FLEX CEUs

TMD Treatments and Outcomes

Reported concepts for the treatment modalities and pain management of temporomandibular disorders

Abstract

Background: Pain related to temporomandibular disorders (TMD) is a common problem in modern societies. The aim of the article is to present the concepts of TMD pain clinical management.

Methods: A survey was performed using the PubMed, SCOPUS and CINAHL databases for documents published between 1994 and 2014. The following search keywords were selected using MeSH terms of the National Library of Medicine in combination: TMD pain, TMD, TMJ, TMJ disorders, occlusal splint, TMD physiotherapy, TMJ rheumatoid disorders and TMJ surgery. Original articles and review papers which presented the clinical relevance and practical validity regarding the possibility of application in TMD management have been included. Authors have excluded articles without outstanding practical aspect and evidence-based background. A first selection was carried out by reviewing titles and abstracts of all articles found according to the criteria. After that the full texts of potentially suitable articles were assessed. In line with these criteria, among 11467 results the writers have included 66 papers.

Results: The most commonly reported conservative treatments are massage therapy and individually fabricated occlusal splints. In addition to massage, other popular methods include manual therapy and taping, warming/cooling of aching joints, and light and laser therapy. Drugs are also commonly used. In the most severe cases of the temporomandibular joint degeneration, surgical restoration of the joint is sometimes applied.

Conclusions: The authors concluded that conservative treatment including counselling, exercises, occlusal splint therapy, massage, manual therapy and others should be considered as a first choice therapy for TMD pain because of their low risk of side effects. In the case of severe acute pain or chronic pain resulting from serious disorders, inflammation and/or degeneration pharmacotherapy, minimally invasive and invasive procedures should be considered.

Keywords: Temporomandibular disorders, Temporomandibular joint disorders, Facial pain, Masticatory muscle pain

Introduction

Currently, temporomandibular disorders (TMD) refer to the causes responsible for the impaired function of the temporomandibular joints (TMJ) and the associated neuro-muscular system, which may provoke TMD-related pain [1]. The term TMD is not a diagnosis but rather a broad term that contains a number of disease entities, such as pain in masticatory muscles and temporomandibular joints, headache, disturbances in jaw movements and sounds in joints while opening and closing the mouth. The causes of these diseases/symptoms are numerous and include trauma, systemic, iatrogenic, occlusal and mental health disorders [2–7]. Today, mental health plays a dominating role in the pathogenesis of TMD [8, 9]. The neuromuscular system responsible for chewing function has a high potential to adapt to changing conditions. Only when the compensatory capabilities of the masticatory- and the neuromuscular system are overstretched dysfunction occurs resulting in clinical symptoms and manifests as pain, severe clicking, or limited mobility of the mandible, forcing the patient to seek help.

The pain may radiate to different regions, such as the dental arches, ears, temples, forehead, occiput, cervical region of spine or shoulder girdle [10–13]. However, despite the fact that comparatively few patients are seeking treatment, it is known that there is a high prevalence of TMD in developed societies [14, 15]. TMD is mostly accentuated on the neck, where the lateral support imbalance leads to the bending of the neck to the affected side [16].

TMD are a group of dysfunctions and disorders related to impaired function of the temporomandibular joints and associated muscles therefore they may lead to the painful impairment in stomatognathic system functioning [17]. The TMJ is used 1500–2000 times a day, which shows how great discomfort is carried by the pathologies in jaw movements [9].

In most cases, the symptoms are the reason for the increased tension of the masticatory musculature, and the parafunctions may worsen the symptoms [18, 19]. Due to the large subjectiveness of the symptoms, TMDs are very difficult to diagnose, especially because patients usually search for help from other specialists besides dentists (e.g., neurologist, otolaryngologist or ophthalmologist) [10, 20]. The anomalies of the masticatory system including pain caused by increased tension of masticatory muscles are classified as masticatory pain dysfunction syndrome (MPDS) [21].

In addition to pain, a vast majority of patients suffer from intraoral signs of masticatory dysfunction, including increased sensitivity of the teeth due to abfraction and pathological attrition, gingival recessions, teeth hypermobility and bone support loss. In addition, teeth impressions on soft tissues are observed, including teeth impressions on the tongue and (cheek mucosa) *linea alba* [10, 22]. The increased tension in TMJ muscles and co-existing parafunctions or dysfunctions may lead to non-carious tooth lesions (e.g., abfraction), which are characteristic for TMD [23, 24].

The treatment of TMD is complicated and requires specific knowledge and exercises to strengthen some groups of muscles and weaken others, occlusal splint therapy, massage and pharmacotherapy. Although the treatment seems difficult, most of the patients searching for help due to TMD assess that the treatment is successful, although an accurate diagnosis needs to be made to start the proper protocol of treatment [20, 25–27]. Theories on the origin of TMD are presented in Table 1 [27]. Yet, it is important to note that treating TMD only from the dental perspective may fail, as many of these anomalies are caused by somatic diseases that should have be cured in the first place [28].

The prevalence of these disorders and the multifactorial pathogenesis and therapeutic difficulties of TMD prompted the authors to undertake an effort to describe therapeutic concepts associated with TMD pain.

Review

Materials and methods

A survey was performed using the PubMed, SCOPUS and CINAHL databases for documents published between 1994 and 2014. The following search keywords were selected using MeSH terms of the National Library of Medicine in combination: TMD pain, TMD, TMJ, TMJ disorders, occlusal splint, TMD physiotherapy, TMJ rheumatoid disorders and TMJ surgery. Original articles and review papers which presented the clinical relevance and practical validity regarding the possibility of application in TMD management have been included. The inclusion of the papers were based

Table 1 Theories concerning TMD origin [27]

Name of the theory	Statements of the theory
Mechanical displacement (by Costen)	Lack of support in lateral teeth or functional occlusal premature contacts lead to direct eccentric positioning of the condyle in the glenoid fossa; this leads to pain, ear symptoms, adverse muscle activity and TMD
Trauma theory (by Zack and Speck)	The principal factor of TMD is micro-/macro-trauma; trauma can cause structural alternation to the muscles or directly to the joint structures
Biomedical (by Reade)	Disorder is initiated by trauma; specific factors (malocclusion, parafunctions, occupational activities) cause the progression of the symptoms
Osteoarthric (by Stegenga)	Osteoarthrosis is a main cause of TMD; muscular symptoms and systemic diseases are secondary to TMJ pathology
Muscle (by Travell and Rinzler)	Masticatory muscles are the primary etiologic factor to TMD; myalgia (caused by chronic myospasm) is secondary to parafunctions and can refer pain to TMJ
Neuromuscular (by Ramfjord)	Occlusal problems cause TMDs, the loss of occlusal equilibrium leads to the incoordination of muscles and spasms
Psychophysiological (by Schwartz and Laskin)	TMD occurs outside of the physical factors; psychosocial factors play a crucial role in TMD pathogenesis – the main factor of hypertension and overcontraction of the muscle is due to the parafunctions performed to relieve stress
Psychosocial theory (by Dworkin)	Emotional disturbances induce hyperactivity of the muscles and lead to parafunctional habits and occlusal anomalies; the muscle contractivity is accentuated with teeth clenching, and repeatability leads to pain

on precise descriptions of the treatment procedures and detailed presentation of the treatment outcomes. Authors have excluded articles without outstanding practical aspect and evidence-based background. A first selection was carried out by reviewing titles and abstracts of all articles found according to the criteria. After that the full texts of potentially suitable articles were assessed. In line with these criteria, among 11467 results the writers have included 66 papers.

Conservative treatment

Therapeutic exercises

The most important stage of a treatment protocol is education with cognitive awareness training and relaxation therapy as well as self-observation that should be completed by patients with masseter hypertrophy, tension-type headaches or bruxomania (the grinding of teeth occurring as a neurotic habit during the waking state). It is important to explain to the patient the background of the disorders (especially the role of one's emotional stress) and warn about habitual parafunctional activities (e.g., nonfunctional tooth contacts or oral mucosa biting). The patient should be aware of what he or she does with their teeth, and when they fall into bad habits, try to eliminate that habit [28].

Muscular training is the primary mode to achieve muscle restoration, especially after traumas and injuries. It is thought to be the most conservative treatment as well as the simplest and most non-invasive method of TMD treatment. In patients with severely expressed asymmetries and symptoms, exercises to restore the muscular equilibrium seem to be the only proper route of treatment [3, 29]. Muscular therapy must be restrictive; it should be carried out moderately, and the intensity should be increased with time to avoid aches and patient discouragement from the suggested treatment. In this situation, muscular therapy is effective in 70 % of suffering patients. In some cases, such as patients with muscular or joint (muscular or arthritis pain) pain, the mouth opening is limited, and therefore, therapy is less effective [3, 27]. The exercises can require stretching, relaxation and isometric movements that should be performed routinely to eventually lead to a shortening of the excessively expanded muscles or to a restoration of the full length of the shortened muscles. Additionally, the natural tension and symmetric jaw movement can be restored [3].

The training is underdone to correct the mobility of the mandible. To strengthen the muscles and to acquire balance between the left and right sides, opening the mouth along a straight line in front of the mirror is recommended. The resistance is acquired from the gentle pressure of the patient's fingers to the mandible. The exercises are repeated in sets of 15 to 20 repetitions, 2 to 3 times a day. The improvement should be observed after 6 weeks [3].

Research from Bae and Park [30] showed that active and relaxation exercises could improve the limited range of motion, deviation and pain in masticatory muscles. For muscle relaxation, they recommend putting the front one-third of the tongue on the anterior part of palate and applying a light force to the tip of the tongue so it does not touch the teeth, having the patient maintain this position as long as he/she can withstand (3 times over a period of 4 weeks, 10 min each time).

In case of too wide of a mouth opening, or excessive mobility of the jaw and mandible deviation during opening (with excluded suspicion of subluxation), the exercises are limited, and straightening of the opening pathway are recommended. The exercise involves opening the mouth with the tip of the tongue touching the palate (usually near the A-H line) in front of a mirror, along the straight line. It is recommended to maintain the contraction of the tongue muscles for two seconds during mouth opening. The exercises should be repeated 2 to 3 times a day, 15 to 20 repetitions each [3].

Occlusal splint therapy

To achieve the proper relation of the jaw, centric relation (CR) should be restored. It is easily performed by occlusal splints. An occlusal appliance is any removable artificial occlusal surface used for diagnosis or therapy affecting the relationship of the mandible to the maxillae. Occlusal appliances may be used for occlusal stabilization, for the treatment of temporomandibular disorders, or for the prevention of dentition wear [31]. Occlusal splints are used in a vast majority of patients with TMDs to restore the static and dynamic symmetry of the stomatognathic system. Most commonly, they are used in cases with disc displacement [3, 32, 33]. The splints are fabricated individually by an experienced team consisting of a dentist and technician.

One of the most popular occlusal splints is the Michigan-type bite splint, precisely described by Ramfjord and Ash Jr [34]. This splint could be used in both dental arches, but preferably in the maxilla. The mandibular splint is used when the posterior area is missing teeth in the mandible and unwanted tooth movement must be avoided. The main purpose of this device is to disengage the occlusion, place the condyle in the centric position, relax the masticatory muscles and prevent further tooth wear due to nocturnal parafunctional activity. The main features of this splint are freedom in centric and canine guidance.

It is important to note that the relation of the maxillary and mandibular arches may differ after the treatment when compared to the initial state, especially when partial coverage splints are used [32, 35]. After the

replacement of the mandible, the condyles are replaced, and consequently, the mandible is positioned properly and the pain is reduced [32].

Walczynska-Dragon and Baron [10] have proven that occlusal splint therapy using the SVED (Sagittal Vertical Extrusion Device) appliance decreases not only aches in the head and all parts of the spine but also disc displacements within 3 weeks of treatment. The next decrease in frequency of unwanted, unfavorable symptoms was observed after 3 months of treatment with splints. When properly performed, these splints also unblock a limited mouth opening.

Research performed by Lee et al. [36] in a group of 59 patients with somatic TMJ dysfunction showed that intraoral appliance could improve cervical spine alignment and alleviate symptom severity.

The occlusal splints are also used in the initial phase of treatment in patients with mouth overclosure caused by a pathologic deep bite. Before the prosthetic rehabilitation of the severe tooth wear, one should remember that initially, splint therapy should be applied to adapt the stomatognathic system to the new occlusion [37]. A classification of the occlusal appliances with activities and recommendations is presented in Table 2.

Beside occlusal splint therapy subsequently selective grinding of the teeth to restore physiological and/ or proper and /or balanced occlusal support is required in some cases [27].

Massage therapy

Myofascial pain is a common symptom of TMD – it is often associated with the clenching of teeth, grinding and stress. TMD myofascial pain occurs in 31 to 76 % of the population [38–41]; it can be relieved by massage therapy, which leads to re-establishing the proper flexibility and muscular length and relieves pain. The massage therapy for TMD might be divided into effleurage, kneading, friction, stretching and petrissage, leading to the permanent adaptation of the muscles. The types of massage and their influence to the surrounding tissues are presented in Table 3 [26, 42]. Massage reduces tissue swelling as well as pain in TMD patients [21, 41, 43]. The pressure used during massage must not be too intense and should increase over time at each therapeutic session because therapy performed too strongly may lead to increased muscular tonus [44]. Massages should be performed twice a week, with a minimum of 30 min for each session. It takes at least 8 therapeutic sessions to receive true relief [23]. In addition to the local influence, massage leads to the relaxation of the entire body and reduces stress, thus improving the patient's mood [45, 46]; it reduces tension headaches and muscle aches, restores equilibrium between the masseter tension, and improves mastication [26]. The physiotherapist may also recommend heating or cooling of the affected muscles [28].

To restore the accurate function of the TMJ, changes in daily habits is important. The change of food consistency (eating softer foods), applying cold or heat, and avoiding extreme movements of the mandible (chewing gum, wide yawning or loud singing) might be enough to decrease TMD symptoms [47]. In this situation, counselling, behavioral therapy and stress management should also be applied to decrease muscle hypertension and bad habits [25].

Manual therapy

Manual therapy is similar to massage therapy, but the procedure performed by the physiotherapist is different; it refers to stimulation of the so-called "trigger points". There are two main methods of treatment by applying manual therapy: mobilization and the muscle energy technique.

The mobilization technique is most commonly used in disc displacements; it involves repeated traction or sliding movements at a slow speed and with increasing amplitude. The desirable effect is to increase the limited range of motion within the joint and reduce pain. The movements are carried out perpendicularly or parallel to the plane of the treated joint, oscillating, and typically repeated 8 to 10 times in 3 sets. The procedure is

Table 2 Classification of occlusal splints according to Freesmeyer et al. [28]

Type of occlusal appliances	Activity	Recommendations
Reflex appliances e.g., Interceptor, Anterior Plateau, NTI-tss	Prevent habitual tooth contact and thus prevent gnashing and clenching temporarily, which positively influences the resultant tooth and muscle complaints.	Indicated for acute symptoms that can be attributed to an overloading of the involved tissue (short-term appliances).
Stabilization appliances e.g., Michigan type splint	Create ideal occlusion, synchronous tooth contact in a centric condyle position in static occlusion and an anterior tooth position with disclusion in the lateral teeth region in dynamic occlusion.	Can be used on a short-term and long-term basis, for acute or chronic symptoms and also in psychological and physiological overloading reactions.
Repositioning appliances e.g., Anterior repositioning splint, Farrar type splint, Gelb type splint	The temporomandibular joint or joints is/are set in a therapeutic position by the splint to support healing and to maintain a symptom-free joint posture.	Used for the treatment of temporomandibular joint diseases such as anterior disc displacement with and without reduction, temporomandibular joint compression, retral displacement of the condyle and osteoarthritis. Can be used as a short-term or long-term therapy.

Table 3 Massage procedures in myofascial TMD pain management [26]

Type of movement in massage procedure	Manner of performing	Result
Effleurage, Kneading	Soothing, stroking, circular movements of skin and underlying tissues (performed at the end or beginning of therapeutic session)	Warming up the muscles, providing blood and lymph flow, increasing blood level in the massaged tissues (improved blood flow in small vessels)
Friction	Pressure of fingertips in trigger points therapy; the pressure is increased in particular, sensitive points until the release	Remodeling tissues locally (reconstruction of muscular microstructure); effective in short-term pain relief (activates pain-gate mechanism)
Stretching ("petrissage")	Rolling of the muscles	Increasing the range of movement and pain relief, decreasing muscle contraction

performed in a seated position with the patient's head stabilized on the chest of the physiotherapist who holds the patient's head and mobilizes the mandible with one hand. Traction consists of 3 stages: relaxation (abolition of forces acting on joint), tension (remotion of the articular area) and stretch (increase in remotion of articular area) [48, 49].

The muscle energy technique (MET) is used when limited movements of the mandible are observed and caused by soft tissue (muscles and connective tissue) damage. The treatment involves repeating 3 phases: the first phase is making a movement that is possible due to limited tissue elasticity; in the second phase, the patient slightly tightens the muscles trying to make a move in the opposite direction of the force created by the physiotherapist and should last approximately 10 s; in the last phase, the patient relaxes the muscles. The technique can be performed both in a seated or lying position [50, 51].

Other physiotherapeutic techniques

Physiotherapy involves many techniques of treatment. The most common massage and manual therapies were previously described, but for TMD treatment, also other techniques are used. Among them, biofeedback, lamp exposure, iontophoresis, ultrasound and transcutaneous electrical nerve stimulation (TENS) are used.

The purpose of biofeedback is to stimulate the muscles to work properly and achieve maximal relaxation of the muscles in a short period of time. The therapy involves electromyography to train the adequate neuromuscular tension of the patient and develops the ability to alter a physiological response. The surface electrodes are placed on the muscles (typically masseter) uni- or bilaterally; other muscles (e.g., anterior temporalis) may also be included. SEMG biofeedback may include muscle tension discrimination. The treatment protocol involves teaching the patient how to open their mouth properly to strengthen the tension of the tongue and protrude the mandible. Only after this are the electrodes applied in line with the muscle fibers (usually upon the midsubstance of the masseter muscle belly). The measurements of the minimal muscular tension are performed when the patient rests with all their muscles relaxed; this is used as a reference in the follow-up. Observing the movements and muscular tonus the patient exercises help to restore the appropriate muscular activity [52–54].

Transcutaneous Electrical Nerve Stimulation (TENS) is another well-known method of pain relief for TMDs. The method is based on electrical stimulation of pain areas via surface electrodes and is considered safe and non-invasive. TENS helps to relieve chronic and acute pain in joint and/or muscle disorders. Unfortunately, due to the small number of studies (especially randomized trials), TENS cannot yet be considered a standard treatment for TMDs, as its effectiveness is still uncertain [55]. In addition to the therapeutic value of electric potential, a tool called electromyography (EMG) is used for establishing muscular function and is the most reliable and objective technique [56].

For pain release, especially in subacute arthropathies and inflammatory rheumatic diseases, heat treatment is applied; it alleviates strong pain, although the result is typically short-therm. Heat is supplied either by means of Solux lamps (ca. 15 min from 20 cm distance) or through a thermophor filled with water at a temperature of 158 to 176 °F (70 to 80 °C) and wrapped with a towel. Other recommendations to decrease pain are sulfur and iodide baths. Cryotherapy is another form of temperature related therapy but applies cold instead of heat. Cold packs, cold spray or air, and ice compresses are used as analgesic agents. The application of cold is used immediately prior to kinesiotherapy and helps fight muscle hypertension and tendinopathies as well as rheumatic diseases. One should remember that there is a high risk of frostbite (skin damage due to low temperature) with this form of therapy. The cold compresses should be applied for 10–15 min. Cryotherapy leads to the attenuation of pain, reduces stiffness in the TMJ and increases mandibular mobility [57].

A new method of rehabilitation with the aim of TMJ stabilization and increased jaw stability is taping, or Kinesio Taping (KT). KT also decreases drooling and provides mouth closure. To increase jaw stability, one piece of tape in a "Y"-shape cut should be prepared and placed proximal to the joint; the superior tail is shorter than the inferior tail. The superior tail should be applied diagonally along the upper jaw and directed towards the

lower cheek with "paper-off" tension. The tape width should be 1.5 to 2 inches (3.8 to 5 cm). The mandible cannot subluxate at the movement. To decrease the hypermobility of the joint and release TMJ pain, two tape pieces (1 inch wide and 2 inches long each) should be placed diagonally to each other over the joint, forming an "X". To improve jaw stability, tape is usually applied to both sides. The balance in head position and body posture usually leads to a decrease in hypertension of not only the masticatory muscles but also the neck, arms and spine [58, 59]. The method is quite new but has become increasingly popular [60, 61]. The special therapeutic tape adheres to the skin with adequate flexibility and consists of a polymer elastic strand wrapped by 100 % cotton fibers. The tape allows for a normalization of muscle tone and increases the process of self-healing. KT stimulates an endogenous analgesic system and changes the subjective feelings of the patient. Alignment of muscular tone is possible by improving proprioception. KT could be applied for myofascial pain therapy in a range of masticatory muscles, especially the masseters. The clinical technique has been described by Kase et al. [62].

Ultrasound therapy is one of the efficacious methods for pain reduction, decrease in muscular tonus and improving the function of the muscles. It consists of three types of signals: constant waves, sound impulses and ultrasound combined with stimulation current, which is found to be most effective. The procedure is performed 6–12 times, every 1–2 days, 6–8 min each. The impulses should be applied at 0.5–0.7 W/cm in the case of devices with constant waves, and 0.6–0.9 W/m in the case when sound impulses (50 or 100 Hz) are emitted [57].

There are few rarely used methods of TMD management. Among them are iontophoresis with different medications (e.g., nonsteroidal anti-inflammatory drugs, steroids and analgesics), especially in patients with concurrent temporomandibular joint disc displacement without reduction and capsulitis [63]. As the data show, pain release is not observed, but patients present with a wider opening of the mouth than when analgesics alone are used [63]. Inflammatory processes may be healed with a laser light that is used at a wavelength of 904 nm and a frequency of 700 Hz at 30 mm depth into the skin. This method had gained popularity [57].

Pharmacotherapy and minimally invasive and invasive procedures

Oral and injectable pharmacotherapy

Pharmacotherapy for TMD is not commonly used. It is only used when other somatic symptoms, such as sleep disorders, chronic pain, arthralgias, inflammatory diseases, myalgias or neuropathies are associated with TMD [28]. As TMD may manifest from different systemic diseases (e.g., arthritis, inflammatory bowel diseases, Parkinson disease), it is important to diagnose the patient properly and implement treatment for the underlying disease, especially when depression is a suspected diagnosis [47, 64]. One has to remember that pharmacotherapy has its goal in decreasing pain and inflammation within the joint and/or muscles. This therapy improves function and inhibits the progression of the disease [65]. Pharmacotherapy can be considered as a complementary therapy rather than a treatment itself. The exceptions are systemic diseases with TMJ involvement [57].

For TMD release, the most commonly used medications are myorelaxants, nonsteroidal anti-inflammatory drugs (NSAIDs), analgesics, tricyclic antidepressants, benzodiazepines and corticosteroids [28]. The first medication of choice for moderate pain relief is acetaminophen (average daily dose of 325–1000 mg). NSAIDs and analgesics help to relieve pain (including radiating pain) in the head, jaw muscles, face, neck or shoulders. A high efficiency of TMD pain relief is shown with ibuprofen* and meloxicam** (average daily dose of 400–800 mg* and 7.5–15 mg**). In this particular situation, pharmacotherapy is considered a supportive therapy that supplements other therapies. Used by itself, pharmacotherapy is considered for palliative therapy [48]. NSAIDs decrease pain and stop the inflammatory process [64].

Muscle relaxants (baclofen, tizanidin, cyclobenzaprine), opiates (morphine), anticonvulsants (e.g., gabapentin), ketamine, and TCA (e.g., amitriptyline) have also been used clinically for TMJ management, but there is no evidence for their efficacy [65, 66]. To achieve the myorelaxation effect with low CNS impact, metaxolone is recommended (average daily dose of 800 mg).

In specific cases, medications should be used admittedly. During acute spasms (sudden muscular contraction and painful shortening that is maintained over time), anesthetics are advised to block the pain and allow therapeutic stretching. Usually, the analgesic blockage with an infiltration of 1 ml of 2 % lidocaine (without vasoconstrictor) in the involved muscle is applied. A complementary therapy may include dypirone 500 mg (also in association with a myorelaxant, such as orfendrine, if necessary) 3 times a day, for 2 days [46]. In this situation, 90 % of cases require analgesic therapy [65].

In myositis and other inflammatory disorders, the most appropriate strategy is the administration of one dose of corticosteroid intramuscularly. Another approach is the injection of an analgesic or anti-inflammatory agent. The most common injections contain corticosteroids (with anti-inflammatory action) or hyaluronic acid [67]. In animal models, the use of an inhibitor selective for the inducible COX-2 enzyme may attenuate the neurogenic component of inflammation [47]. COX enzymes are blocked by NSAIDs. Unfortunately, those medications have a high risk of adverse side effects, which may include

Table 4 Reported treatment modalities related to the selected disease entities associated with temporomandibular disorders

Type of the disease entity acc. ICD-10[a]	Treatment modalities	Type and year of the selected confirming article	Authors
Pain disorders:			
1. Myalgia, Myofascial pain (M79.1)	Counselling; Occlusal splint therapy; Massage; Manual therapy; Other physiotherapeutic techniques; Oral and injectable drug therapy	Review (1994)	Ramfjord et al. [34]
		Original (2004)	Magnusson et al. [35]
		Original (2009)	Hamata et al. [32]
2. Arthralgia (M26.62)		Review (2012)	Miernik et al. [26]
3. Headache attributed to TMD (G44.89)		Original (2003)	Hilbert et al. [46]
		Review (2007)	Smith [44]
4. Tension-type headache (G44.2)		Review (2010)	Cairns [65]
		Original (2008)	Guarda-Nardini et al. [71]
Joint disorders:			
1. Disc displacement (M26.63)	Counselling; Therapeutic exercises; Occlusal splint therapy; Massage; Manual therapy; Other physiotherapeutic techniques; Oral and injectable drug therapy; Minimally invasive and invasive surgical procedures	Original (2013)	Bae et al. [30]
		Review (1994)	Ramfjord et al. [34]
2. Degenerative joint disease (M19.91)		Original (2004)	Magnusson et al. [35]
3. Subluxation (S03.0XXA)		Original (2009)	Hamata et al. [32]
4. Derangement of TMJ (K07.6)		Review (2012)	Miernik et al. [26]
5. Arthritis of TMJ (K07.6)		Original (2003)	Hilbert et al. [46]
6. Injuries of TMJ (S03.0-dislocation; S01.4-open wound; S02.6-fracture)		Review (2007)	Smith [44]
		Original (1996)	Schiffman et al. [63]
		Review (2010)	Cairns [65]
		Original (2007)	Gunson et al. [67]
		Original (2013)	Emara et al. [70]
		Original (2014)	Vos et al. [87]
		Original (2013)	Sidebottom et al. [93]
Bruxism:			
1. Psychogenic (F45.8)	Counselling; Psychotherapy; Occlusal splint therapy; Massage; Other physiotherapeutic techniques; Oral and injectable drug therapy	Review (1994)	Ramfjord et al. [34]
		Original (2004)	Magnusson et al. [35]
2. Sleep related (G47.63)		Original (2009)	Hamata et al. [32]
		Review (2012)	Miernik et al. [26]
		Original (2003)	Hilbert et al. [46]
		Review (2006)	Medlicott et al. [51]
		Review (2010)	Cairns [65]
		Original (2008)	Guarda-Nardini et al. [71]
Excessive attrition of teeth (K03.0)	Counselling; Occlusal splint therapy; Prosthodontic rehabilitation	Review (1994)	Ramfjord et al. [34]
		Original (2004)	Magnusson et al. [35]
		Review (2011)	Johansson et al. [37]

Table 4 Reported treatment modalities related to the selected disease entities associated with temporomandibular disorders *(Continued)*

Anomalies of dental arch relationship (K07.2); Dentofacial anomalies (K07.0; K07.1); Unilateral condylar hyperplasia or hypoplasia (K10.8)	Counselling; Occlusal splint therapy; Prosthodontic rehabilitation; Orthodontic therapy; Invasive surgical procedures	Review (1994)	Ramfjord et al. [34]
		Original (2004)	Magnusson et al. [35]
		Review (2011)	Johansson et al. [37]
		Original (1997)	Gerbino et al. [94]
		Original (2013)	Abrahamsson et al. [95]

[a]*ICD-10* International Classification of Diseases 10th Revision

exacerbation of hypertension or gastrointestinal upset that may lead to ulcerations. COX-2-selective NSAIDs (eg. Celecoxib, Meloxicam) which have less side effects, are not found to be better for the treatment of TMD. There is a hope that lotions containing NSAIDs will not have as many side effects and will have a positive impact on relieving pain [65].

In chronic facial pain, aside from pain relievers, antidepressants should be used as a supplementary treatment [47]. Antidepressants may be used for chronic pain as a primary analgesic. These medications manage headaches and neuropathic pain, reducing the feeling of depression caused by pain and improving sleep quality [65].

It had been proven that NSAIDs relieve pain in patients who suffer from arthritis. In this situation, diclofenac at a maximum dose of 50 mg orally 3 times daily or naproxen sodium 500 mg twice a day are recommended, as they improve pain in more than half of the patients [65]. It had been shown that the use of antibiotics, such as doxycycline or other tetracyclines, could help prevent condylar resorption. Regardless of their antibiotic activity, antibiotics inhibit matrix metalloproteinases (MMPs), whose levels are elevated in inflammatory processes involving TMJ [67]. Doxycycline is also a medication of choice in patients who undergo orthognathic surgery to avoid the resorption process [68].

For anxiety treatment and stress relieve, benzodiazepine (eg. Diazepam 5 mg, Lorazepam 1 mg or Alprazolam 0.5 mg) for 5–10 days should be prescribed [46].

Clinical investigations by Bakke et al. [69] and Emara et al. [70] confirm the possibility of applying botulinum toxin type A (BTX-A) for the treatment of disc displacements using injections in the lateral pterygoid muscles. BTX-A decreases myofascial pain and symptoms in the bruxers by reducing muscle tension [71].

Botulin is a biologic neuromuscular blocking agent that works as a muscle relaxant and therefore relieves pain in the head and neck; it also decreases neuromuscular tonus and bruxing at night. Hypertrophic masseter muscles activity is also reduced. Due to the large scope of BTX-A, it can be used in various temporomandibular disorders, such as bruxism, oromandibular dystonia, myofascial pain (also including TMJ involvement), trismus, hypermobility, masseter or temporalis hypertrophy, headaches and neck pain [72, 73].

Acupuncture

A common method frequently used in Asian countries is a needle puncture, also known as acupuncture. This method is also gaining popularity in western countries. Acupuncture originated in China over 3,000 years ago. A skilled acupuncturist restores whole body balance and the flow of energy within it (called *Qi*) to relieve a patient's pain and to improve the inflammatory process within the joint and decrease hypertension. The method is more successful in patients who change their dietary habits (soft food, avoidance of chewing gum, less saturated fats, coffee and fried foods in the diet). Interestingly, acupuncture is very successful in long-term follow-ups (18–20 years). There are several recommended acupuncture points (e.g., SI-18, GV-20, GB-20, ST-6, ST-7, BL-10 and LI-4) that should be "triggered" weekly, 30 min per session. Needles are inserted within the pain area and around the ear and jaw. In some cases, needles near elbows, knees and the big toe are inserted to relieve pain and inflammatory process within the TMJ. It is recommended to complete 6 sessions of acupuncture treatment, but chronic disorders may require more. Often, acupuncture should be associated with pharmacotherapy [66, 74–76].

A modern approach of needle puncture is based on the findings of trigger points in painful muscles [77]. Dry needles are inserted at the trigger points, or taut bands, which are not related to the meridian or Chi points, are placed according to traditional Chinese acupuncture practices [78, 79]. Biochemical differences have been found between healthy muscle fibers, and active and latent trigger points [80]. Therefore, needle puncture at trigger points actually change the biochemical environment of the painful muscles of TMD patients.

Drug therapy and alternatives in rheumatoid disorders

In rheumatoid disorders, the TMJ is usually only one of the joints (or only one of the organs) involved in the disease process. The pharmacologic treatment in this case

plays a crucial role and is not only an adjuvant therapy. In those cases, pharmacologic treatment refers to the whole systemic disease and not only to the TMD.

Among patients with juvenile idiopathic arthritis (JIA), joint involvement may be accompanied by periodontal disorders and gingivitis; it usually shows no relation in higher incidences of the caries process. TMD in this disorder are confirmed by the Ai Helkimo and Di Helkimo indexes, which show that disorders within this joint are reported both objectively and subjectively [81]. Patients with JIA or RA (rheumatoid arthritis) are believed to suffer from TMD in 1 to 25 % of cases, but up to 75 % prevalence might be observed. Arthritis may be asymptomatic but might be associated with TMJ pain, especially during movement. The disorders may include condylary damage and synovitis. The untreated process may lead to mandibular growth disturbances, leading to laterogenia, malocclusions and micrognathia. The joint involvement would, in this case, impact the treatment decisions. In pharmacotherapy, systemic methotrexate and/or TNF inhibitors are used. Additionally, corticosteroids might be successful for modifying the course of the disease. Splint therapies and functional orthodontic appliances might still be used but are adjuvant to the pharmacologic treatment. The medications themselves may reduce the inflammatory process within the joint [82–85].

Surgical procedures

The arthrocentesis that involves draining the joint with a therapeutic substance reduces the inflammatory process, evacuates inflammatory exudate, releases the disc, breaks up adhesions, eliminates pain, and improves joint mobility; this should be performed with the mouth wide open and a protruded mandible [80, 85]. Two needles are used to puncture the joint space to restore normal maximal mouth opening and functioning. This technique has limitations due to low tolerability and difficulties in performing the procedure; therefore, single needle arthrocentesis has become more popular [86]. Randomized controlled trial carried out by Vos et al. [87] tried to determine the effectiveness of arthrocentesis compared to conservative treatment as initial treatment with regard to temporomandibular joint pain and mandibular movement. They showed that arthrocentesis reduces pain and functional impairment more rapidly compared to conservative treatment but in long term observations the effectivnes of both treatment modalities achieved comparable outcomes.

The method of intra-articular injections of platelet-rich plasma (PRP) to patients with persistent pain related to severe temporomandibular joint dysfunction described by Pihut et al. [88] seems to be a valid procedure for decreasing TMD pain.

In the most severe cases in who TMJ is too severely damaged by the inflammatory process to be cured in a conservative way, implants are used to replace the TMJ. Examples include the Christensen system, the TMJ Concepts system and the Lorenz (BMF) system. Ciocca et al. [89] showed the regenerative properties of mesenchymal stem cells and CAD-CAM-customized pure and porous hydroxyapatite scaffolds to replace the temporomandibular joint condyle. Previously mentioned articles and other papers have

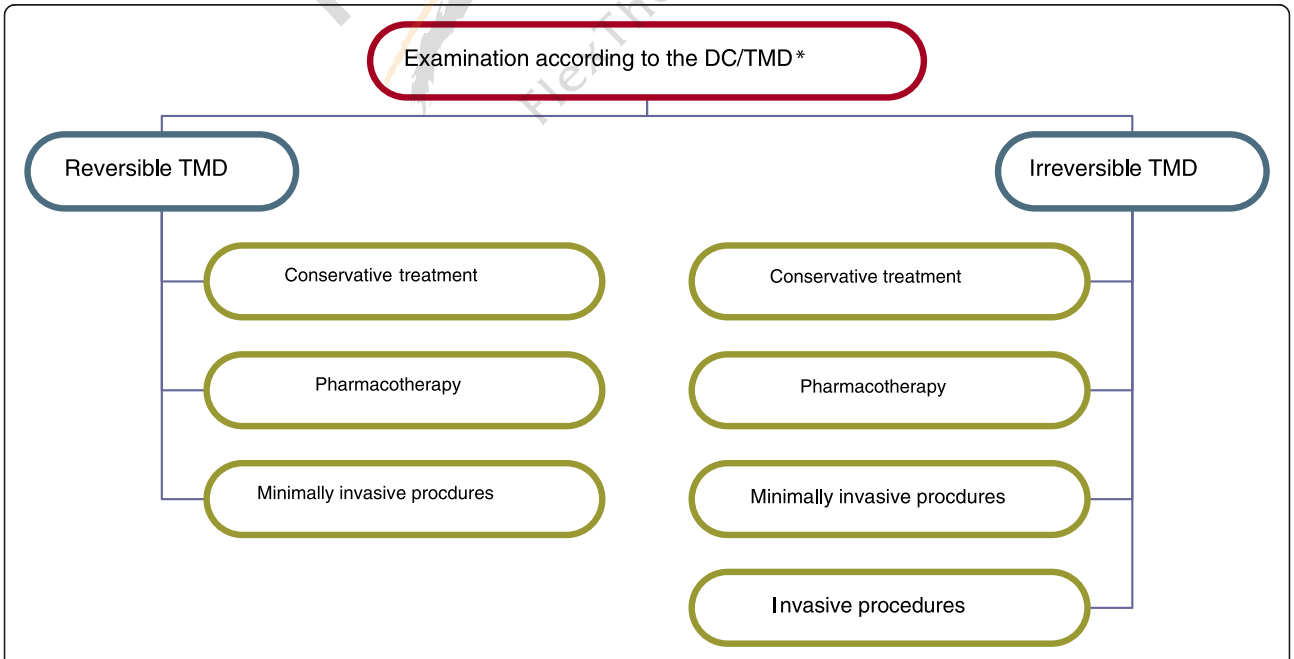

Fig. 1 Treatment algorithm for the management of TMD-related pain (*The Diagnostic Criteria for Temporomandibular Disorders by Schiffman et al. [1])

confirmed that tissue engineering and stem cells therapy seem to be a promising alternative to the traditional procedures for the management of pain associated with degenerative TMJ disease [90, 91].

The main indication for TMJ replacement is pain relief and functional improvement in arthritis (osteoarthritis, psoriatic, rheumatoid arthritis and ankylosing spondylitis). The other situations where the TMJ needs replacement are ankylosis, damage by trauma and complications after earlier joint replacement [92, 93]. In a a case of severe malocclusion, dentofacial anomalies and unilateral condylar hyperplasia or hypoplasia complicated by TMJ dysfunction the surgical procedures combined with orthodontic treatment should be considered [94, 95].

Conclusions

Due to the diverse causes of these disorders, TMD pain management requires various methods of treatment that are conformable to the origin of the dysfunction (Table 4). The authors concluded that conservative treatment including counselling, exercises, occlusal splint therapy, massage, manual therapy and others should be considered as the first choice treatment for TMD pain because of their low risk of side effects. In cases of severe acute or chronic pain resulting from serious disorders, inflammation and/or degeneration pharmacotherapy, minimally invasive and invasive procedures should be included (Fig. 1).

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Comparison of self-reported pain intensity, sleeping difficulty, and treatment outcomes of patients with myofascial temporomandibular disorders by age group: a prospective outcome study

Abstract

Background: Subjective symptoms of temporomandibular disorders (TMDs) have rarely been studied by age group. We aimed to compare self-reported pain intensity, sleeping difficulty, and treatment outcomes of patients with myofascial TMDs among three age groups.

Methods: The study population included 179 consecutive patients (151 women and 28 men) who underwent comprehensive clinical examinations at a university-based orofacial pain center. They were classified into myofascial pain subgroups based on the Research Diagnostic Criteria for Temporomandibular Disorders. They were stratified by age group: M1, under 20 years; M2, 20–39 years; and M3, 40 years and older. The patients scored their pretreatment symptoms (first visit) and post-treatment symptoms (last visit) on a form composed of three items that assessed pain intensity and one item that assessed sleeping difficulty. Their treatment options (i.e., pharmacotherapy, physical therapy, and orthopedic appliances) and duration were recorded. All variables were compared between sexes in each group and between the age groups by using the Kruskal–Wallis test, the Mann–Whitney *U* test, the chi-square test, and analysis of variance ($p < 0.05$).

Results: No significant sex differences were found in any age group. Only sleeping difficulty was significantly different before treatment ($p = 0.009$). No significant differences were observed in the treatment options or treatment duration. After treatment, the intensity of jaw/face pain and headache and sleeping difficulty was significantly reduced in groups M2 and M3, but only the intensity of jaw/face pain was significantly decreased in group M1. The changes in the scores of pain intensity and sleeping difficulty were not different between the groups.

Conclusions: Pain intensity does not differ by age group, but older patients with myofascial TMDs had greater sleeping difficulties. However, there were no differences between the age groups in the treatment outcomes. Clinicians should carefully consider the age-related characteristics of patients with myofascial TMDs when developing appropriate management strategies.

Keywords: Age, Headache, Myofascial pain, Outcomes, Temporomandibular disorders

Background

Temporomandibular disorders (TMDs) include musculoskeletal and neuromuscular conditions that involve the masticatory muscles, temporomandibular joint (TMJ), and associated structures [1]. They are a subclass of musculoskeletal disorders and cause nondental pain in the orofacial region [1]. TMDs primarily affect young and middle-aged adults rather than children or the elderly [2], although symptoms are frequently observable in the latter populations [3-6]. Most TMDs occur between 20 years and 40 years of age, show a female preponderance [7,8], and are self-limiting or fluctuate over time [9].

TMDs are associated with many diagnostic features such as internal derangements and myogenous disorders [10]. They can be classified according to the extent of TMJ and muscular involvement. The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) allow standardization and replication of research on the most common forms of TMDs [11]. Symptoms of TMDs can accordingly be investigated by diagnostic subgroups. Patients with chronic TMDs in the myofascial pain subgroup (i.e., RDC/TMD, Axis I, Group I) reportedly have greater dysfunctionality, higher pain intensity, and greater psychological difficulties, compared to patients in the intracapsular pain subgroup (i.e., RDC/TMD, Axis I, Group II or Group III) [12,13]. In addition, young patients with myofascial pain have significantly greater difficulty in sleeping, compared to patients with TMJ-related problems [14].

Symptoms of joint-related TMDs resolve with minimal care [15]. However, symptoms of myogenous TMDs can become chronic because many patients focus less on tightness in the masticatory muscles or on the presence of trigger points, which may also be responsible for their myofascial pain. Patients with chronic myogenous TMDs may have persistent central sensitization and psychological comorbidity that is similar to patients with chronic pain [16]. Therefore, early intervention is needed to reduce muscle tenderness and associated disability. However, few studies have compared the subjective symptoms of TMDs by age group [17-19].

In this study, we aimed to compare self-reported pain intensity, sleeping difficulty, and treatment outcomes of patients with myofascial TMDs among three age groups. We hypothesized that young patients are more likely to have mild symptoms and their symptoms are easy to treat, whereas older patients are more likely to show severe symptoms, which are difficult to treat.

Methods

Study population

We screened 862 consecutive patients who attended the University of California–San Francisco (UCSF) Center for Orofacial Pain (San Francisco, CA), a public university-based specialty clinic that treats TMD and orofacial pain problems. We used a prospective study approach to examine pretreatment and post-treatment differences in pain intensity and sleeping difficulty in the three age groups. We obtained the necessary data from the patients' medical records. Ethical considerations were anonymity, privacy, and obtaining informed consent from all patients. The UCSF Committee on Human Research approved this prospective outcome study.

Diagnostic procedures

The patients underwent standardized comprehensive clinical examinations by two examiners who were diplomates of the American Board of Orofacial Pain. The examinations included provocation testing of the TMJs, measurements of the mandibular and cervical ranges of motion, determination of TMJ noise, masticatory and cervical muscle examination, cranial nerve assessment, and intraoral examination. Additional diagnostic tests (i.e., imaging, physical therapy evaluation, and other medical consultation) were performed, if needed.

The RDC/TMD guidelines were followed for classification, based on the primary diagnosis. Patients were excluded if they had neuropathic pain, generalized pain (e.g., fibromyalgia), neurovascular headache (e.g., cluster headache or migraine), or any psychiatric disorder. The RDC/TMD Axis I, Group I.a (i.e., myofascial pain) or Group I.b (i.e., myofascial pain with limited opening) included a painful response to palpation of the following muscle sites: posterior temporalis, middle temporalis, anterior temporalis, origin of the masseter, body of the masseter, insertion of the masseter, posterior mandibular region, submandibular region, lateral pterygoid area, and tendon of the temporalis [11]. Patients with clinical features fulfilling the RDC/TMD Axis I Group I.a or Group I.b criteria were classified as the myofascial pain subgroup and were the focus of this study. This myofascial pain subgroup was stratified according to age: under 20 years (group M1; n = 41); 20–39 years (group M2; n = 62); and 40 years and older (group M3; n = 76).

Symptom measurement

The patients completed a form that assessed their symptoms at the first visit and at subsequent visits during the treatment period. In several studies, self-reported questionnaires focused on the intensity of TMD symptoms, headaches, and neck pain and related impact on activities of daily living [20-22]. Self-reported measures provide the 'gold standard' in assessing pain outcomes, and commonly used methods of rating pain intensity are reliable and valid [23]. Thus, the form in our study included three items related to pain intensity (jaw/face pain, headache, and neck pain) and one item related to difficulty in sleeping. To measure pain intensity and sleeping difficulty, an 11-point numeric rating scale (NRS), which

ranged from 0 to 10, was used in which 0 indicated "no pain/difficulty" and 10 indicated "the worst pain/difficulty imaginable" [24]. We used the NRS because it is a well-understood measure for pain evaluation and it has an acceptable reliability [25]. The patients scored the items on the 11-point NRS by circling the number that best represented their pain intensity and sleeping difficulty. For each age group, the treatment outcomes were analyzed by comparing the scores of the first visit (i.e., pretreatment) and last visit (i.e., post-treatment). To compare the treatment outcomes between the age groups, the changes in the scores were calculated by the difference between the post-treatment and pretreatment scores (i.e., post-treatment score – pretreatment score).

Statistical analysis

For each age group, sex differences were assessed with the Student *t* test for age and treatment duration, and by the Mann–Whitney *U* test for pain intensity and sleeping difficulty. Analysis of variance (ANOVA) and the chi-square test were used for analyzing differences in treatment duration and sex ratio, respectively, between the age groups. The Kruskal–Wallis test was used to compare pain intensity and sleeping difficulty by age group. If a significant difference was found, a pair of variables in the three groups was assessed with the Mann–Whitney *U* test. Because three tests were performed, Bonferroni adjustment was applied with the alpha level set at $p = 0.0167$ (i.e., 0.05/3). The Wilcoxon signed-rank test was used to compare subjective symptoms between the pretreatment and the post-treatment periods. A value of $p < 0.05$ was considered significant. All analyses were performed by using IBM SPSS Statistics 21 software (IBM Japan, Tokyo, Japan).

Results

No age group showed any significant sex differences. In general, 84.4% (151/179) of the study population included female patients with a higher proportion in group M3 (88.2%) than in groups M1 (80.5%) or M2 (82.3%). However, the sex ratio was not significantly different between the age groups (chi-square test, $p = 0.60$) (Table 1).

Pretreatment pain intensity was not significantly different among the age groups (Table 2). However, significant differences were observed in sleeping difficulty (Kruskal–Wallis test, $p = 0.009$). Groups M2 and M3 had similar sleeping difficulties (Mann–Whitney *U* test, $p = 0.71$), but scored significantly higher than group M1 (Mann–Whitney *U* test: M1 vs. M2, $p = 0.006$; M1 vs. M3, $p = 0.005$).

Regarding treatment options, patients in groups M2 and M3 were more likely to receive pharmacotherapy, compared to patients in group M1 (Table 3). However, no significant difference in the distribution of various treatments was noted (chi-square test, $p = 0.76$). The average treatment durations were 15.8 weeks, 18.7 weeks, and 20.0 weeks in groups M1, M2, and M3, respectively, but this was not significantly different (ANOVA, $p = 0.68$).

After treatment, the intensity of jaw/face pain, headache, and sleeping difficulty significantly improved in groups M2 and M3. However, only the intensity of jaw/face pain significantly reduced in group M1 (Table 4). The changes in the scores of pain intensity and sleeping difficulty were not different between the groups (Table 5).

Discussion

This study focused on patients with myofascial TMDs and compared self-reported symptoms between three age groups. From the findings of previous studies [5,26], we hypothesized that young patients are more likely to have mild symptoms and their symptoms are easy to treat, whereas older patients are more likely to show severe symptoms, which are difficult to treat. However, our present findings did not support this hypothesis: pretreatment symptoms of myofascial TMDs were similar in all age groups and no differences were found in the treatment outcomes among the different age groups.

A study of consecutive patients of all ages showed that 85.4% of patients who sought treatment for TMDs were females [27], which was consistent with our findings in each age group (i.e., more than 80%). Therefore, TMDs show a female preponderance at all ages. Temporomandibular disorder conditions such as myofascial pain are associated with female sex [28]. Women with TMDs report more severe physical symptoms, compared to men [29]. However, ratings of pain rarely show significant sex differences [30]. In our study, pain intensity was

Table 1 Demographic data of patients with myofascial TMDs by age group

Variable	M1 (n = 41)	M2 (n = 62)	M3 (n = 76)
Median age (y)	15.5 ± 2.5	29.6 ± 5.9	54.9 ± 10.8
Age range (y)	10 – 19	20 – 39	40 – 84
Female/male ratio	33/8	51/11	67/9

M1 = less than 20 years; M2 = 20–39 years; M3 = 40 years and older.
The data are presented by the mean ± the standard deviation or by the number of patients.

Table 2 Comparison of pretreatment symptom scores between the age groups

Symptom	M1 (n = 41)	M2 (n = 62)	M3 (n = 76)	p*
Jaw/face pain	5.5 ± 2.9	5.3 ± 2.4	5.5 ± 2.2	0.83
Headache	4.2 ± 3.3	3.6 ± 2.5	4.2 ± 3.3	0.41
Neck pain	3.2 ± 3.4	3.6 ± 2.7	4.1 ± 3.0	0.26
Sleeping difficulty	2.7 ± 3.2	4.2 ± 3.0	4.5 ± 3.4	0.009

M1 = less than 20 years; M2 = 20–39 years; M3 = 40 years and older.
The data are presented by the mean ± the standard deviation.
*The p value is based on the Kruskal–Wallis test.

Table 3 Treatment options and duration by age group

Treatment	M1 (n = 41)	M2 (n = 62)	M3 (n = 76)
Pharmacotherapy	23 (56.1)	50 (82.0)	52 (83.1)
Physical therapy	25 (61.0)	45 (75.4)	47 (61.0)
Pharmacotherapy + physical therapy	17 (41.5)	38 (62.3)	41 (53.2)
Orthopedic appliances	6 (14.6)	8 (13.1)	7 (9.1)
Outside reference	5 (12.2)	3 (4.9)	9 (11.7)
Duration of treatment (wk)	15.8 ± 10.3	18.7 ± 18.3	20.0 ± 33.2

M1 = less than 20 years; M2 = 20–39 years; M3 = 40 years and older.
The data are presented by the number of patients (%) or by the mean ± the standard deviation.

not significantly different between the sexes, which may have been influenced by the selection bias associated with the patients' seeking health care [31].

Levitt and McKinney [29] report that the pain severity of patients with TMDs is the same across age groups and that the severity of symptoms is greater in groups in which TMDs have existed for a long duration. We did not study the natural course of the disease in the present study; however, the patients with myofascial TMDs experienced similar pain intensity, regardless of age. From our results, the duration of treatment was not different between the age groups, which suggests a similar duration of TMDs. Furthermore, each age group showed a wide range in the standard deviation for each symptom score, which indicated different levels of severity in each age group. These factors may have influenced the lack of a significant difference in pain intensity associated with myofascial TMDs. However, even patients younger than 20 years have headache and neck pain intensity that is similar to that of older groups. Individuals who develop TMDs are more likely to describe comorbidities such as headache and other body pain [32,33]. Clinicians should therefore pay more attention to young patients with myofascial TMDs who complain of high-intensity pain.

Myogenous pain is treated by various strategies such as trigger point injections, vapocoolant spray and stretch, transcutaneous electrical nerve stimulation, biofeedback, posture correction, tricyclic antidepressants, muscle relaxants and other medications, and by addressing perpetuating factors [34]. Fricton [34] states that the complexity of the treatment program needs to match the complexity of the patient's condition. In the current study, pharmacotherapy was provided by one of two board-certified orofacial pain specialists and included analgesics (nonsteroidal anti-inflammatory drugs), muscle relaxants (cyclobenzaprine, 10 mg), and low-dose tricyclic antidepressants (amitriptyline, 10–25 mg). Physical therapy was provided by a licensed therapist and included a home-care program (i.e., self-management and exercise regimen), posture training, mobilization, and the use of physical agents such as ultrasound or vapocoolant spray. Dental treatment other than orthopedic appliances (i.e., interocclusal splints) was not provided to most patients.

Table 4 Comparison of pretreatment and post-treatment symptom scores by age group

Symptom	M1 (n = 41)	p*	M2 (n = 62)	p*	M3 (n = 76)	p*
Jaw/face pain						
Before	5.5 ± 2.9	0.002	5.3 ± 2.4	< 0.001	5.5 ± 2.2	< 0.001
After	4.1 ± 2.4		3.5 ± 1.9		3.6 ± 2.4	
Headache						
Before	4.2 ± 3.3	0.28	3.6 ± 2.5	0.002	4.2 ± 3.3	0.001
After	3.6 ± 3.0		2.3 ± 2.1		2.4 ± 2.5	
Neck pain						
Before	3.2 ± 3.4	0.88	3.6 ± 2.7	0.08	4.1 ± 3.0	0.07
After	3.1 ± 2.9		3.0 ± 2.4		3.2 ± 2.5	
Sleeping difficulty						
Before	2.7 ± 3.2	0.96	4.2 ± 3.0	0.001	4.5 ± 3.4	0.005
After	2.7 ± 3.1		2.8 ± 2.6		3.2 ± 3.0	

M1 = less than 20 years; M2 = 20–39 years; M3 = 40 years and older.
The data are presented by the mean ± the standard deviation.
*The p value is based on the Wilcoxon signed-rank test.

Table 5 Comparison of the changes in the scores between age groups

Symptom	M1 (n = 41)	M2 (n = 62)	M3 (n = 76)	p*
Jaw/face pain	−1.4 ± 2.8	−1.9 ± 2.5	−2.0 ± 3.2	0.53
Headache	−0.5 ± 3.1	−1.3 ± 3.1	−1.8 ± 4.3	0.24
Neck pain	0.1 ± 2.4	−0.5 ± 2.7	−0.8 ± 3.9	0.33
Sleeping difficulty	−0.1 ± 2.8	−1.5 ± 3.2	−1.2 ± 4.7	0.08

M1 = less than 20 years; M2 = 20–39 years; M3 = 40 years and older.
The data are presented by the mean ± the standard deviation. The score change is calculated by the difference between the post-treatment and pre-treatment symptom scores (i.e., score change = post-treatment symptom score – pretreatment symptom score).
*The p value is based on the Kruskal–Wallis test.

The treatment options and duration did not significantly differ by age group, although medications tended to be prescribed more frequently in groups M2 and M3. The average duration of treatment was more varied in group M3. We did not determine the treatment periods of each patient because the treatment interval varied among the age groups. We defined the treatment duration as the time from the first visit to the last visit. Further, older patients may have a chronicity of symptoms [5]. These factors may have influenced the large dispersion of treatment duration in group M3.

A study that compared treatment outcomes of young patients (20–30 years) and elderly patients (50–70 years) with TMDs [18] showed that, although 54% and 38% of the respective groups had a muscle disorder diagnosis, both groups responded equally well to a conservative treatment regimen and experienced marked reduction in pain. In the present study, the patients in all age groups demonstrated a significant decrease in jaw/face pain after the treatments, and the changes in the scores were not different between the age groups. Therefore, conservative treatment methods are effective for myofascial TMDs at all ages.

Approximately one-third of patients with TMDs report poor sleep quality [1]. Numerous factors such as medical condition, mental disorders, breathing disorders during sleep, or other sleep disorders can induce insomnia symptoms [35]. A population-based study reports that insomnia is one consequence of chronic pain [36]. A recent epidemiological study reports that the prevalence of difficulty in maintaining sleep increased with age, reaching nearly 50% in elderly individuals (i.e., older than 60 years) [37]. Older patients are more likely to have a physical illness—especially arthritis and heart disease—or have a painful physical affliction such as back pain. These physical conditions may cause older patients to experience greater sleeping difficulty, compared to young patients. In our study, groups M2 and M3 had greater pretreatment sleeping difficulty but had a significant post-treatment improvement. They also reported a similar level of sleep difficulty as that of the young patients. A meta-analysis of fibromyalgia showed that patients treated with cyclobenzaprine were three times more likely to report moderate reductions in individual symptoms, particularly in sleep [38]. In the present study, medications (i.e., muscle relaxants) and a home-care program (i.e., sleeping position and using appropriate pillows) may have improved self-reported sleep difficulty in the older patients.

We did not assess treatment effectiveness. Because of this limitation, we cannot describe the most effective treatment for symptoms of myofascial TMDs in young or elderly patients. However, tailored treatment protocols are necessary for patients with TMDs. Further well-designed studies are needed to clarify the effects of each treatment and the effects of patient compliance with a home-care program on reducing orofacial pain and difficulty in sleeping.

Conclusions

Pain intensity associated with myofascial TMDs does not differ by age, but older patients experience greater sleeping difficulty, compared to young patients. Conservative treatment strategies can reduce pain in the jaw or face region at all ages. Treatment outcomes of self-reported pain intensity and sleeping difficulty are not different between different age groups. Clinicians should carefully consider the age-related characteristics of patients with myofascial TMDs when developing appropriate management strategies.

Abbreviations

TMD: Temporomandibular disorder; TMJ: Temporomandibular joint; RDC/TMD: Research diagnostic criteria for temporomandibular disorders; UCSF: University of California San Francisco; NRS: Numeric rating scale; ANOVA: Analysis of variance.

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