particularly in the sternocleidomastoid, trapezius, and suboccipital muscles [26]. Moreover, sustained cervical flexion or poor neck posture can lead to mandibular displacement, altered occlusion, and increased strain on the TMJ [27].

The deep cervical flexors and the muscles of mastication, although serving distinct functions, are functionally coupled in maintaining head and jaw stability. Dysfunction or fatigue in one group can produce compensatory overactivation in the other, perpetuating a cycle of tension and imbalance [28].

Pain in TMD and cervical spine disorders is often chronic and may involve central sensitization, a process in which the central nervous system amplifies nociceptive input. Due to the convergence in the TCC, persistent nociceptive stimuli from the cervical spine can sensitize neurons that also receive input from orofacial structures, leading to referred pain and widespread hyperalgesia [29].

This phenomenon helps explain the high comorbidity between TMDs, tension-type headaches, and cervicogenic pain. Functional MRI studies have confirmed overlapping brain activation patterns in patients with TMD and chronic neck pain, supporting the concept of shared neural circuits [30].

Postural deviations such as forward head posture (FHP) have been shown to affect mandibular kinematics. FHP alters the cranio-cervical angle and leads to downward and posterior repositioning of the mandible, increasing joint loading and potentially contributing to displacement and intra-articular dysfunctions [31].

Clinical trials have shown that correcting cervical posture through physiotherapy can improve the TMJ range of motion, reduce joint sounds, and alleviate myofascial pain [32]. Thus, postural assessment should be an integral part of TMD evaluation.

Cervical disc herniation (CDH) represents a degenerative or traumatic displacement of the intervertebral disc material beyond the normal margins of the disc space, frequently resulting in nerve root compression and neuroinflammatory responses. While its classical clinical manifestations include neck pain, radiculopathy, and restricted mobility, increasing attention has been paid to its potential association with temporomandibular dysfunction (TMD) and orofacial pain syndromes [33,34].

The functional and neurological overlap between the cervical spine and the temporomandibular system is mediated by the trigeminocervical complex (TCC)-a convergence zone in the upper cervical spinal cord (C1–C3) where nociceptive afferents from both the trigeminal nerve and cervical nerves integrate. Compression or irritation of cervical roots, particularly at levels C3–C5, may result in referred pain to the mandibular and preauricular regions, mimicking or exacerbating TMD symptoms [35].

Moreover, muscle chain interactions and reflex protective mechanisms following cervical pathology may alter mandibular positioning and masticatory muscle activation. Several studies have shown increased contraction and asymmetry in the activity of temporalis and masseter muscles in patients with cervical pathology, suggesting a compensatory neuromuscular pattern aimed at stabilizing the cranio-cervical junction [36,37].

Cervical disc pathology can also impair proprioceptive input and influence head and jaw positioning, contributing to joint overload or intra-articular disc displacement in predisposed individuals [36].

In a cohort study by Tseng et al. (2017), patients with cervical disc herniation had a 1.5-fold increased risk of being diagnosed with TMD over a 5-year follow-up, indicating a clinically significant correlation between the two conditions [37]. Other clinical reports indicate that cervical decompression surgery or targeted physiotherapeutic rehabilitation (manual therapy, neural mobilization, postural training) may result in concurrent improvement of both cervical and TMJ symptoms, especially in patients with comorbid signs of craniomandibular dysfunction [38,39].

From a therapeutic perspective, the presence of coexisting CDH and TMD necessitates a multidisciplinary approach, integrating neurologic, dental, and physiotherapeutic evaluations. Misattribution of facial or preauricular pain to primary TMJ disorders in patients with undiagnosed cervical pathology may delay appropriate intervention and perpetuate symptoms.

Future research is needed to better define diagnostic algorithms, electromyographic patterns, and rehabilitation protocols that address both the cervical and temporomandibular components in affected patients.

- *Role of Physiotherapy and Postural Rehabilitation in TMJ and Cervical Spine Disorders*The interdependence between the

temporomandibular joint (TMJ), cervical spine alignment, and overall postural control suggests that rehabilitation strategies addressing only one anatomical region may be insufficient. Physiotherapy and postural re-education have emerged as valuable, non-invasive therapeutic options for managing both temporomandibular disorders (TMDs) and cervical dysfunction, particularly when these conditions coexist. Targeted interventions can restore muscular balance, reduce joint load, and improve proprioception and neuromuscular control.

Postural rehabilitation aims to correct dysfunctional alignment patterns that overload the musculoskeletal system. In TMD patients, common deviations such as forward head posture (FHP), scapular protraction, and thoracic kyphosis may increase the biomechanical stress on the masticatory system and alter mandibular kinematics [40]. These postural faults can be addressed through a combination of stretching, strengthening, and sensorimotor training, often under the guidance of a physiotherapist.

Studies have shown that specific cervical stabilization exercises can lead to significant reductions in TMJ-related pain and joint clicking [41]. In a randomized clinical trial by Olivo et al., patients with TMD who received cervical manual therapy and postural training exhibited better outcomes than those treated with occlusal splints alone [42].

Manual therapy—including joint mobilizations, soft tissue release, and myofascial trigger point therapy—can alleviate muscular tension and restore range of motion in both the cervical spine and TMJ. Trigger points in the masseter, temporalis, sternocleidomastoid, and suboccipital muscles are often implicated in referred pain and limited mandibular function [43,44].

A meta-analysis by Kalamir et al. concluded that manual therapy targeting the craniocervical region has a moderate-to-strong effect on pain reduction in TMD patients, especially when combined with therapeutic exercises [45].

Rehabilitation of the TMJ must also consider proprioceptive training to enhance jaw positioning, coordination, and awareness. Biofeedback, controlled mandibular movements, and tongue positioning techniques are often used in physiotherapy to retrain the orofacial musculature [46]. These methods can reduce dysfunctional chewing patterns and clenching behaviors, contributing to long-term stabilization.

In cases of coexisting cervical disc herniation (CDH) and TMD, an integrated rehabilitation approach becomes even more critical. Treatment may involve graded cervical mobilizations, neural gliding exercises, TMJ stabilization drills, and postural correction protocols. Clinical experience and observational studies suggest that improving cervical alignment can relieve TMJ loading and reduce symptoms such as joint clicking, headaches, and facial pain [47].

Functional improvements in jaw opening and muscle symmetry have also been reported following cervical spine decompression surgery or structured physiotherapy programs, indicating that cervical pathology may play a contributory or perpetuating role in TMD [48].

- *Integrative and Preventive Perspectives in TMJ and Postural Health*

The multifactorial nature of temporomandibular disorders (TMDs) and their interplay with cervical spine dysfunction and postural disturbances calls for a holistic, integrative approach in both clinical management and public health policy. Beyond isolated symptom control, attention must be directed toward prevention, early detection, and multidisciplinary care to improve long-term outcomes and reduce chronicity.

The convergence of dental, medical, and physiotherapeutic perspectives is essential in the effective management of patients presenting with combined orofacial and cervical complaints. Evidence supports the development of interdisciplinary clinics that include dentists, physiotherapists, neurologists, and rheumatologists to provide comprehensive assessment and treatment [49]. Such collaboration enhances diagnostic accuracy, improves therapeutic outcomes, and reduces redundant or ineffective

interventions.

Multidisciplinary rehabilitation programs that incorporate dental occlusal therapy, cervical spine stabilization, behavioral interventions, and biofeedback have been associated with significant improvements in pain reduction and functional restoration [50-52].

Given the rising incidence of TMDs and spinal dysfunctions in both young and aging populations, early screening in dental and primary care settings should include postural evaluation, TMJ palpation, and assessment of cervical range of motion. Preventive education targeting ergonomic awareness, bruxism control, and stress management should be integrated into health promotion strategies, especially in adolescents and office workers [53,54].

In older adults, TMJ and cervical dysfunction are frequently underdiagnosed due to overlapping symptoms with other degenerative conditions. Including TMJ and cervical spine evaluation in routine geriatric screenings could help identify at-risk individuals before the onset of chronic dysfunction [55].

With advances in digital health, tele-rehabilitation platforms, virtual posture analysis tools, and mobile apps for jaw tracking and cervical exercise guidance offer new opportunities to monitor progress and reinforce home-based therapy [56]. These tools are especially valuable in underserved areas or during limited clinical access, such as during the COVID-19 pandemic.

As awareness grows regarding the intricate interplay between temporomandibular joint (TMJ) function, cervical spine dynamics, and systemic musculoskeletal health, future research must prioritize the development of standardized clinical protocols that seamlessly integrate TMJ and cervical assessments into routine musculoskeletal evaluations. Longitudinal studies are needed to clarify the long-term benefits of postural correction strategies on TMJ health and functionality. In parallel, biomarker research exploring the role of systemic inflammation in mediating joint and muscle dysfunction could provide molecular targets for early diagnosis and intervention.

Technological innovation also plays a vital role—particularly through the implementation of AI-assisted postural analysis tools in clinical settings, allowing for objective, scalable, and personalized diagnostics. Ultimately, the design of individualized rehabilitation programs, tailored to each patient's postural profile and occlusal characteristics, represents a critical direction toward improving outcomes and preventing recurrence in patients with overlapping TMJ and cervical disorders [57].

The intricate relationship between oral health, temporomandibular joint (TMJ) function, and cervical spine dynamics highlights the need for a more integrative understanding of musculoskeletal balance and dysfunction. Emerging literature increasingly supports the notion that postural deviations, particularly forward head posture and cervical spine misalignment, can alter mandibular biomechanics, muscle activation patterns, and temporomandibular joint loading. These findings are consistent with neuroanatomical evidence implicating the trigeminocervical complex in the convergence of cervical and craniofacial sensory inputs [58].

Moreover, the bidirectional interaction between TMJ disorders (TMDs) and systemic inflammatory processes has important implications. Low-grade chronic inflammation—whether originating from periodontal disease, cervical disc degeneration, or systemic conditions such as rheumatoid arthritis—may contribute to a shared pathophysiological substrate marked by elevated cytokine activity (e.g., IL-6, TNF-α), nociceptive sensitization, and neuromuscular imbalance [59,60].

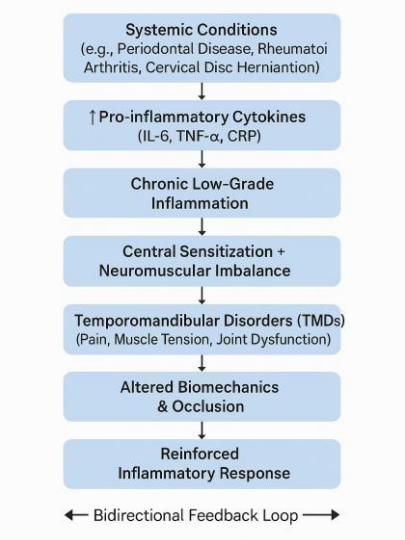

Figure 2-Inflammation-Jaw Disorder Connection

Physiotherapy and postural rehabilitation have demonstrated moderate to strong clinical efficacy in the management of both cervical dysfunctions and TMDs, particularly when applied within a multidisciplinary framework that includes dental, orthopedic, and neurologic input. Studies have shown that interventions targeting cervical alignment and muscle coordination may improve not only local symptoms but also occlusal balance and mandibular mobility [61]. Nevertheless, the degree of individual variation in response to therapy suggests that standardized protocols must be accompanied by personalized assessments that account for occlusal morphology, postural patterns, and psychosocial stressors.

One notable limitation across the literature is the lack of large-scale, prospective studies that directly evaluate causal links between postural correction and improvements in TMJ function. Additionally, the underrepresentation of older adults, patients with complex comorbidities, and longitudinal follow-up weakens the generalizability of current findings. Future research must address these gaps through interdisciplinary clinical trials and biomarker-driven cohort studies.

Lastly, the implementation of preventive strategies, including ergonomic education, myofunctional exercises, and routine TMJ-postural assessments—remains inconsistent across clinical settings. Bridging this gap will require educational reform, update clinical guidelines, and increase public awareness of the interdependence between posture, oral health, and musculoskeletal integrity.

4.FUTURE PERSPECTVES:

Looking ahead, the integration of temporomandibular joint (TMJ) assessment within broader musculoskeletal and postural health paradigms offers promising avenues for both clinical innovation and interdisciplinary collaboration. The increasing recognition of the functional continuum between the jaw, cervical spine, and global posture invites a shift from isolated, symptom-based treatments to more systemic, patient-centered models of care.

Technological advancements—such as AI-assisted motion tracking, wearable postural sensors, and tele-rehabilitation platforms—are expected to redefine diagnostics and follow-up strategies, especially in settings with limited access to specialized care. Furthermore, epigenetic and inflammatory biomarkers may soon offer predictive value for identifying individuals at risk of chronic orofacial and spinal dysfunctions, allowing for early, pre-symptomatic intervention.

In education, embedding knowledge of TMJ-spine interrelationships into both dental and physiotherapy curricula could improve interprofessional awareness and foster integrated therapeutic approaches. On a public health level, preventive campaigns addressing posture, bruxism, ergonomics, and stress management, especially in digital device users and sedentary populations-may mitigate the growing burden of temporomandibular and cervical disorders.

Ultimately, the future of TMJ and postural rehabilitation lies in precision medicine, where individualized care protocols will be informed by anatomical, biomechanical, systemic, and psychosocial factors-offering more effective and durable outcomes for patients across the lifespan.

CONCLUSIONS:

- The complex interplay between oral health, temporomandibular joint (TMJ)

function, and postural alignment-particularly cervical spine dynamics-underscores the necessity of a multidimensional and interdisciplinary approach in both research and clinical practice. Mounting evidence supports the bidirectional relationship between TMJ disorders and cervical dysfunctions, mediated through shared neuromuscular pathways and central pain processing mechanisms.

- Moreover, oral health, particularly in the presence of periodontal disease, may exacerbate systemic inflammation, contributing not only to joint dysfunction but also to neuroplastic changes affecting musculoskeletal control. Postural deviations such as forward head posture can further alter mandibular mechanics, perpetuating cycles of muscle imbalance and pain.
- Integrating dental assessment, physiotherapeutic strategies, and postural rehabilitation-alongside systemic inflammation management-holds significant promise for improving outcomes in patients with overlapping orofacial and musculoskeletal complaints. Future clinical protocols should prioritize individualized, evidence-based interventions that consider occlusal dynamics, cervical alignment, and the broader biopsychosocial context of each patient.
- Ultimately, bridging the gap between dentistry, rehabilitation sciences, and neuromuscular research will be key to addressing chronic dysfunctions that span from jaw to spine.

REFERENCES

1. Corriero A, Farinella F, Cicciù M, Cervino G. Temporomandibular joint (TMJ) and cervical spine: is there any relationship between them? *J Funct Morphol Kinesiol*. 2022;7(2):33.
2. Khawaja SN, Waseem Z, Saeed M. The role of physical therapy in the management of temporomandibular joint dysfunction: a review. *Front Oral Maxillofac Med*. 2023; 5:11
3. de Giorgi I, Graziuso G, Adduci F, Brindisino F, Megna M, Fiore P. Effects of exercise programs on temporomandibular disorders: a systematic review. *Physiother Theory Pract*. 2022;38(5):625-640.
4. Almeida RS, Barreto R, Costa D, Rondon A, Sousa N, Alburquerque-Sendin F. Cervical spine manual therapy and exercise for patients with temporomandibular disorders and headache: a randomized clinical trial. *BMC Sports Sci Med Rehabil*. 2023; 15:26.
5. Liberato FA, Martins WR, Wuo AM, Pazzianotto-Forti EM, et al. Effects of cervical spine mobilization in patients with temporomandibular disorder: a randomized clinical trial. *J Oral Facial Pain Headache*. 2023;37(2):101-110.
6. Pihut, M.E.; Kostrzewa-Janicka, J.; Orczykowska, M.; Biegańska-Banaś, J.; Gibas-Stanek, M.; Gala, A. Initial assessment of the psycho-emotional state of patients with temporomandibular disorders: A pilot study. *Dent. Med. Probl.* **2024**, *61*, 153–159.
7. González-González, A.M.; Herrero, A.J. A systematic review of temporomandibular disorder diagnostic methods. *CRANIO—J. Craniomandib. Sleep Pract.* **2024**, *42*, 348–360.
8. Yap, A.U.; Lei, J.; Zhang, X.H.; Fu, K.Y. TMJ degenerative joint disease: Relationships between CBCT findings, clinical symptoms, and signs. *Acta Odontol. Scand* **2023**, *81*, 562–568.
9. Matos, M.; Thumati, P.; Sutter, B.; Ruiz-velasco, G.; Goldberg, J.; Booth, J.; Radke, J. Are Temporomandibular Disorders Really Somatic Symptom Disorders? Part II—Joint Vibration Analysis of the Temporomandibular Joint. *Adv. Dent. Technol. Tech.* **2021**, *4*, 21–34.
10. Gözler, S. JVA, Mastication and Digital Occlusal Analysis in Diagnosis and Treatment of Temporomandibular Disorders. In *Temporomandibular Joint Pathol*, 1st ed.; Intech: London, UK,

2018; pp. 127–159.
11. Bortoluzzi, M.C.; Traebert, J.; Lasta, R.; Da Rosa, T.N.; Capella, D.L.; Presta, A.A. Tooth loss, chewing ability and quality of life. *Contemp. Clin. Dent.* **2012**, *3*, 393–397.
12. Ribeiro, J.A.; de Resende, C.M.; Lopes, A.L.; Farias-Neto, A.; Carreiro Ada, F. Association between prosthetic factors and temporomandibular disorders in complete denture wearers. *Gerodontology* **2014**, *31*, 308–313.
13. Stuginski-Barbosa, J.; Macedo, H.R.; Bigal, M.E.; Speciali, J.G. Signs of temporomandibular disorders in migraine patients: A prospective, controlled study. *Clin. J. Pain* **2010**, *26*, 418–421.
14. Van Kampen, F.M.; van der Bilt, A.; Cune, M.S.; Bosman, F. The influence of various attachment types in mandibular implant-retained overdentures on maximum bite force and EMG. *J. Dent. Res.* **2002**, *81*, 170–173.
15. Elsyad, M.A.; Hegazy, S.A.; Hammouda, N.I.; Al-Tonbary, G.Y.; Habib, A.A. Chewing efficiency and electromyographic activity of masseter muscle with three designs of implant-supported mandibular overdentures. A cross-over study. *Clin. Oral Implant. Res.* **2014**, *25*, 742–748.
16. Goiato, M.C.; Garcia, A.R.; dos Santos, D.M. Electromyographic Activity of the Mandible Muscles at the Beginning and End of Masticatory Cycles in Patients with Complete Dentures. *Gerontology* **2008**, *54*, 138–143.
17. Dibai Filho, A.V.; Packer, A.C.; Costa, A.C.; Rodrigues-Bigaton, D. Accuracy of infrared thermography of the masticatory muscles for the diagnosis of myogenous temporomandibular disorder. *J. Manip. Physiol. Ther.* **2013**, *36*, 245–252.
18. Moreira, A.; Batista, R.; Oliveira, S.; Mendes, J.; Sampaio-Fernandes, M.; Figueiral, M.H. The Thermal Influence of Oral Rehabilitation on the Cranio-Cervico-Mandibular Complex: A Thermographic Analysis. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10441.
19. De Caxias, F.P.; Dos Santos, D.M.; Goiato, M.C.; Bitencourt, S.B.; da Silva, E.V.F.; Laurindo, M.C.B., Jr. Effects of mouth rehabilitation with removable complete dentures on stimulus perception and the electromyographic activity of the orbicularis oris muscle. *J. Prosthet. Dent.* **2018**, *119*, 749–754.
20. McGilvery, W.; Eastin, M.; Sen, A.; Witkos, M. Self Manipulated Cervical Spine Leads to Posterior Disc Herniation and Spinal Stenosis. *Brain Sci.* **2019**, *9*, 125.
21. Suetsuna, F.; Okudera, Y.; Tanaka, T.; Tamura, T. Spinal cord injury due to cervical disc herniation caused by bench pressing. *J. Spine* **2014**, *3*, 154.
22. Kaneda, M.; Shimpo, Y.; Yoshida, K.; Kubo, R.; Kobayashi, F.; Mishima, A.; Igarashi, C.; Tomonari, H. Structural Features of the Temporomandibular Joint Evaluated by MRI and Their Association with Oral Function and Craniofacial Morphology in Female Patients with Malocclusion: A Cross-Sectional Study. *J. Clin. Med.* **2025**, *14*, 4921.
23. List, T.; Jensen, R.H. Temporomandibular disorders: Old ideas and new concepts. Cephalalgia 2017, 37, 692–704.
24. Malgorzata, P.; Malgorzata, K.-M.; Karolina, C.; Gala, A. Diagnostic of temporomandibular disorders and other facial pain conditions—Narrative review and personal experience. Medicina 2020, 56, 472.
25. Butts, R.; Dunning, J.; Perreault, T.; Mettille, J.; Escaloni, J. Pathoanatomical characteristics of temporomandibular dysfunction: Where do westand? (Narrative review part 1). J. Bodyw. Mov. Ther. 2017, 21, 534–540.
26. Chisnoiu, A.M.; Picos, A.M.; Popa, S.; Chisnoiu, P.D.; Lascu, L.; Picos, A.; Chisnoiu, R. Factors involved in the etiology of temporomandibular disorders—A literature review. Clujul Med. 2015, 88, 473–478.
27. Lekaviciute, R.; Kriauciunas, A. Relationship between occlusal factors and temporomandibular disorders: A systematic literature review. Cureus 2024, 16, e54130.
28. Manfredini, D.; Segù, M.; Arveda, N.; Lombardo, L.; Siciliani, G.; Rossi, A.; Guarda-Nardini, L. Temporomandibular joint disorders in patients with different facial morphology. A systematic review of the literature. J. Oral Maxillofac. Surg. 2016, 74, 29–46.
29. Bueno, C.H.; Pereira, D.D.; Pattussi, M.P.; Grossi, P.K.; Grossi, M.L. Gender differences in temporomandibular disorders in adult populational studies: A systematic review and meta-analysis. J. Oral Rehabil. 2018, 45, 720–729.

30. Florjanski, W.; Winiewska, S. Role of mental state in temporomandibular disorders: A review of the literature. Dent. Med. Probl. 2021, 58, 127–133.
31. Aldayel, A.M.; AlGahnem, Z.J.; Alrashidi, I.S.; Nunu, D.Y.; Alzahrani, A.M.; Alburaidi, W.S.; Alanazi, F.; Alamari, A.S.; Alotaibi, R.M. Orthodontics and Temporomandibular Disorders: An Overview. Cureus 2023, 15, e47049.
32. Ângelo, D.F.; Faria-Teixeira, M.C.; Maffia, F.; Sanz, D.; Sarkis, M.; Marques, R.; Mota, B.; João, R.S.; Cardoso, H.J. Association of Malocclusion with Temporomandibular Disorders: A Cross-Sectional Study. J. Clin. Med. 2024, 13, 4909.
33. Gonçalves, T.M.; Sanchez-Ayala, A.; Ambrosano, G.M.; Rodrigues Garcia, R.C.M. Female hormonal fluctuation and masticatory function in patients with disc displacement—A case-control study. Int. J. Prosthodont. 2011, 24, 320–327.
34. Kurita, H.; Ohtsuka, A.; Kurashina, K.; Kopp, S. Chewing ability as a parameter for evaluating the disability of patients with temporomandibular disorders. J. Oral Rehabil. 2001, 28, 463–465.
35. Schiffman, E.; Ohrbach, R.; Truelove, E.; Look, J.; Anderson, G.; Goulet, J.-P.; List, T.; Svensson, P.; Gonzalez, Y.; Lobbezoo, F.; et al. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for Clinical and Research Applications: Recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J. Oral Facial Pain Headache 2014, 28, 6–27.
36. Toh, A.Q.J.; Chan, J.L.H.; Leung, Y.Y. Mandibular asymmetry as a possible etiopathologic factor in temporomandibular disorder: A prospective cohort of 134 patients. Clin. Oral Investig. 2021, 25, 4445–4450.
37. Bag, A.K.; Gaddikeri, S.; Singhal, A.; Hardin, S.; Tran, B.D.; Medina, J.A.; Curé, J.K. Imaging of the temporomandibular joint: An update. World J. Radiol. 2014, 6, 567–582.
38. Talmaceanu, D.; Lenghel, L.M.; Bolog, N.; Hedesiu, M.; Buduru, S.; Rotar, H.; Baciut, M.; Baciut, G. Imaging modalities for temporomandibular joint disorders: An update. Clujul Med. 2018, 91, 280–287.
39. Dias, M.I.; Coelho, R.P.; Assis, P.S.M.N.; Leite, P.P.F.; Devito, L.K. Evaluation of the correlation between disc displacements and degenerative bone changes of the temporomandibular joint by magnetic resonance images. Int. J. Oral Maxillofac. Surg. 2012, 41, 1051–1057.
40. Gil, C.; Santos, K.C.P.; Dutra, M.E.P.; Kodaira, D.K.; Oliveira, J.X. MRI analysis of the relationship between bone changes in the temporomandibular joint and articular disc position in symptomatic patients. Dentomaxillofac. Radiol. 2012, 41, 367–372.
41. John, Z.A.S.; Shrivastav, S.S.; Kamble, R.; Jaiswal, E.; Dhande, R. Three-dimensional comparative evaluation of articular disc position and other temporomandibular joint morphology in Class II horizontal and vertical cases with Class I malocclusion: A magnetic resonance imaging study. Angle Orthod. 2020, 90, 707–714.
42. Chavan, S.J.; Bhad, W.A.; Doshi, U.H. Comparison of temporomandibular joint changes in Twin Block and Bionator appliance therapy: A magnetic resonance imaging study. Prog. Orthod. 2014, 15, 57.
43. Kohi, K.; Igarashi, C.; Sugisaki, M.; Osano, T.; Sato, Y.; Kobayashi, K.; Ohkubo, C. Quantitative measurements of the articular areas of mandibular condyles with temporomandibular joint disorders using magnetic resonance imaging. Cranio 2016, 34, 79–87.
44. Igarashi, C.; Kobayashi, K.; Ito, H.; Eda, T.; Wakae-Morita, S. Clinical and magnetic resonance imaging findings in patients with and without improvement after mandibular manipulation and conservative physical therapy for temporomandibular joint disorders. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. 2023, 135, 294–302.
45. Sasaki, Y.; Yamamoto, J.-I.; Kanzaki, H.; Shimpo, Y.; Miyamoto, Y.; Kobayashi, F.; Nishida, T.; Mizokami, K.; Katayama, M.; Sekiya, T.; et al. Association Between Severity of Malocclusion and Parameters of Oral Functions in Permanent Dentition With Various Malocclusion: Case-Control Study. Clin. Investig. Orthod. 2023, 82, 212–221.
46. Horibe, Y.; Matsuo, K.; Ikebe, K.; Minakuchi, S.; Sato, Y.; Sakurai, K.; Ueda, T. Relationship Between Two Pressure-Sensitive Films for Testing Reduced Occlusal Force in Diagnostic Criteria for Oral Hypofunction. Gerodontology 2022, 39, 3–9.
47. Komagamine, Y.; Kanazawa, M.; Minakuchi, S.; Uchida, T.; Sasaki, Y. Association Between

Masticatory Performance Using a ColourChangeable Chewing Gum and Jaw Movement. J. Oral Rehabil. 2022, 38, 555–563.
48. Ueda, K.; Motegi, E.; Yata, R.; Torikai, T.; Harasaki, M.; Yamaguchi, H. Lip Seal Study of Japanese Adults With Malocclusion. Bull. Tokyo Dent. Coll. 2002, 43, 89–93.
49. Xiong, X.; Huang, Y.; Liu, W.; Wu, Y.; Yi, Y.; Wang, J. Distribution of various maxilla-mandibular positions and cephalometric comparison in Chinese skeletal class II malocclusions. J. Contemp. Dent. Pract. 2020, 21, 822–828.
50. Bavia, P.F.; Vilanova, L.S.R.; Garcia, R.C.M.R. Craniofacial Morphology Affects Bite Force in Patients with Painful Temporo mandibular Disorders. Braz. Dent. J. 2016, 27, 619–624.
51. Mizokami, K.; Tohyama, S.; Kanzaki, H.; Sasaki, Y.; Katayama, M.; Seki, M.; Rikitake, H.; Ueda, S.; Sekiya, T.; Tomonari, H. Quantitative Comparison of Age-Related Development of Oral Functions During Growing Age. Clin. Exp. Dent. Res. 2024, 10, e70033.
52. Tomonari, H.; Seong, C.; Kwon, S.; Miyawaki, S. Electromyographic activity of superficial masseter and anterior temporal muscles during unilateral mastication of artificial test foods with different textures in healthy subjects. Clin. Oral Investig. 2019, 23, 3445–3455.
53. Abbassy, M.A.; Abushal, A. Differences in dentofacial characteristics of Class I malocclusion between Saudi and Japanese adult females. J. Orthod. Sci. 2015, 4, 86–91.
54. Yan, Z.-B.; Wan, Y.-D.; Xiao, C.-Q.; Li, Y.-Q.; Zhang, Y.-Y.; An, Y.; Xiong, X. Craniofacial Morphology of Orthodontic Patients with and without Temporomandibular Disorders: A Cross-Sectional Study. Pain Res. Manag. 2022, 22, 9344028.
55. Pereira, L.J.; Gaviao, M.B.D.; Bonjardim, L.R.; Castelo, P.M.; van der Bilt, A. Muscle thickness, bite force, and craniofacial dimensions in adolescents with signs and symptoms of temporomandibular dysfunction. Eur. J. Orthod. 2007, 29, 72–78.
56. Alessandro, M.; Dorothea, B.; Andrea, S.; Giulia, F.; Tomson, Z. Correlation between temporomandibular disorders and malocclu sions: A retrospective observational study-can malocclusions or previous orthodontic treatments affect TemporoMandibular Disorders? Int. J. Oral Craniofacial Sci. 2022, 8, 001–009.
57. Hawker, G.A.; Mian, S.; Kendzerska, T.; French, M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). Arthritis Care Res. 2011, 63 (Suppl. S11), S240–S252.
58. Kumar,A.; Castrillon, E.; Svensson, P. Can experimentally evoked pain in jaw or temporomandibular joint affect anterior bite force in humans? J. Oral Facial Pain Headache 2015, 29, 31–40.
59. Shimada, A.; Baad-Hansen, L.; Svensson, P. Effect of experimental jaw muscle pain on dynamic bite force during mastication. Arch. Oral Biol. 2015, 60, 256–266.
60. Vilanova, L.S.; Gonçalves, T.M.; Meirelles, L.; Rodrigues Garcia, R.C.M. Hormonal fluctuations intensify temporomandibular disorder pain without impairing masticatory function. Int. J. Prosthodont. 2015, 28, 72–74.
61. Colonna, A.; Manfredini, D.; Lombardo, L.; Muscatello, L.; Marchese-Ragona, R.; Arveda, N.; Siciliani, G. Comparative analysis of jaw morphology and temporomandibular disorders: A three-dimension imaging study. Cranio 2020, 38, 158–167.