7 Adjunctive Therapies for Temporomandibular Disorders

César Fernández-de-las-Peñas and Kimberly Bensen

Abstract

Proper management of patients with temporomandibular pain disorders (TMD) needs a multidisciplinary approach including several professionals such as medical doctors, dentists, physical therapists, osteopaths, chiropractors, acupuncturists, orthodontists, surgeons, and psychologists [1]. Each professional will conduct an exhaustive clinical examination and will plan a multimodal program for these patients. In fact, treatment should be personalized based on the patient's experience and including different therapeutic strategies such as passive and active techniques, active listening, empathy, and management of psychosocial issues, i.e., depression, anxiety, and catastrophizing, always based on clinical findings during the history and examination. For instance, dentists could recommend hard stabilization appliances [2] or splint therapy [3] for reducing pain in patients with TMD, whereas physical therapists can apply manual therapies or exercises for the same objective. Clinical and scientific evidence suggest that an interdisciplinary work between dentistry and physical therapy increases the effects of each isolated intervention for patients with TMD [4]. The current chapter summarizes different adjunctive therapies including physical therapy and chiropractic therapy for TMD.

C. Fernández-de-las-Peñas (✉)
Department of Physical Therapy, Occupational Therapy, Physical Medicine and Rehabilitation, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain

Esthesiology Laboratory, Universidad Rey Juan Carlos, Alcorcón, Madrid, Spain

Centre for Sensory-Motor Interaction (SMI), Laboratory for Musculoskeletal Pain and Motor Control, Aalborg University, Aalborg, Denmark
e-mail: cesar.fernandez@urjc.es

K. Bensen
TMJ Therapy, San Jose, CA, USA
http://www.drkimberlybensen.com

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7.1 Introduction

Proper management of patients with temporomandibular pain disorders (TMD) needs a multidisciplinary approach including several professionals such as medical doctors, dentists, physical therapists, osteopaths, chiropractors, acupuncturists, orthodontists, surgeons, and psychologists [1]. Each professional will conduct an exhaustive clinical examination and will plan a multimodal program for these patients. In fact, treatment should be personalized based on the patient's experience and including different therapeutic strategies such as passive and active techniques, active listening, empathy, and management of psychosocial issues, i.e., depression, anxiety, and catastrophizing, always based on clinical findings during the history and examination. For instance, dentists could recommend hard stabilization appliances [2] or splint therapy [3] for reducing pain in patients with TMD, whereas physical therapists can apply manual therapies or exercises for the same objective. Clinical and scientific evidence suggest that an interdisciplinary work between dentistry and physical therapy increases the effects of each isolated intervention for patients with TMD [4]. The current chapter summarizes different adjunctive therapies including physical therapy and chiropractic therapy for TMD.

7.2 Physical Therapy and Temporomandibular Disorders

Physical therapy include different physical agents for the management of TMD, e.g., manual therapy, therapeutic exercise, dry needling, electro-physical modalities (e.g., low-level laser, therapeutic ultrasound), or electro-analgesic modalities such as transcutaneous electrical nerve stimulation (TENS). Since TMD can affect different structures or tissues such as the temporomandibular joint (TMJ), the masticatory musculature, or their associated tissues (e.g., ligaments, connective tissues), the appropriate technique would depend on the affected tissue responsible of nociception. Physical therapy has evolved from a biomechanical point of view to a neurophysiological conceptualization. In this updated scenario, clinicians should consider potential neurophysiologic and tissue mechanisms underlying the effects of any intervention that they will apply on each patient. In fact, the challenge for clinicians is how to select proper treatment for each patient who is likely to be different with an individual clinical presentation. An important topic to consider for determining the proper therapeutic program is to determine if the clinical pattern of a patient exhibits a more peripheral or more central input dominance. This clinical reasoning is based on better understanding of nociceptive mechanisms in patients with chronic pain. Pfau et al. described two subgroups of patients with TMD grouped by their sensitization mechanism: one group (sensitive) exhibiting more central sensitization and other (nonsensitive) group showing more peripheral sensitization [5]. This classification agrees with literature supporting that identification of nociceptive processing is highly important since the presence of central sensitization can constitute a worse prognosis factor for physical therapy [6] and also may determine the dose of the interventions, e.g., intensity, amplitude, and frequency of the sessions [7]. Therefore, it seems that identification of sensitization mechanisms in patients with TMD implies a complex clinical reasoning [8].

There is evidence suggesting that individuals with TMD exhibit widespread pressure pain hypersensitivity over different tissues, e.g., muscle, joint, and nerve [9], as a manifestation of central sensitization; nevertheless, the magnitude of this sensitization is higher within the trigeminal area since widespread pressure hypersensitivity is associated with the intensity and duration of the symptoms in the orofacial area [5]. Therefore, if a particular patient with TMD seems to be more mediated by peripheral nociception, specific treatment of the affected tissue and application of exercises and functional activities should be encouraged. In this patient, localized treatments targeting muscles or joints of the TMJ responsible of nociception would be the first therapeutic step for decreasing central sensitization. If a patient with TMD seems to be more centrally mediated, a multimodal approach including pharmacological, physical, and cognitive interventions is encouraged. In these patients, it may be not possible to clearly identify a particular tissue responsible for nociception; therefore, patients should be also educated on optimizing normal functional movements and on undertaking active and specific exercises, in combination with proper passive manual therapies and educational programs.

7.3 Scientific Evidence for Physical Therapy Modalities

A national survey conducted in the United Kingdom showed that, despite limited evidence, physical therapy is usually considered to be an effective treatment option for TMD, with jaw exercises (79%), therapeutic ultrasound (52%), manual therapy (48%), acupuncture (41%), and laser therapy (15%) being considered the most effective modalities for managing TMD [10]. This section chronologically reviews scientific evidence for several physical therapy therapeutic options for the management of patients with TMD.

An old review (1999) found little evidence supporting the use of ultrasound therapy in the treatment of musculoskeletal disorders [11]. This review analyzed 13 randomized placebo clinical trials, of which 4 included individuals with TMD. Most studies did not clinically or statistically support the use of ultrasound therapy for TMD [7].

In 2006, McNeely et al. found few studies investigating the effectiveness of manual therapies for the management of TMD and concluded that the methodological quality of these studies was poor [12]. This review concluded that the use of manual therapies combined with active exercises may be effective for reducing pain and improving function in TMD, although more high-quality studies are clearly needed [8]. Another systematic review also published in 2006 concluded that active exercises combined with manual mobilizations may be effective for TMD and that postural training may be used in combination with other interventions [13]. Again, authors also pointed out for the low methodological quality of the available trials since most papers included were case series [9].

List and Axelsson, in a critical review of systematic reviews, analyzed the evidence of 23 qualitative systematic reviews and seven meta-analyses regarding the management of TMD [14]. These authors investigated the results of reviews on occlusal appliances, occlusal adjustments, bruxism, physical therapy, drug treatment, surgery, and behavioral therapy and concluded that there is limited evidence supporting the application of occlusal appliances, acupuncture, behavioral therapy, exercise, and pharmacological drug treatment for TMD [10]. An important conclusion of this review was that occlusal adjustments seem to have no effect and should be avoided [10].

Brantingham et al. conducted, in 2013, a systematic review focusing on manual and manipulative therapy conducted by chiropractors and concluded that there is limited evidence that manual and manipulative therapy may be helpful at short-term (≤3–6 months) for TMD [15].

The review by Calixtre et al. published in 2015 aimed to determine the effectiveness of manual therapies in isolation, not the application of multimodal treatments [16]. This review found low to moderate evidence supporting that myofascial release and massage applied on the masticatory muscles and spinal manipulative therapy applied to the upper cervical spine are more effective than control for the management of TMD pain [12].

The most recent meta-analysis analyzed the effects of manual therapy and exercises for the management of TMD symptoms. Armijo et al. concluded that manual therapy alone or combined with exercises at the jaw or cervical spine showed promising benefits for treatment of TMD, although effect sizes were low to moderate and related to the kind of TMD [17]. This meta-analysis found that:

1. Manual therapy significantly reduced pain (mean difference, 1.35 cm; 95% CI 0.91–1.78) at short-term compared with botulinum toxin or waiting list (mean difference, 1.31 cm; 95% CI 0.86–1.76) in myofascial TMD.
2. Head and neck exercises were significantly effective for increasing pain-free maximum mouth opening (mean difference, 5.94 mm; 95% CI 1.0–12.9) and decreasing pain (standardized pooled mean difference, 0.43; 95% CI 0.02–0.87) compared with a control group in myofascial TMD.
3. A trend, but not significant, effect of exercise (standardized pooled mean difference, 0.68; 95% CI −0.04, 1.40) against a control group was observed for arthrogenous TMD, including disc displacement with or without reduction.
4. Posture correction exercises were significantly more effective for increasing maximum pain-free mouth opening (mean difference, 5.54 mm; 95% CI 2.93–8.15) and for decreasing symptoms and disturbances with daily life activities (standardized pooled mean difference, 1.13; 95% CI 0.48–1.78) than a control group for myofascial TMD [13].

No significant adverse event was observed with any manual therapy procedure [13].

The meta-analysis conducted by Martin et al. also showed significant differences and large clinical effects on active, but not passive, mouth opening (standardized pooled mean difference, 0.83; 95% CI 0.42–1.25) and on pain during active mouth opening (standardized pooled mean difference, 1.7; 95% CI 1.1–2.3) favoring musculoskeletal manual techniques compared to other conservative treatments for TMD [18]. Although current evidence clearly supports that manual therapies and exercise can be effective for the management of TMD, it is not possible to draw any firm conclusion about the most effective techniques to improve pain and range of motion. This is related to the fact that most studies, as it is commonly done in clinical practice, have combined articular and soft tissue techniques [8–14].

A recent systematic review [19] and a meta-analysis [20] observed a moderate clinical effect (standardized pooled mean difference, −0.6; 95% CI −0.73, −0.47) for the application of low-level laser (dosages and treatments with wavelengths of 780 and 830 nm) on the masticatory muscles or joint capsule for TMD, although the optimal parameters are still controversial.

7.4 Manual Therapies

The American Academy of Orthopedic Manual Physical Therapists (AAOMPT) defines manual therapy/orthopedic manual physical therapy as "any hands-on treatment provided by the physical therapist." Manual therapy may include moving joints in specific directions, at a different speed and amplitude (joint mobilization and manipulation), soft tissue interventions, stretching interventions, passive movements of the affected body part, or having the patient move the body part against the therapist's resistance to improve muscle activation and timing (exercises) [21]. Manual therapies have been traditionally used for increasing restricted range of motion, reduce local ischemia, stimulate proprioception, break fibrous adhesions, stimulate synovial fluid production, and reduce pain symptoms. Nevertheless, recent theories suggest that manual therapy-induced effects are caused by neurophysiological mechanisms including the activation of periaqueductal gray substance; lessening of temporal summation; reduction of nociceptive substances, e.g., cytokines and substance P; and changes in muscle activity and motor-neuron pool activity [22].

Several manual therapies are clinically proposed for the management of TMD pain. In fact, patients with TMD can be treated with manual therapies targeting the TMJ (Fig. 7.1), the musculature (Fig. 7.2), or the neural tissues (Fig. 7.3), depending on the structure responsible of nociception. Additionally, preliminary evidence suggests the effectiveness of the inclusion of manual therapies targeting the cervical spine (Fig. 7.4) for the management of individuals with TMD [23, 24]. Since the cervical spine is biomechanically and neurophysiologically associated with the thoracic spine, some authors proposed the inclusion of thoracic spine manipulation (Fig. 7.5), although the isolated application of upper thoracic spine thrust manipulation did not lead to a reduction in pain in TMD [25].

Fig. 7.1 Mandibular distraction mobilization technique

Fig. 7.2 Intraoral massage of the masseter muscle

Fig. 7.3 Neural mobilization of the right trigeminal nerve

Fig. 7.4 Posterior-anterior joint mobilization of the upper cervical spine

Fig. 7.5 Upper thoracic spine thrust manipulation

It is important to consider that common clinical practice use different manual therapies with other interventions such as exercise and educational program. This multimodal approach is supported by current scientific evidence where combination of manual therapy, education, and exercise has demonstrated to be effective for myofascial TMD [26–28], TMJ arthralgia [29], or anterior disc displacement without reduction (closed lock) [30].

7.5 Exercise Programs

Therapeutic exercise interventions are prescribed to address specific TMJ impairments and to improve the function of the cranio-cervico-mandibular system. Exercise programs should be designed to improve muscle coordination, relax hypertonic muscles, increase range of motion, and increase muscle proprioception. Recent evidence supports the use of exercises to correct head and neck posture (Fig. 7.6) and active oral exercises (Fig. 7.7) for reducing TMD pain and improving orofacial motor function [13]; however, no information regarding dosage, frequency, or adherence to exercise programs are currently available. Further, there is no trial investigating the effectiveness of the isolated application of therapeutic exercises for TMD pain; so we do not currently know the effects of this intervention on isolation.

Fig. 7.6 Corrective exercise for forward head posture against the wall

Fig. 7.7 Active oral exercise with the tongue

In addition to specific therapeutic exercises, general aerobic exercise has been shown to improve strength, flexibility, and functional capacity and also induce analgesia [31]. Nevertheless, it is important to note that patients with central sensitization, such as TMD, can exhibit an abnormal pain threshold response to exercise since aerobic exercise usually exerts exercise-related hypoalgesia by activating the descending inhibitory pain mechanisms. In individuals with TMD pain exhibiting central sensitization, this situation is the opposite; exercise induces hyperalgesia [32]. Therefore, clinicians need to assess these exercise-induced mechanisms, since activation of descending inhibitory pathways will be extremely helpful during the treatment process of patients with myofascial TMD.

7.6 Trigger Point Dry Needling

Different needling therapies can be applied in individuals with TMD depending on the health-care profession: acupuncture (acupuncturists), dry needling (physical therapists), and botulinum toxin type A (medical doctors or dentists) [33].

The American Physical Therapy Association (APTA) defines dry needling as "skilled intervention using a thin filiform needle to penetrate the skin that stimulates TrPs, muscle, and connective tissue for the management of musculoskeletal pain disorders" [34]. Clinical rational for application of dry needling is that the referred pain elicited by active trigger points in the head and neck muscles reproduces the pain symptoms in patients with TMD [35]. Recent meta-analyses support the use of trigger point dry needling for reducing pain in upper quadrant syndromes [36] and multiple body areas [37], including myofascial TMD pain.

Several studies have demonstrated that trigger point dry needling of different muscles, such as the lateral pterygoid or masseter (Fig. 7.8), is effective for reducing pain and increasing active mouth opening in individuals with myofascial TMD [38–40] or sleep bruxism [41]. A small study found that trigger point dry needling was

Fig. 7.8 Dry needling of trigger points in the right masseter muscle

also effective for improving TMD-related symptoms such as tinnitus [42]. Interestingly, trigger point dry needling has shown better effects for reducing pain and improving jaw movements compared with methocarbamol/paracetamol drug treatment [43, 44].

An important topic to discuss is that the effect of dry needling arises in the own needle and not in any substance associated with it. This is supported by several studies demonstrating similar outcomes after application of trigger point dry needling and injections of lidocaine or botulinum toxin A in patients with TMD and headaches [45–47]. In fact, a meta-analysis found no significant differences in pain between dry needling and lidocaine injections immediately (standardized pooled mean difference, 0.41; 95% CI −0.15, 0.97), at 1 month (−1.46, 95% CI −2.04, 4.96) and 3–6 months (−0.28, 95% CI −0.63, 0.07) after the treatment [48].

Nevertheless, as manual therapies, trigger point dry needling should be integrated into a multimodal management [49].

7.7 Low-Level Laser Therapy

Several authors have proposed the application of low-level laser (i.e., application of light amplification by stimulated emission of radiation) for the management of patients with TMD. The basic therapeutic effects of low-level laser include biostimulation, regeneration, antinociception, and anti-inflammatory of the affected tissues [50]. Others have reported that low-level laser could affect the synthesis of prostaglandin, causing arachidonic acid to enter endothelial tissues allowing them to generate vasodilatation and anti-inflammation [51].

Evidence supports the use of low-level laser therapy over the masseter, temporalis (Fig. 7.9), and pterygoid muscles for the management of TMD [15, 16]. Additionally, low-level laser seems to be more effective than other modalities such as transcutaneous electrical neural stimulation (TENS) [52]. However, the most controversial topics are the number of session, the type of laser, time of application,

Fig. 7.9 Application of low-level laser over the right lateral pterygoid muscle

and proper dose since various doses, methods, and modes of low-level laser could also result in different treatment effects. In fact, the radiation dosage is determined by the irradiation time and treatment course. The key for an effective treatment is the adequacy of the dosage delivered to the tissue.

The light used with low-level laser is typically of narrow spectral width in the red or near-infrared spectrum (600–1,000 nm), with a power density (irradiance) between 1 mW and 5 W/cm^2. Previous studies investigating the effects of low-level laser in TMD patients have used different doses: (1) total dose, 4 J/cm^2; wavelength, 904 nm; intensity, 0.6 W; time, 60 s [53], or (2) total dose, 5 J/cm^2; wavelength, 780 nm; intensity, 20 mW; time, 10 s [54]. The heterogeneity of laser application is manifested in the review conducted by Maia et al. who observed that the energy density used in published studies ranged from 0.9 to 105 J/cm^2, while the power density ranged from 9.8 to 500 mW [55]. In addition, the number of sessions varied from 1 to 20, whereas the frequency of applications ranged from daily for 10 days to 1 time per week for 4 weeks [51].

As most physical therapy interventions, low-level laser combined with exercises was more effective for TMD rehabilitation than low-level laser alone [56].

7.8 Therapeutic Ultrasound

It has been proposed that therapeutic ultrasound can reduce inflammation, promote muscular relaxation, increase blood flow, and induce analgesia by increasing the temperature in the targeted tissue. Based on these effects, therapeutic ultrasound is clinically applied over the masticatory musculature. Nevertheless, current evidence for therapeutic ultrasound in individuals with TMD is lacking and controversial. It seems that the isolated application of therapeutic ultrasound is not effective for TMD pain [7]; however, the combination of home exercise with therapeutic ultrasound was more effective for decreasing pain and increasing mouth opening than home exercises alone for patients with TMD [57]. Again, the topic of dose and time of application remains unknown.

7.9 Transcutaneous Electrical Neural Stimulation (TENS)

The application of TENS consists of a controlled exposure of electrical current to the surface of the skin, causing muscle relaxation and decrease in pain. It is usually applied with an electronic device producing pulsed biphasic electrical waves through the electrodes placed on the skin surface [58]. The effectiveness of TENS in patients with TMD [59] and bruxism [60] has been documented in some studies. In fact, one study observed that TENS reduced both pain and muscle activity of the anterior portion of the temporal muscle but increased the activity of the masseter muscles suggesting a complex mechanism of action of this intervention [61].

7.10 Neuroscience Education

The difficulty for proper long-term management of patients with TMD usually lies in the complex task of changing the attitudes, lifestyles, and social and physical environment of the individual. This hypothesis is based on the premise that pain is potentially influenced by inappropriate cognitions, emotions, and behaviors including catastrophizing, hyper-vigilance, avoidance behavior, and somatization. Several of these psychological disturbances should be treated by the appropriate professional, i.e., a psychologist; however, neuroscience education can be also applied by physical therapists. There is evidence suggesting that neurophysiology education aiming at conceptualizing pain is effective in patients with chronic pain [62] and should be included in the initial phase of treatment in individuals who have inappropriate beliefs about their pain symptoms and complaints. If not, a poor understanding of their pain may lead to the acquisition of maladaptive attitudes, cognitions, and behaviors and a consequent poor compliance to any active exercise program. In fact, Kalamir et al. found that the inclusion of short talks on the anatomy, physiology, and biomechanics of the jaw plus instruction and supervision of self-care exercises increased the effects of oral myofascial therapies in patients with TMD at short- and long-term follow-ups [63].

7.11 Chiropractic Introduction

Kimberly Bensen

Chiropractic is the third largest health-care profession [64] and is the largest, most regulated, and best recognized of the complementary and alternative medicine (CAM) professions [65].

Chiropractic is now a well-acknowledged health profession routinely used by the public, capable of broad diagnostic activity, conservative treatment, and health promotion. It has developed a respected scientific evidence base, and Doctors of Chiropractic (DCs) are embedded in a growing number of health delivery and reimbursement systems, including Workers' Compensation programs, Medicare, the Veteran's Health Administration, and the US Department of Defense. The practice of chiropractic is a licensed health-care profession in all 50 states, the District of Columbia, the US Virgin Islands, Puerto Rico, and other territories of the United States. All of these licensing jurisdictions accept or require graduation from a Council on Chiropractic Education (CCE)-accredited educational program, and all recognize the CCE Standards as the educational requirements for chiropractic licensure [66].

Chiropractic care is a systems-based, whole-person approach to health care. It incorporates the recognition that all aspects of the body are interrelated and interdependent and that the body has powerful self-healing mechanisms. Their primary focus is on disorders of the musculoskeletal system and the nervous system and the effects of these disorders on general health. Chiropractic services are used most often to treat neuromusculoskeletal complaints [67]. They make adjustments using their hands or a small instrument to apply a controlled, sudden, specific, high-velocity thrust, with a low-level force to a joint that has abnormal movement patterns, and fail to function normally, hypermobility, hypomobility, or dyskinesia (also called a subluxation) [68]. The goal of chiropractic adjustment is to reduce the subluxation; correct structural alignment; improve musculoskeletal joint range of motion, nerve irritability, and pain [69]; decrease inflammation [70]; and stimulate the body's communication system to work more effectively to initiate, control, and coordinate the various functions of the cells, organs, and systems of the body [71]. They incorporate modalities and procedures, lifestyle counseling, nutritional advice and therapy, and other measures that lie within the professional and legally authorized scope of practice of Doctors of Chiropractic (DC) [66].

The DC's license also includes training and use of physiotherapies (as described in the previous physical therapy pages) such as: mobilization or soft tissue techniques, use of complementary measures, such as passive modalities, air, cold, diet, exercise, heat, light, massage, ultrasound, TENS, galvanic current, motor nerve stimulation, therapeutic ultrasound, electrical muscle stimulation, H-wave, galvanic current, FDA-approved laser, decompression, traction, ergonomics, posture training, nutritional counseling and supplementation, therapeutic and rehabilitative exercises and stretches, manual hands-on or tool muscle work including trigger point therapy, neuromuscular reeducation, active release type work, acupressure, deep tissue massage, as well as bracing, strapping, and orthoses. Their license limits the puncturing of the skin, surgery, or prescription of medications. Not all states recognize all aspects of training in their scope of practice licensure [72]. The licensed scope of practice is as broad as the individual doctor's practice philosophy, and not all DCs practice all modalities. Most DCs are not yet trained in comprehensive TMD-specific diagnosis and treatment (Figs. 7.10, 7.11, 7.12, 7.13, 7.14, and 7.15).

Chiropractic has earned recognition for its safe and effective treatment for a wide range of health conditions through the use of natural, nonsurgical, and drugless methods of treatments [64], enhancing patient quality of life and performance; promoting vitality, wellness, and patient empowerment; improving the quality of life without drugs or surgery; and offering readily accessible care [67].

7.12 Chiropractic and TMD

The most common conditions treated by chiropractors are back pain, neck pain, and headaches. The best available evidence supports manipulative therapy as a reasonable option for many of these complaints. Manipulative therapy also holds potential value for the treatment of a variety of extremity conditions, including the TMJs [73].

TMD is a multifactoral condition consisting of some or all of these components: joint subluxations, body positioning, muscle imbalance, neurologic interference, nutritional considerations, occlusion, and psychosocial/psychosomatic characteristics.

The subluxation of the temporomandibular joint is fairly frequent [74, 75], and TMD is the second most common musculoskeletal condition [76]. Chiropractic

Fig. 7.10 Cervical adjustment

Fig. 7.11 Cranial instrument-assisted adjustment

Fig. 7.12 "Infinity" manual mandibular mobilization

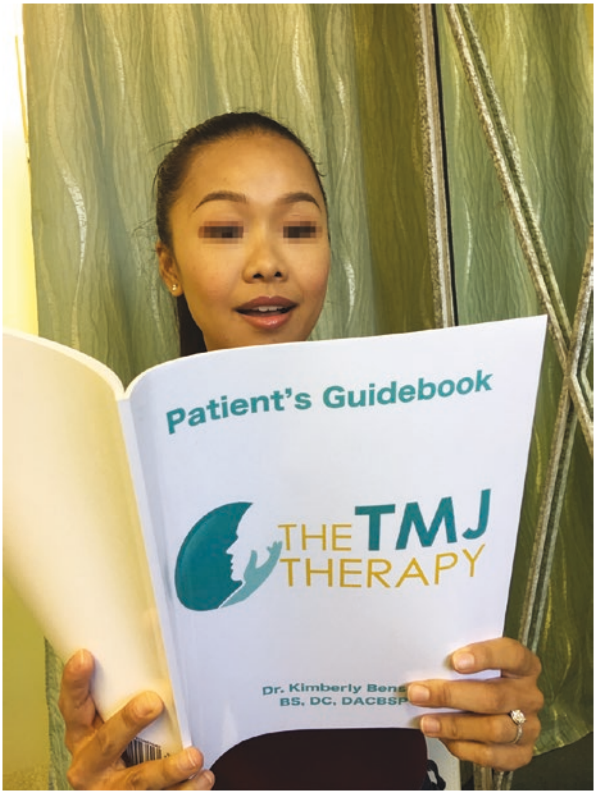

Fig. 7.13 Behavior modification lessons

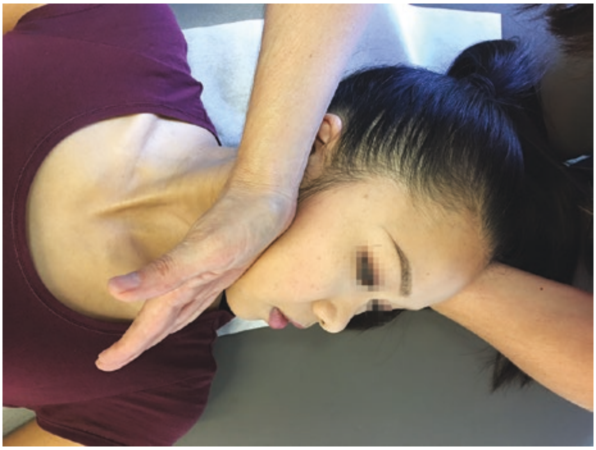

Fig. 7.14 Mandibular adjustment

Fig. 7.15 Mandibular measurement

treatment, in a retrospective series, showed that all patients selected for that case series showed a reduction of temporomandibular dysfunction symptoms [77]. The main outcome measures change from baseline to follow-up of visual analog scale (VAS) for temporomandibular joint pain and maximum active mouth opening without pain. Their full spine and TMJs were assessed and adjusted in accordance with the advanced protocol of Activator Methods International. Participants were typically seen three times per week for 2 weeks and according to individual progress thereafter for 6 more weeks. Results of this prospective case series indicated that the TMD symptoms of these participants improved following a course of treatment using the Activator Methods International protocol. Consequently, further investigation of this type of chiropractic treatment for patients with the articular type of TMD is warranted [78].

Dysfunction is a process, not a static condition. Physiologic manifestations of the process of a dysfunctional joint are that the tissues undergo constant changes, including hyperemia, congestion, edema, minute hemorrhages, fibrosis, local ischemia, atrophy, and tissue rigidity. Eventual rigidity and adhesions form not only in joint capsules but also in the ligaments, tendons, and muscles themselves [79].

Manual therapy (including soft tissue techniques, mobilization, exercise, and manipulation) is postulated to reduce local ischemia, stimulate proprioception, break fibrous adhesions, stimulate synovial fluid production, and reduce pain among other effects [80].

A joint can become subluxated and malfunctional as a kinesiopathogical joint lesion (usually hypomobility) that develops as a consequence of micro- and/or macrotrauma which cause tissue injury and associated inflammatory response, degenerative changes in muscular and connective tissues, decreased descending inhibitory pathway activity due to aberrant psychological states, dysafferentation (i.e., increased nociception), and decreased mechanoreception which can be caused by some or all of the above [81].

This single-subject case study was conducted to investigate the capability of chiropractic manipulation of the temporomandibular joint (TMJ) in treating unilateral anterior displacement of the articular disc with adhesion to the articular eminence. A specific joint manipulation was designed to reduce the anteriorly displaced and adherent TMJ disc. The findings of this study show this specific manipulation of the TMJ may be appropriate for the conservative treatment of adherent anteriorly dislocated disc [82].

Precise and complex balance of the head and neck muscles must exist to maintain proper head position and TMJ function. To understand the effects the muscles have on each other and their bony attachments, there are pairs of muscles that are agonistic or antagonistic, stabilizing or moving the head, neck, and TM joints. These muscle attachments on bones are craniomandibular, craniovertebral, mandibulohyoid, and hyoclavicular/thoracic. There is a highly coordinated, complex neuromuscular event that occurs to synchronize the muscular pulley system of the neck, cranium, and jaw in order to complete all aspects of jaw movement. Each of the major muscles acts like an elastic band. The tension provided must precisely contribute to the balance that maintains the desired head position. If one elastic band is stretched, is adhered, or breaks, the balance of the entire system is disrupted and the head position is altered. When one muscle is compromised, another can compensate, causing abnormal movements [83–85]. To fully assess the cause of the TMJ dysfunction, all associated structures must also be evaluated (Figs. 7.16, 7.17, 7.18, 7.19, and 7.20).

Neurologically, central sensitization and convergence are the primary mechanisms behind referred pain, which can enable tooth pulp pain to be perceived as masseter or facial muscle pain, and posterior neck muscles can generate referred pain to the forehead, periodical, vertex, temple, occipital, postauricular, and ear [86].

The correlation between primary temporomandibular joint disorders and the cervical spine dysfunction is well documented [87–94].

And therefore, we also must include the cervical spine in evaluation and treatment protocols.

Fig. 7.16 Occipital adjustment

Fig. 7.17 Postural exercise

As a case of the concept of integrated dental-orthopedic and craniochiropractic care for treating structural disorders of the jaw, neck, and spine demonstrated, the position of the jaw and head and neck is inextricably linked. Some dental treatment can cause the inability of the head and neck to adapt to maxillary and mandibular

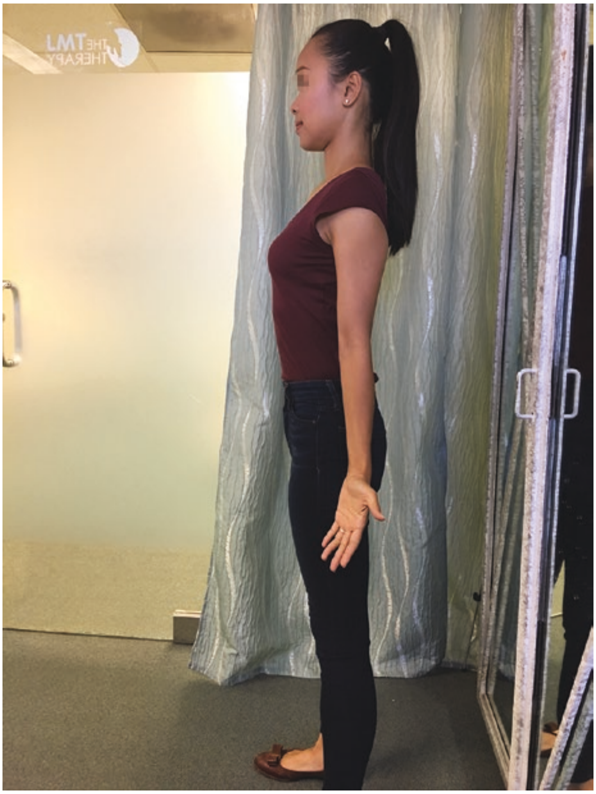

Fig. 7.18 Postural exercise 2

changes, and this study showed that mandibular position improved in response to chiropractic treatments [95].

As the issue of cranial and facial bone compliance and its affect on occlusion and TMJ functioning has gained greater acceptance in the dental and chiropractic fields, what has become a common theme between our professions is the relationship between the stomatognathic system and posture. While the pelvis and the TMJ might seem to be distant and unrelated aspects of our patients' presenting symptoms, research is suggesting otherwise. The rationale for greater relationships between chiropractors and dentists has been discussed in the literature, since in some cases, the only possible chance of a patient having any resolution of their TMD/CMD was with co-treatment [96].

Another study investigated the effect of a rehabilitation program based on cervical mobilization and exercise on clinical signs and mandibular function in subjects with temporomandibular disorder. In this study, 12 women (22.08 ± 2.23 years) with myofascial pain and mixed TMD, according to the Research Diagnostic Criteria for Temporomandibular Disorders, were evaluated three times: twice before (baseline phase) and once after intervention. Self-reported pain, jaw function [according to the Mandibular Functional Impairment Questionnaire (MFIQ)], pain-free maximum mouth opening (MMO), and pressure pain thresholds (PPTs) of both

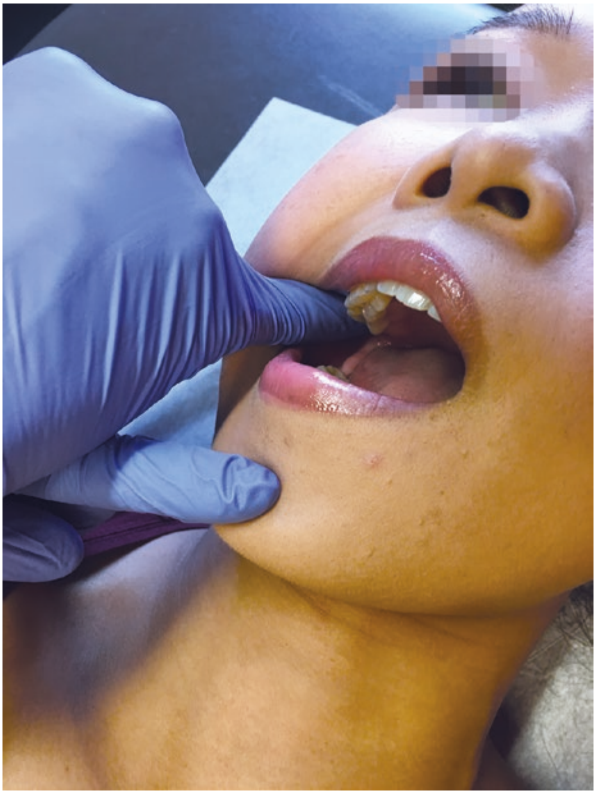

Fig. 7.19 Intraoral lateral pterygoid muscle therapy

Fig. 7.20 Cranial manual adjustment

masseter and temporalis muscles were obtained. Baseline and post-intervention differences were investigated, and effect size was estimated through Cohen's d coefficient. Despite the small sample size, the results showed jaw function improved 7 points on the scale after the intervention, and self-reported pain was significantly reduced. Pain-free maximum mouth opening varied from 32.3 ± 8.8 mm to 38 ± 8.8 mm and showed significant improvement with moderate effect size when compared to the baseline phase. Pressure pain thresholds also increased with moderate effect size, and subjects had the baseline values changed from 1.23 ± 0.2 to 1.4 ± 0.2 kg/cm^2 in the left masseter ($P = 0.03$), from 1.31 ± 0.28 to 1.51 ± 0.2 kg/cm^2 in the right masseter ($P > 0.05$), from 1.32 ± 0.2 to 1.46 ± 0.2 kg/cm^2 in the left temporalis ($P = 0.047$), and from 1.4 ± 0.2 to 1.67 ± 0.3 kg/cm^2 in the right temporalis ($P = 0.06$). The protocol caused significant changes in pain-free maximum mouth opening, self-reported pain, and functionality of the stomatognathic system in subjects with myofascial TMD, regardless of joint involvement. Even though these differences are statistically significant, this study concludes that their clinical relevance is still questionable [97].

A recent case study presented a patient who had complaints associated with a disorder of the TMJ and cervical atlas subluxation. Vertebral subluxation of the cervical spine may result in a TMJ disorder and that removal of subluxations through adjustments may alleviate the extra vertebral complaint. The conclusion was to suggest that the treating chiropractor consider the possibility that some of these disorders may be effects of subluxations through referred pain or dysfunction in the craniovertebral kinematic chain [98].

The jaw is suspended from the cranium by a tonus of many muscles to hold the mandible in correct anatomical and functional position. The association, as found in the study done by Lee WY, Okeson JP, and Linderoth J., is that the head was positioned more forward in the group with temporomandibular disorders than in the control group [99].

Dr. Okeson's textbook entitled *Management of Temporomandibular Disorders and Occlusion* 5th Edition, states "the skull is supported in position by the cervical spine." It is not, however, centrally located or balanced over the cervical spine. In fact, if a dry skull were placed in its correct position on the cervical spine, it would be overbalanced to the anterior and quickly fall forward. Any balance becomes even more remote when the position of the mandible hanging below the anterior portion of the skull is considered; it is obvious that a balance of the skeletal components of the head and neck does not exist. If the head is to be maintained in an upright position so one can see forward, muscles that attach the posterior aspect of the skull to the cervical spine and shoulder region must contract.

Some of the muscles that serve this function are the trapezius, SCMs, splenius capitis, and longus capitis. It is possible, however, for these muscles to over contract and direct the line of vision too far upward; to counteract this action, an antagonistic group of muscles exists in the anterior region of the head: the masseter, suprahyoids, and infrahyoids. When these muscles contract, the head is lowered. Thus a balance of muscular forces exists that maintains the head in a desired position. These muscles, plus others, also maintain proper side-to-side position and rotation of the head, as supported by additional studies [99].

Other literature suggests a correlation between the orientation of craniofacial planes and temporomandibular disorder in young adults with normal occlusion.

In this instance, TMD might be mainly associated with head posture rather than with craniofacial morphology or specific pathophysiology [100]. Forward head posture is associated with cervical curve or lack of it, and the study done by D'Attilio, on a cross-sectional group of 50 females with mean age of 28.9, offered support of the existing literature demonstrating evidence of correlations between cervical alterations and cervical pain and the existence of cervical pain in subjects with temporomandibular joint internal derangement [101]. There is a significant association between TMD treatment and reduction of cervical spine pain, as far as improvement of cervical spine mobility, as discussed in BioMed Research International (2014). Cervical spine and TMJ positioning-proprioceptive positioning [102] and the biomechanical relationship between the craniocervical region and the dynamics of the TMJ, as well as trigeminal nociceptive processing, are different in different craniocervical postures.

Vladimir Janda documented the influence of the somato-sensorimotor system and the neuromuscular imbalances that can develop, potentially leading to an unfavorable chain reaction affecting the whole body, articular, muscular, and neurological system in his work "*The Assessment and Treatment of Muscle Imbalance*". He terms the head forward posture as the Upper Cross Syndrome (UCS) as well as a condition now known as proximal or shoulder girdle crossed syndrome. In UCS, tightness of the upper trapezius and levator scapula on the dorsal side crosses with tightness of the pectoralis major and minor. Weakness of the deep cervical flexors ventrally crosses with weakness of the middle and lower trapezius. This pattern of imbalance creates joint dysfunction, particularly at the atlanto-occipital joint, C4–C5 segment, cervicothoracic joint, glenohumeral joint, and T4–T5 segment. Janda noted that these focal areas of stress within the spine correspond to transitional zones in which neighboring vertebrae change in morphology. Specific postural changes are seen in UCS, including forward head posture, decreased cervical lordosis and thoracic kyphosis, elevated and protracted shoulders, and rotation or abduction and winging of the scapulae [103].

Further, TMD can be considered to be associated with an imbalance of the whole physical body. According to a literature search by Brantingham JW, Cassa TK, Bonnefin D, Pribicevic M, Robb A, Pollard H, Tong V, and Korporaal C., called Manipulative and multimodal therapy for upper extremity and temporomandibular disorders: a systematic review, there is a fair level of evidence for the implementation of manual manipulative therapy (MMT) to specific joints and the full kinetic chain combined with exercise and/or multimodal therapy for lateral epicondylopathy, carpal tunnel syndrome, and temporomandibular joint disorders. The authors' intent was that the study would help guide practitioners in the use of MMT, soft tissue techniques, exercise, and/or multimodal therapy for the treatment of a variety of upper extremity complaints in the context of the hierarchy of published and available evidence [103].

Given the correlation between global body posture, muscle imbalances caused by forward posture of the head in Upper Cross Syndrome, and temporomandibular joint internal derangement, a full assessment of the whole kinematic chain, (above and below the TMJs) and treatment plan should be incorporated and considered with any patient expressing TMD symptomotology. Posture training and TMD self-management instructions are significantly more effective than TMD self-management instructions alone for patients with TMD who have a primary muscles disorder [104].

The studies are pointing to a multimodal approach for TMD patient management. Collaborative approach between chiropractic and dentistry [105], with a fair level of evidence for manipulative and multimodal therapy to specific joints and the full kinetic chain combined generally with exercise and/or multimodal therapy TMJ disorders [106], and some findings may suggest interconnectivity between the craniocervical junction and an individual's occlusal contacts and support the need for further integration between chiropractors and dentists seeking to co-manage temporomandibular joint disorders [107].

7.13 Conclusion

TMD is a multifactoral condition consisting of some or all of these components: joint subluxations, body positioning, muscle imbalance, neurologic interference, nutritional considerations, occlusion, and psychosocial/psychosomatic characteristics.

Chiropractors are ideal for initial, co-management, and adjunct care, as they are known for a wholistic approach to health and wellness. Seeing the body as a kinematic chain, they employ joint manipulation, physiotherapies as their practice philosophies allow, nutrition, posture/ergonomic, stress, and lifestyle advice. However, the DC's scope of practice varies from state to state, and their individual philosophies also vary, as well as their interest and/or advanced training in TMD and rehabilitation techniques.

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