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Conservative approach to temporomandibular disorders in physiotherapy.

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CONSERVATIVE APPROACH TO TEMPOROMANDIBULAR DISORDERS IN PHYSIOTHERAPY

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The purpose of this thesis is to inform physiotherapists as well as other healthcare providers about the conservative temporomandibular disorder management approaches available and to allow an efficient differential diagnosis for individuals whose temporomandibular disorder is out of scope of the professional. An additional goal of this thesis is to raise awareness amongst physiotherapists about the diagnostic criteria of temporomandibular disorder, pathologies and comorbidities related, as to improve the treatment provided. For this purpose, both PubMed and sciencedirect were included as viable databases of research. In sciencedirect two review articles published between 2008-2018 whose full text was available were included. In pubmed, two articles of the following Meshterms were used: "Symptoms of TMD (sciencedirect)","signs and symptoms" + "tmj disorder".

CONTENTS

1 INTRODUCTION

Temporomandibular joint (referred to as TMJ) and surrounding structures produce jaw motions such as swallowing, talking, chewing, and yawning, hence making TMJ one of the most commonly used joints in the human body. Temporomandibular dysfunctions (referred as TMDs) can significantly affect patients' quality of life by limiting and reducing the quality of activities of daily living (referred to as ADL) by causing muscle and joint pain. TMDs are a group of heterogeneous disorders affecting the TMJ, and other hard and soft tissues surrounding it. (Lippert 2011, 197.) Furthermore, TMDs are no longer considered as localized pathologies of TMJ or other orofacial structures, but rather a result of both multiple genetic and environmental factors (Ohrbach & Dworkin 2016, 1094). TMDs have a complex etiology, which can be overwhelming even for professional healthcare providers (Slade et al. 2016, 1091). The discussion of TMDs, as in other complex musculoskeletal disorders, should be in the context of chronic pain's interaction with biological, psychological and social factors. (Ohrbach & Dworkin 2016, 1093)

Many TMD patients seek firstly help from dentists due to the location of their pain. Furthermore, TMD in relation to dentistry has been the main focus of TMD research, but lately larger studies have included more physiotherapeutic approach to TMD research. Increased knowledge has provided evidence for the efficacy of conservative physiotherapy treatments. Physiotherapists are musculoskeletal experts and due to the nature of the most common TMD types, physiotherapists can provide many treatment options (Lippert 2011, 197). Furthermore, the diagnosis and treatment of TMD requires a multidisciplinary approach (dentistry, physiotherapy, psychiatry and oral surgery) if needed and it is one of the underlying core principles. The second core principle is to implement firstly, if possible, the least invasive treatment methods and only if these treatments fail to provide remedy to a patient's symptoms or in serious case of TMD, more invasive approaches should be implemented. (Liu & Steinkeler 2013, 469-470)

2 THE AIM AND OBJECTIVES OF THE THESIS:

Physiotherapists can approach TMD with conservative treatment methods, which can provide a preliminary strategy preceding invasive and often nonreversible treatments such as surgeries. The aims of this thesis are to increase the knowledge amongst physiotherapist, of these possible noninvasive treatment methods, bring awareness to diagnostic criteria of TMD and increase cooperation between physiotherapists and other healthcare professionals by encouraging multidisciplinary treatment plan. The objective of this thesis is to raise the awareness of conservative physiotherapy treatments of the most common pathologies behind TMD so that physiotherapists could provide better quality treatment for TMD patients.

3 TEMPOROMANDIBULAR JOINT ANATOMY

The temporomandibular joint (Fig 1.) consists of two bones: Temporalis and Mandible. TMJ is a hinge-like joint, with two joint spaces divided by a disk and a joint capsule. It also has four ligaments and four main muscles besides accessory muscles. The cervical spine is sometimes an overlooked structure regarding TMD, which requires a thorough evaluation. (Lippert 2011, 197-198; Shaffer 2016)

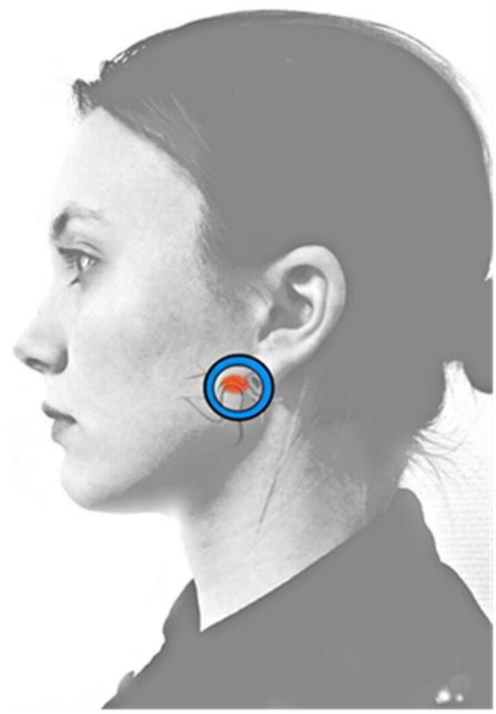


Fig 1. The location of the TMJ (Lautamaja 2018).

3.1 Muscles and tendons of the temporomandibular joint

The four main muscles of mastication are temporalis, masseter, medial and lateral pterygoid muscles. The aforementioned muscles, innervated by the mandibular nerve (V3) stem from the trigeminal nerve (the fifth cranial nerve). The muscles attach to the bone with the temporalis tendon. The temporalis tendon has great importance with regards to TMD because of its origin and insertion either which can often be affected pathologically. (Lippert 2011, 203; Shaffer 2016)

The temporalis is a fan-shaped and wide muscle (Fig 2.). Its origin is the temporal fossa whereas the insertions are the anterior portion of the ramus (of the mandible) and the coronoid process. Posterior muscle fibres run almost horizontally, middle fibres are at diagonal direction and the anterior fibres run nearly vertically. The temporalis primarily elevates the mandible, but is also involved in retraction of the jaw, done by its posterior muscle fibres, as well as side-to-side movements. (Lippert 2011, 203-204)

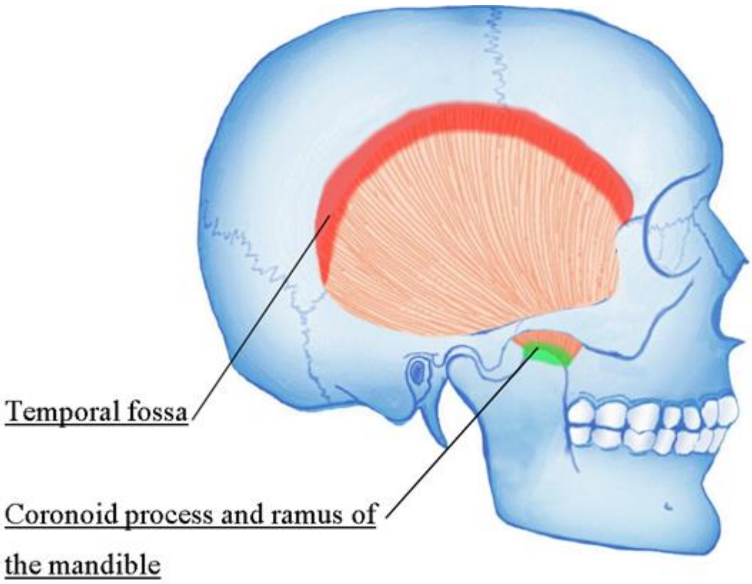


Fig 2. The origins and insertions of the temporalis (Lautamaja 2018).

The masseter is a strong muscle that contributes to the fullness of the cheeks due to it being a superficial muscle. It is located on the lateral side of the Mandibular ramus (Fig 3.). The origins of the masseter are the zygomatic arch of temporal bone, and zygomatic process of maxilla, whereas the insertions are the coronoid process of mandible and angle of the ramus (Fig 3.). The masseter has a larger superficial part, as well as the smaller deeper part. Both parts contribute in closing the jaw (mandibular elevation) and bilateral movement of the masseter contributes in ipsilateral lateral deviation (lateral movements of the same side's muscle). (Lippert 2011, 204)

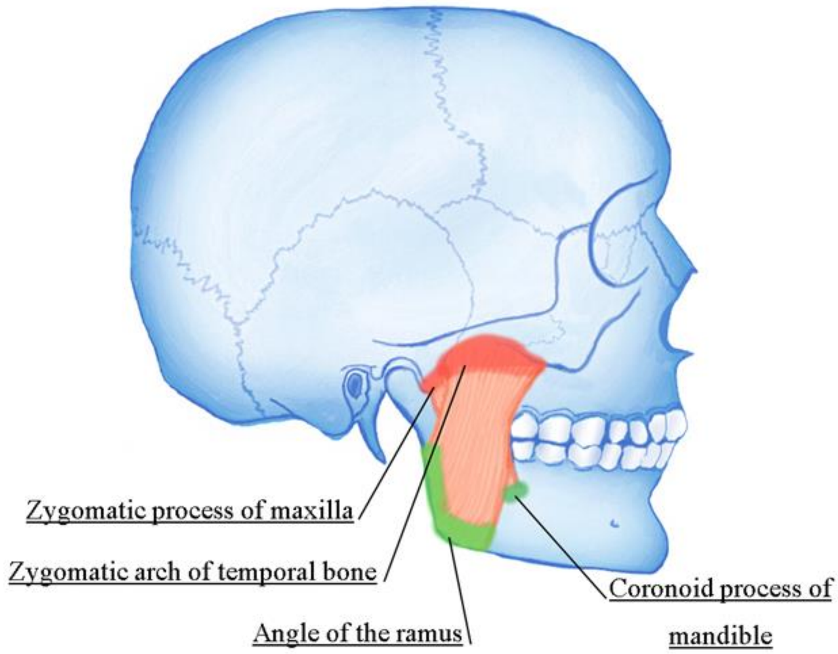


Fig 3. The origins and insertions of the masseter (Lautamaja 2018).

The medial pterygoid has a resemblance to the masseter in function, but it is comparably much weaker and is located on the medial aspect of the Mandibular ramus (Fig 4.). The origins of the medial pterygoid are the tuberosity of the maxilla and medial aspect of the lateral pterygoid plate of the sphenoid bone. The insertions of the medial pterygoid are the medial side of the ramus and angle of the mandible. Its actions are mandibular elevation, protraction, and contralateral lateral deviation (lateral movements of the opposite side to the muscle). (Lippert 2011, 204)

The lateral pterygoid muscle has superior and inferior heads. The origin of the superior part is the greater wing of the sphenoid bone and the inferior part's is the lateral pterygoid plate. The insertions of the lateral pterygoid muscle are the neck of the mandibular condyle and the articular disk (Fig 4.). The lateral pterygoid muscle depresses, protracts, and contralateral lateral deviates the mandible. (Lippert 2011, 204-205)

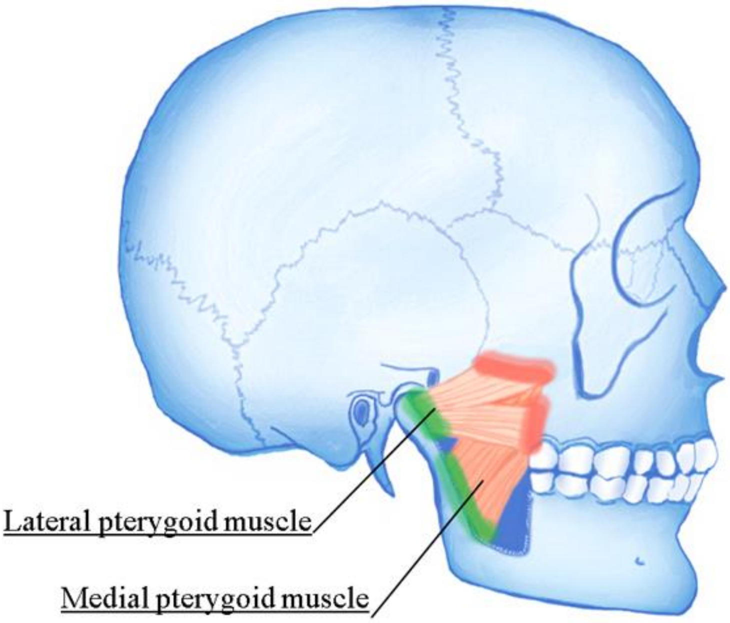


Fig 4. Locations of the lateral pterygoid and the medial pterygoid muscles (Lauta-maja 2018).

Other muscles involved in the TMJ complex are suprahyoid muscles and infrahyoid muscles (Table 1.). The suprahyoid muscles are a group of four muscles located above the hyoid bone. Their primary function is to elevate the hyoid, but they also assist in depressing the mandible. The infrahyoid muscles are also a group of four muscles located below the hyoid bone. Their function is to stabilize the hyoid bone. Nerve innervation of the suprahyoid and the infrahyoid muscles comes from cranial nerves (CN) 7 and 12. (Lippert 2011, 205-208)

Table 1. Summary of the muscles of the temporomandibular joint (Lippert 2011, 203- 208).

Muscle group:	Muscle:	Origin:	Insertion:	Activity:	Nerve:
Muscles of mastication	Temporalis	Temporal fossa	Coronoid process and ramus of the Mandi-ble	Bilaterally: elevation, retrusion Unilater-ally: ipsi-	Trigeminal nerve, CN5

				lateral lateral deviation	
	Masseter	Zygomatic arch of temporal bone and zygomatic process of maxilla	Angle of the ramus and coronoid process of mandible	Bilaterally: elevation Unilaterally: ipsilateral lateral deviation	Trigeminal nerve, CN5
	Medial pterygoid	Lateral pterygoid plate of the sphenoid bone and tuberosity of the maxilla	Ramus and angle of the mandible	Bilaterally: elevation, protraction Unilaterally: contralateral lateral deviation	Trigeminal nerve, CN5
	Lateral pterygoid	Lateral pterygoid plate and greater wing of the sphenoid	Mandibular condyle and articular disk	Bilaterally: depression, protraction Unilaterally: contralateral lateral deviation	Trigeminal nerve, CN5
Suprahyoid muscles	Mylohyoid	Interior medial mandible	Hyoid	Assists in depressing mandible	Trigeminal nerve, CN5
	Geniohyoid	Mental spine of mandible	Hyoid	Assists in depressing mandible	C1, hypoglossal nerve, CN12

	Stylohyoid	Styloid process of temporal bone	Hyoid	Assists in depressing mandible	Facial nerve, CN7
	Digastric	Anterior: internal inferior mandible Posterior: mastoid process	Via tendon to hyoid	Assists in depressing mandible	Trigeminal nerve, CN5 and CN7
Infrahyoid muscles	Sternohyoid	Medial end of clavicle, sternoclavicular ligament, and manubrium of sternum	Inferior border of hyoid bone	Stabilize hyoid bone	C1 to C3, hypoglossal nerve, CN12
	Sternothyroid	Manubrium of sternum and cartilage of the first rib	Thyroid cartilage	Stabilize hyoid bone	C1 to C3, hypoglossal nerve, CN12
	Thyrohyoid	Thyroid cartilage	Inferior border of hyoid bone	Stabilize hyoid bone	C1, hypoglossal nerve, CN12
	Omohyoid	Superior border of the scapula	Inferior border of hyoid bone	Stabilize hyoid bone	C1 to C3, hypoglossal

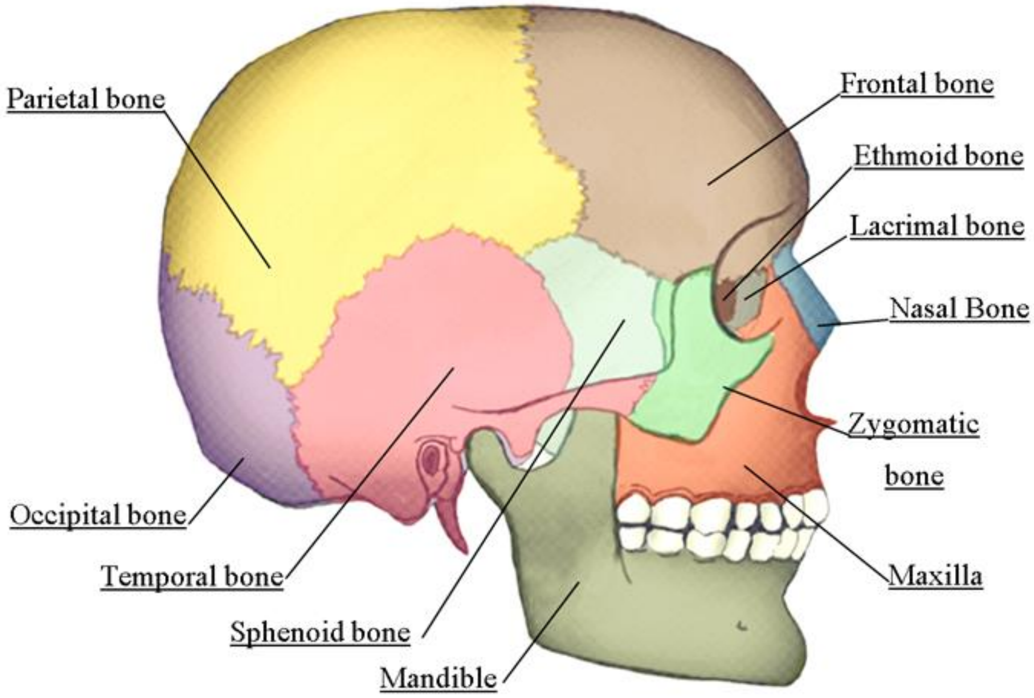
					nerve, CN12

3.2 Bones

The bones of the skull are classified as facial and cranial bones. The mandible (facial bone) and the temporal bone (cranial bone) articulate to create the TMJ. The surrounding bones (Fig 5.) have relevance to TMJ because they provide an area of muscular and ligamentous attachments. (Lippert 2011, 198)

The Mandible is located in the inferior part of the TMJ and it is the largest and strongest facial bone (Tortora & Derrickson 2012, 226). The mandible and the auditory ossicles are the only movable bones of the skull. The condyle of the mandible articulates with the temporal bone, located above the TMJ. Together they form bilateral identical joints known as TMJ. The sphenoid bone's lateral pterygoid plate, spine and greater wing provide some relevance to TMJ by providing attachment to a sphenomandibular ligament and attachment to temporalis and pterygoid muscles. (Lippert 2011, 198-200).

Fig 5. Lateral view of the facial and cranial bones of the skull (Lautamaja 2018).



3.3 The temporomandibular joint and ligaments

The TMJ, usually classified as a synovial hinge joint due to its hinge-like shape, allows a gliding motion to some degree, thus making it not a true hinge joint. Opening the mouth (mandibular depression), closing the mouth (elevation), side-to side jaw movement (lateral deviation), moving the jaw forward (protraction), and moving the jaw posteriorly (retraction) are the five motions (Fig 6.) of the TMJ. The joint capsule (Fig 7.) surrounds the TMJ whereas the articular disk attaches to the tendon and capsule of the lateral pterygoid to shift the condyle of the mandible forward when the mouth opens and returns when the mouth is closed. (Lippert 2011, 197-198.) The temporomandibular ligament, also known as the lateral ligament, limits depression, retraction, and lateral deviations of the mandible. The sphenomandibular ligament restraints the mandible and together with the stylomandibular ligament prevents excessive anterior motion. The stylohyoid ligament stabilizes the hyoid bone. (Lippert 2011, 201-202.)

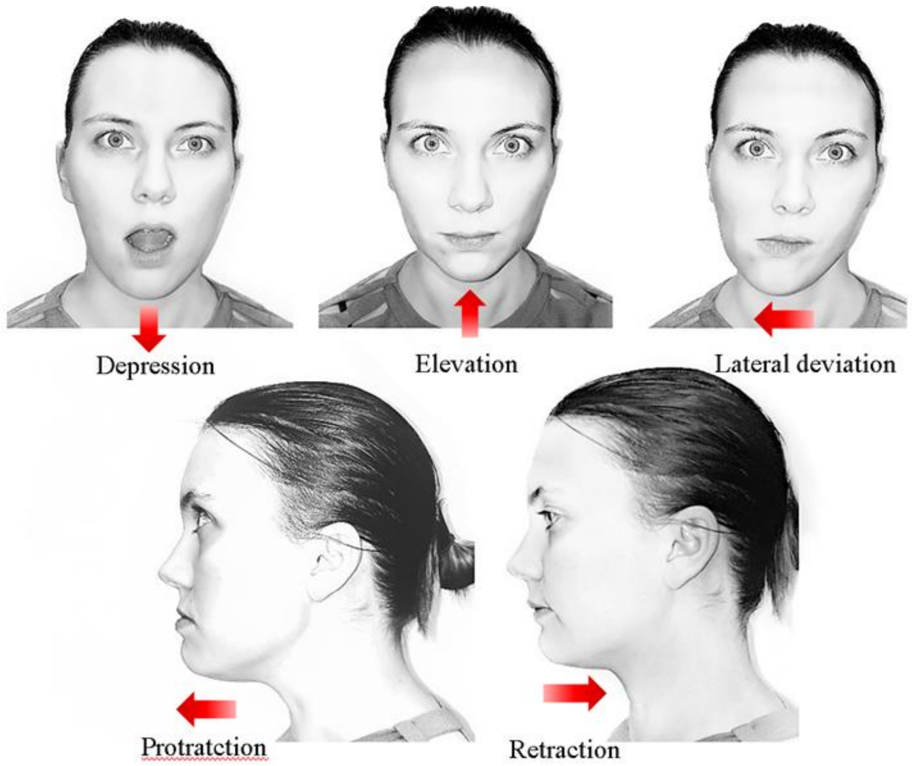


Fig 6. The five motions of the TMJ (Lautamaja 2018).

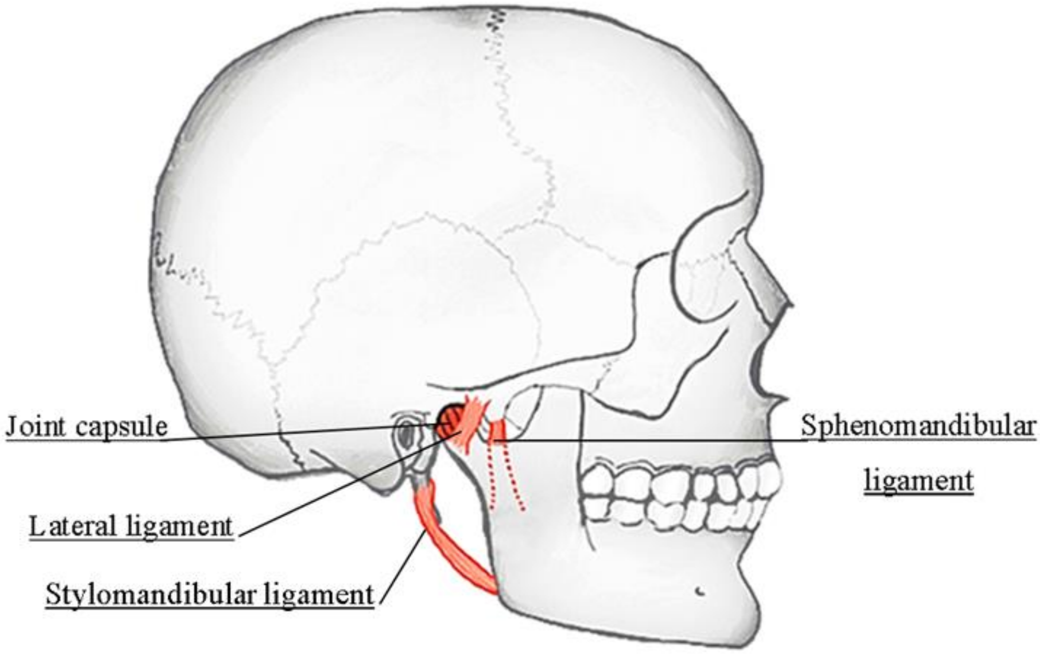


Fig 7. Lateral view of the ligaments of the mandible (Lautamaja 2018).

4 CLINICAL PRESENTATION

Temporomandibular disorders' symptoms peak occurrence is between the ages of 20-40 and is more prevalent amongst women than men. TMD is often a multifactorial disease involving TMJ, muscles of mastication, and other surrounding hard and soft tissue. TMDs are often a cluster of various clinical problems and therefore the signs and symptoms can vary greatly depending on the absence or presence of the inflammatory component. (Liu, & Steinkeler 2013, 465-466.) The 12 most common TMDs (table 2. & 3.) can be classified into pain-related TMDs and intra-articular TMDs (Schiffman et all. 2014, 9).

Table 2. International Statistical Classification of Diseases and Related Health Problems: pain-related TMDs based on the DC/TMD (Schiffman et all. 2014, 9).

	Arthralgia of temporomandibular joint	Myalgia	Local Myalgia	Myofascial pain	Myofascial pain with referral	Headache attributed to TMD
ICD-10-CM Diagnosis Code	M26.62*	M79.1	M79.1	M79.1	M79.1	G44.89*

Descrip-tion	Pain of Joint origin related to TMJ function and parafunction	Pain of muscle origin related to TMJ function and parafunction	Localized pain of muscle origin locations at the site of palpation	Pain of muscle origin which spreads beyond the site of palpation within the palpated muscle	Pain of muscle origin which spreads beyond the site of palpation	TMD pain-related secondary headache affected by TMJ function and parafunction

*Not in the third edition of the Finnish version of ICL

Table 3. International Statistical Classification of Diseases and Related Health Problems: Intra-articular TMDs based on the DC/TMD (Schiffman et all. 2014, 9.).

	Disc displacement with reduction	Disc displacement with reduction with intermittent locking	Disc displacement without reduction with limited opening	Disc displacement without reduction without limited opening	Degenerative Joint disease	Subluxation/dislocation of jaw
ICD-10-CM Diagnosis Code	•M26.631* Right TMJ •M26.632* Left TMJ •M26.633* Bilateral TMJ •M26.634* Nonspecific side	•M26.631* Right TMJ •M26.632* Left TMJ •M26.633* Bilateral TMJ •M26.634* Nonspecific side	•M26.631* Right TMJ •M26.632* Left TMJ •M26.633* Bilateral TMJ •M26.634* Nonspecific side	•M26.631* Right TMJ •M26.632* Left TMJ •M26.633* Bilateral TMJ •M26.634* Nonspecific side	M19.91*	S03.00XA*
Description	Biomechanical disorder of the TMJ-complex. With a history of locking in the closed position affecting the ability to eat	Biomechanical disorder of the TMJ-complex. The limitation of opening of the mouth is intermittent and requires a manual maneuver to unlock	Biomechanical disorder of the TMJ-complex. Limited mandibular opening due to closed lock	Biomechanical disorder of the TMJ-complex. Without limited mandibular opening	Wear and tear of the TMJ with osseous changes	Related to hypermobility of the TMJ complex, where changes can be shortly or extended. Subluxation is when the patient can reduce the dislocation himself

*Not in the third edition of the Finnish version of ICL

Myofascial pain and dysfunction are the most common signs of TMD, most commonly manifesting as radiating pain, muscle spasms, range of motion (referred as ROM) and functional limitations occurring in the muscles of mastication. Movement restrictions and crepitus of TMJ during movements are common symptoms associated with the TMDs. (Liu, & Steinkeler 2013, 465-466.) The associated joint noises of TMD can be unpleasant grating or crunching sounds (Gray, & Al-Ani 2011, 27). Fear or other avoidance of movement due to pain, decreased ROM, functionality or joint noises may decrease patients' ability to enjoy ADLs, such as eating and sleeping, which can significantly affect a patients' quality of life (Schaffer 2016).

In addition, bruxism, teeth clenching and other parafunctional oral habits, are significant contributors to myofascial pain and dysfunction whereas emotional stress predisposes to oral parafunctional habits. (Liu, & Steinkeler 2013, 466.) Intraoral pain, for example due to a toothache, can manifest as pain (e.g. headache) in nearby structures. Furthermore, oral infections, especially the parotid gland infection may cause swelling and due to its location above TMJ, may cause symptoms of TMD (Gray, & Al-Ani 2011, 24). Alternatively, pain associated with TMD can also occur in the cervical spine as well as in the orofacial structures or be combination of multiple pain locations (Kumar, & Brennan 2013, 424). Cervical spine disorders such as limited ROM and poor posture are common findings amongst TMD patients (Schaffer 2016).

It is important to be able to make a differential diagnosis as to the origin of the TMD and orofacial pain (Kumar, & Brennan 2013, 424). Tumors, aneurysms, hemorrhages, hematomas, intra-cranial edemas and infections may be an uncommon underlying cause to TMD symptoms, but potentially life threatening, as such, the clinicians' job is to rule out more severe malignant causes if suspicion arises (Kumar, & Brennan 2013, 421).

TMD symptoms related to intracranial origin may include severe sleep disturbances, pain during postural changes, progressively rapid degenerative symptoms, neurological deficits, seizures, vertigo, partial or complete paralysis, ataxia and many common symptoms of illness such as fever (Kumar, & Brennan 2013, 420-421). In some rare cases, a patient may experience auditory changes due to the vestibulocochlear nerve

(CN VIII) being affected, also known as the auditory vestibular nerve (Gray, & Al-Ani 2011, 24). Clinically, some of these symptoms may occur in TMD and have comparably less serious origins or have little to no comorbidity (Kumar, & Brennan 2013, 421).

5 CAUSES

Adaptive changes of TMJ, as well as of any other joint, are normal responses to different genetic and environmental factors. Joint adaptions can become maladaptive or the joint was not able to adapt to changes appropriately, which can lead to TMD. Furthermore, TMD are often divided into articular and nonarticular disorders. (Laskin et al. 2006, 84-86)

Non-articular disorders include myofascial pain, which constitutes more than 50% of TMDs (chronic pain conditions such as fibromyalgia). On the other hand, articular disorders are further divided into inflammatory conditions (e.g. rheumatoid arthritis and chronic inflammatory conditions) and non-inflammatory conditions (e.g. joint damage due to previous traumas and other cartilage or bone disorders). (Liu & Steinkeler 2013, 466-467)

Maladaptive adaptations include growth disturbances (e.g. imbalance of anabolism and catabolism leading to joint damage), osteoarthritis, traumas and faulty movement patterns. Disc displacement is a common finding in patients MRIs (magnetic resonance imaging) with TMD. Displacements with reduction, limits the elevation and depression of the mandible, manifesting as joint noises associated with discomfort; however, joint noises or MRI findings by themselves alone are not sufficient indicators of TMD, as they can occur in asymptomatic individuals as well. Alternatively, displacements without reduction results in mechanical movement block, known as closed lock, due to anteriorly displaced disc (ADD), associated with intense pain levels and ROM limitations. (Liu & Steinkeler 2013, 465-467)

5.1 Trauma

Trauma that affects one or both of hard and soft tissues can cause temporary or permanent TMD. Trauma of the TMJ can result from immediate initial trauma and secondarily as an indirect result of trauma. Trauma is a major cause of TMD. (Laskin et al. 2006, 62-63)

Macro and micro traumas to TMJ as well as its surrounding tissues are often associated as etiological factors to TMD. Hypermobility and recurring condylar dislocations are examples of such traumas. In addition, dental treatments can also cause or contribute to hard and soft tissue traumas, especially amongst patients with hypermobility, with greater risk of such injury. Moreover, oral parafunctions have the potential of resulting in micro traumas. For example, teeth grinding is difficult to treat and it is commonly associated with TMD. However, many people grind teeth without developing TMD and the relationship between bruxism and TMD is not clear, albeit bruxism is often associated with micro traumatic events that may lead to TMD. (Laskin et al. 2006, 62-63)

Lastly, fractures of cervical spine and maxillofacial fractures can cause trauma that can lead to permanent or temporal TMD. These kind of fractures can occur for example due to falls from height or motor vehicle accidents. Whiplash injuries too, can cause TMD due to the biomechanical relationship between the cervical spine and the TMJ. (Schaffer 2016.) The fifth cranial nerve (CN 5) innervates facial sensations and jaw movements (e.g. the muscles of mastication), therefore, in case of cervical traumas the TMJ and its surrounding structures can be affected. (Schaffer 2016)

5.2 Faulty movement patterns

Prolonged faulty movement patterns of TMJ can result in the tissues loss of ability to adapt and compensate for its trauma. Faulty movement patterns occur due to multiple reasons such as pain or ROM limitations. As previously mentioned, dental treatments such as orthodontic appliance therapy or tooth extractions can alter jaw movement patterns which can affect the loading of the TMJ complex negatively. (Laskin et. Al. 2006, 62-63)

5.3 Cervical spine and posture

Cervical spine pain is associated to TMD due to movement co-occurrence, and therefore is important to assess when treating a patient with TMD. Cervical spine and TMJ movements co-occur, for example; when mandibular depression occurs, there is a small amount of cervical extension, whereas during mandibular elevation, there is cervical flexion (Schaffer 2016.) Thus, cervical spine bears importance to TMD also due to its close proximity to common nerve pathways (Kumar, & Brennan 2013, 424). Furthermore, the cervical spine stabilizers are essential for maintenance of a good posture and help preventing forward head position. (Gil-Martínez et all.2018, 575)

5.4 Other

Temporomandibular disorders as well as other chronic pain conditions are associated with a number of different genes predisposing to a variety of adverse outcomes. The two subtypes of chronic TMD observed in studies are classified by the absence or presence of widespread pain (based on the expression of genes and haplogroups). The incidence of TMD was associated with at least 6 different genes including NR3C1,HTR2, ACHRM2, CAMK4, IFRD1 and GRK5, which may result in chronicity in susceptible individuals. (Slade et al. 2016, 1086-1087)

Additionally, chronicity may occur due to neuroplasticity, the brain's ability to create new synapses, leading to their hyper excitable state in the central nervous system, thus perpetuating central sensitization. Central sensitization occurs due to neurophysiological changes in the brain of chronic pain patients, resulting in: hyperalgesia, structural and functional changes at the brain level and disturbance in pain perception. Comorbidities may occur as a result of central sensitization where an increased representation of pain areas was observed in MRIs (Slade et al. 2016, 1086-1087; Gil-Martínez et all.2018 576-577). The hypothalamic-pituitary-adrenal axis, abundantly discussed in relation to chronic pain, is another proposed mechanism of chronicity in which chronic stress leads to chronic pain and together with neuroplasticity creates a pain loop.

Psychosomatic symptoms may pre-exist before the onset of chronic TMD (e.g. running nose, fatigue, dizziness as well as psychological stress, anxiety and negative emotions) though psychosocial factors, are in fact the single strongest predictor of TMD incidence (Slade et al. 2016, 1086-1087: Gray, & Al-Ani 2011, 24). Prominent psychosomatic symptoms include: pain catastrophizing (e.g. tendencies to touch the painful area repeatedly), fear avoidance behavior or belief (e.g. fear of movement), as well as passive coping skills (fear leading to passivity) resulting in greater levels of disability and worsened prognosis for patients with chronic TMD. (Gil-Martínez et all.2018, 576-577)

Nevertheless, it is not "all in the head" as studies have suggested individuals with TMD experience increased sensitivity to pressure pain, heat, and pinprick stimuli than controls. Though some psychosomatic symptoms are explained by genes (SCN1A and ACE2) associated with jaw stiffness and fatigue, others point out poor health, hypertension and chronic inflammatory systemic diseases as frequent comorbidities (Slade et al. 2016, 1087-1091). Unsurprisingly, cigarette smoking and especially poor quality of sleep were observed as possible contributors in the development of TMD, thus worsening the symptoms and should not be overlooked. (Slade et al. 2016, 1091)

Sleep and breathing patterns may serve as significant, prior warning signs predicting the development of TMD. In effect, disturbed sleeping patterns are associated with increased pain levels in chronic painful TMD, which in turn further disturbs the quality of sleep, resulting in greater pain. Interestingly, pain is a less indicative of sleep disturbances than the quality of sleep affecting pain. For example, sleep disordered breathing due to sleep apnea in severe cases reduces quality of sleep. (Slade et al. 2016, 1089)

Nowadays, it is believed that TMD are caused by an interaction of multiple genes with biopsychosocial risk factors rather than a single gene being turned "on" or just having chronic stress (Slade et al. 2016, 1087-1088). Therefore, self-reported symptoms are regarded as critical predictors of TMD incidence (Slade et al. 2016, 1086). On the other hand, the objective symptoms observed in individuals with TMD are: increased motor activation diminished motor inhibition, decreased proprioception, or continuing psychophysiological reactivity. (Slade et al. 2016, 1088-1089)

Studies suggest an interaction between sex hormones and TMD in both animals and humans. Conversely, higher levels of estrogen were associated with TMD, especially in pre-menopausal women, though no definite causation between hormones and TMD was established. (Liu & Steinkeler 2013, 465-466)

6 MANAGEMENT

The goals of treatment should focus around decreasing joint pain, increasing TMJ ROM and function, while preventing further damage and improving overall quality of life. The treatment plan of a TMD patient should be based on subjective and objective findings, aiming at alleviating the main complaints, signs and symptoms of the patient. The plan should also aim at preventing further joint damage and attempting to affect comorbid conditions (Liu & Steinkeler 2013, 470). Noninvasive (conservative) treatment methods are preferred over invasive (surgical) treatments and only if they do not provide satisfactory clinical outcomes (e.g. a period of at least 6 months of no progress using the conservative approach), more invasive methods should be implemented. (Liu & Steinkeler 2013, 469-470)

Due to the complexity of TMDs, finding a resolution is rather difficult, but usually a treatment can provide symptom alleviation. Moreover, it is important to keep the patient’s expectations on a realistic level. If a patient’s TMD is beyond one’s knowledge and practice, referral to another practitioner is necessary. At times, an appropriate treatment plan might require a multidisciplinary approach. (Kumar & Brennan 2013, 476-427; Liu & Steinkeler 2013, 469)

6.1 My chin hurts and I am in pain: what should we do?

Lack of research, guidelines for diagnosis and treatments have been consistent challenges related to TMD. For a clinician the diagnostic criteria of TMD (DC/TMD) provide a standardized way to assess TMD in clinical settings (Schiffman et all. 2014, 9). DC/TMD was completed in 2014 and the Finnish version's (DC/TMD_FIN) final administrative review was recently completed as well (Leskinen et all. 2017, 493). The DC/TMD_FIN is currently field-tested and its completion is important for many healthcare professionals including physiotherapist for improving TMD patient care. (Ohrbach & Dworkin 2016, 1096; Schiffman et all. 2014, 6-9)

The DC/TMD is the contemporary, field-tested, expert-based classification of commonest TMDs based on epidemiology and clinical data. It is used in conjunction with a dual-axis system containing the AXIS 1 (clinical conditions; table 3.) with AXIS 2 (pain associated disability and psychological status; table 4.) and is the easiest way of processing a new patient presenting with orofacial pain using a decision tree map. (Schiffman et all. 2014, 8-9).

A patient with TMD pain will be assessed for history, pain behavior, psychological status and psychosocial functioning based on general and specific questionnaires. Thereafter, the protocol will be followed to its fullest based on the patients' individual mixed presentation using the AXIS 1 and AXIS 2. As in all clinical settings, the DC/TMD is not a one size fits all and is to be used as an adjunct with sound clinical reasoning.

The axis 1 (table 3.) focuses on pain screening using DC/TMD symptom questionnaire. Following this stage, the physiotherapist will include provocation tests for TMJ as well as palpation in an attempt to provocate the patient's own complaint. The muscle pain diagnosis is then classified as: myalgia (local pain at the palpation site, myofascial pain beyond palpation site but still within the same palpated muscle or myofascial pain radiating to nearby tissues), tendonitis, myositis or spasm according to its clinical presentation. (Schiffman et all. 2014, 11-13).

Table 3. Axis I Assessment (website of rdc-tmdinternational, DC/TMD-FIN)

Axis I Assessment Instrument:

ENGLISH	FINNISH
TMD Pain Screener	TMD Kivun Seulonta (DC/TMD-FIN)
DC/TMD Symptom Questionnaire	TMD Oirekysely (DC/TMD-FIN)
DC/TMD Demographics	Demograafiset taustatiedot (DC/TMD-FIN)
Pain-related Interview and Examiner Commands	Kliininen Tutkimusprotokolla ja vaaditut sanalliset komennot/suulliset ohjeet osa 5
Clinical Examination Form North American and FDI	Available only in English
Diagnostic trees and criteria tables	Both available only in English

The axis 2 (table 4.) relates to the psychosocial functioning of the patient at hand. Therefore, assessment is done through questionnaires like the JFLS (jaw functional limitation scale) assessing limitations of mastication, jaw mobility, and verbal and emotional expression. The PHQ-4 (patient health questionnaire-4) relating to psychological distress in cases of anxiety and/or depression, the GCPS (graded chronic pain scale), pain drawings which are used to inform the location of pain in the head, jaw or body and OBC (oral behaviors checklist) assessing oral parafunctional behaviors. (Schiffman et all. 2014, 16-17)

Table 4. Axis II Assessment (website of rdc-tmdinternational, DC/TMD-FIN).

Axis II Assessment Instrument:

ENGLISH	FINNISH
Pain Drawing	Kipukuva (DC/TMD-FIN, PTH Seulonta, ESH)

Graded Chronic Pain Scale (version 2)	Kivun haitta-aste (DC/TMD-FIN GCPS 2.0, PTH Seulonta, ESH)
Jaw Functional Limitation Scale-8 (JFLS-8)	Leuan toimintarajoitukset (DC/TMD-FIN JFLS-8)
Jaw Functional Limitation Scale-20 (JFLS-20)	Leuan toimintarajoitukset (DC/TMD-FIN JFLS-20, ESH)
Patient Health Questionnaire-4 (PHQ-4)	Kysely terveydentilastanne-4 (DC/TMD-FIN PHQ-4)
Patient Health Questionnaire-9 (PHQ-9)	Kysely terveydentilastanne-9 (DC/TMD-FIN PHQ-9, ESH)
Generalized Anxiety Disorder 7 (GAD-7)	GAD – 7 (DC/TMD-FIN GAD-7, ESH)
Patient Health Questionnaire-15 (PHQ-15)	Kysely terveydentilastanne-15 (DC/TMD-FIN PHQ-15, ESH)
Oral Behaviors Checklist	Purentaelimistön Parafunktiot (DC/TMD-FIN OBC)

It is critical for the physiotherapist or healthcare practitioner to use the DC/TMD as part of their toolbox with the goal of reducing the use of imaging and refer only in suspected cases. In addition, the axis 2 provides a tool for assessing prognosis using the aforementioned screening questionnaires. (Schiffman et all. 2014, 22)

6.2 Physiotherapy

The European Commission on European Skills/Competences, qualifications and Occupations (ESCO) defines the physiotherapists' occupation as:
"Physiotherapists assess, plan and implement rehabilitative programs that improve or restore human motor functions, maximize movement ability, relieve pain syndromes, and treat or prevent physical challenges associated with injuries, diseases and other impairments."(Website of ESCO-EN ISCO-08 code 2264 2018). The aforementioned competences are important parts of the TMD management and physiotherapy should have an essential role in most of TMD management approaches, whether as a noninvasive treatment method or in conjunction with other noninvasive or invasive treatments (Liu & Steinkeler 2013, 471). Physiotherapy provides a wide range of different noninvasive treatment techniques, such as manual therapy, therapeutic exercise, patient education, relaxation therapy, electro- and thermotherapy. (Gil-Martínez et all.2018, 574; Liu & Steinkeler 2013, 471-472)

Manual therapy aims at improving function and pain reduction by using different techniques such as joint mobilization or manipulation and soft-tissue mobilization. Manual therapy in TMD treatment focuses on the TMJ and other orofacial regions as well as on the cervical spine region. The upper cervical spine is of greater importance, where mobilizations have been shown to reduce pain and increase mandibular ROM, possibly due to its biomechanical or neuroanatomical proximity to TMJ. It is not clear what is the preferred manual therapy approach to use for TMD is, but there is evidence that the cervical mobilizations are safer and show better or same efficacy over manipulations. (Gil-Martínez et all.2018, 575)

Therapeutic exercise aims at improving motor control and mastication as well as cervical muscle functions. Therapeutic exercises include: motor control, endurance, coordination, stretching, and muscle relaxation exercises. Most of studies of exercise therapy related to TMD have focused on the ROM improvement with mobility and stretching exercises. Furthermore, studies of exercise therapy show evidence of TMD symptom alleviation, but efficacy over other intervention methods is not clear due to lack of a clear dosage of intensity, duration, and frequency, as well as lacking and limited studies. (Gil-Martínez et all.2018, 575; Liu & Steinkeler 2013, 472)

Patient education and self-management are important for improving the patients' understanding of their condition and it further encourages the patient to take an active role in rehabilitation. However, most TMD related patient education and self-management studies focus only on patients with myofascial TMD (Gil-Martínez et all.2018, 575). The OPPERA studies TMD risk factor findings could also support the idea of using public education as a preventative measure against TMDs. (Slade et all. 2016, 1085, 1089-1090)

Relaxation techniques, such as a mental image and breathing exercises, aim at reducing pain related stress and muscle tension. Some studies suggest that relaxation techniques in conjunction with other treatment methods can have an influence on pain intensity and maximal mandibular depression. (Gil-Martínez et all.2018, 576)

Electro therapy is used for various different reasons such as for pain and inflammation reduction. Use of electrotherapy for symptom relief in TMD patients is currently inconclusive. Compared to placebo, various types of electrotherapy, such as pulsed radiofrequency energy (PRFE), transcutaneous electrical nerve stimulation (TENS), and low-level laser therapy (LLLT) have not shown clear pain reduction benefits in TMD patients, but no definite conclusions can be made as of now. Some studies have found some benefits of electrotherapy in certain types of TMD. Particularly LLLT seems to improve TMJ functionality by increasing mandibular ROM, but the mechanism behind it is not fully understood. (Gil-Martínez et all.2018, 576)

Acupuncture is believed to release neurotransmitters with anti-inflammatory properties, which provides analgesia. Patients with myofascial TMD without limited mandibular ROM seem to get short-term pain relief from acupuncture. Furthermore, based on few studies made, patients with myofascial TMD seem to benefit from dry needling (DN) as well. DN provides similar analgesia to acupuncture and improves mandibular function. (Gil-Martínez et all.2018, 575; Liu & Steinkeler 2013, 472)

Combined interventions, especially manual therapy combined with therapeutic exercises, further benefit the effects of other interventions. It is also important to note that simultaneous orofacial and cervical region treatments provide improved TMD symptom reduction. Moreover, education and self-management strategies are thought to be more beneficial when combined with other treatment techniques. Combined treatments help the patient to adapt and an active role in their rehabilitation. (Gil-Martínez et all.2018, 575-576)

6.3 Other

The treatment should address the various aspects of TMD (such as related comorbidities and other clinical manifestations) and a multidisciplinary treatment plan including physiotherapists, dentists, psychologists, physicians and other healthcare professionals may be the only way to get a satisfactory result. Combining different therapeutic interventions seem to result in better treatment outcomes. (Liu & Steinkeler 2013, 469-470)

Diet changes, altering bad habits and psychological management could help managing comorbid conditions associated with TMDs. For example, cognitive behavioral therapy (CBT) is a noninvasive treatment option for psychological factors related to TMD. It aims at managing thoughts, behaviors, and feelings that might worsen the experience of pain. Moreover, there is evidence that educating patients regarding the mechanisms underlying pain reduces pain, disability, and affects psychological factors in other chronic pain related musculoskeletal disorders. (Gil-Martínez et all.2018, 576)

One of the most common treatments of TMDs are stabilization therapy and occlusal therapy (table 5). Occlusal splints are recommended for preventing further dentition and TMJ damage from nocturnal bruxism/tooth grinding. Bruxism is often difficult to treat, but making patients cognitively aware of it may improve daytime bruxism. Splint therapy is also used for TMD pain management, but its therapeutic effectiveness is controversial based on current research. However, its placebo effect for pain management has good evidence. (Gil-Martínez et all.2018, 574; Liu & Steinkeler 2013, 470). Oral parafunctional related damage observed by clinicians do not seem reliable indicator of early TMD symptoms, nevertheless, self-reported symptoms are significant indicators of TMD. The clinicians should be familiar with the Oral behavior checklist scale, general health, specific pain, and mental health related checklists, which have shown to give good evidence of predicting the risk of developing TMD. (Slade et al. 1088-1090)

Oral and topical pharmacotherapies (table 5) are used for treating TMD related comorbidities as well as symptoms such as pain and swelling. Pain is the primary reason for patients with TMD to request medication (Gil-Martínez et all.2018, 573). The evidence of pharmacotherapy’s effectiveness requires further studies and it should be only used in conjunction with other treatments. (Liu & Steinkeler 2013, 470-471)

Injected pharmacotherapy (table 5) is a minimally invasive treatment option. It aims at improving TMD related symptoms such as pain and reducing inflammation (Liu & Steinkeler 2013, 471-472). Surgical interventions can be split into minimally invasive and invasive treatment options. Arthroscopy and arthrocentesis are gentler and usually quicker options than other arthroplasties that focus on disk repositioning, disk repair, discectomy and discectomy with graft replacement. Invasive surgical treatments such as total joint replacement and discectomy are options only for severe cases of TMD and the main aim is to restore TMJ function. Possible pain reduction is only a secondary benefit of these surgeries. (Liu & Steinkeler 2013, 472-476)

Table 5. Occlusal splint, pharmacologic, intra-articular injection and surgical interventions for TMD patients (Liu, & Steinkeler 2013, 470- 476).

Management strategy:	Treatment:	Description:	Purpose:
Noninvasive	Occlusal splints	Commonly used splints are stabilization, repositioning and soft splints.	Thought to unload the condyle and to protect the TMJ, articular disk and dentition against degeneration.

	Oral and topical pharmacotherapy	Such as NSAIDs, opioids, corticosteroids, muscle relaxants, antidepressants and anxiolytics are used in TMD treatment.	Used for treating underlying or related diseases and to reduce the symptoms, such as pain and inflammation.
Minimally invasive:	Intra-articular injection pharmacotherapy .	Therapeutic injections administered directly to TMJ space. For example, hyaluronic acid and corticosteroids are therapeutic solutions used in TMD treatment.	Targeted treatment for inflammation, pain, muscle spasm and tension.
	Arthroscopy and arthrocentesis	Arthroscopy is a minimally invasive surgical procedure. Arthrocentesis is synovial fluid aspiration and it is less invasive than arthroscopy.	Arthroscopy allows observation, irrigation, mobilization and lysis of adhesion. Arthrocentesis allows adhesion release and elimination of intra-articular inflammatory mediators.
Invasive	Arthroplasty: • Disk repositioning	An invasive surgical procedure.	Performed for pain reduction and

	• Disk repair • Discectomy • Discectomy with graft replacement		function restoration of the TMJ. Discectomy and discectomy with graft replacement are performed in more severe cases, or when less invasive treatments have not provided symptom alleviation.
	Total joint replacement	An invasive surgical procedure where a damaged or arthritic joint is removed and replaced with a prosthesis.	The primary purpose is to restore the function of the TMJ. Recommended when less invasive treatments have not provided symptom alleviation.

7 DISCUSSION

My personal experience with TMD has influenced the topic of my decision. I suffered a sports related trauma of TMJ a decade ago and received barely any treatment or guidance when i sought help from doctors and dentists. I suffered from whiplash injury, and dislocated my jaw during the initial trauma. Following the trauma, I experienced recurring locking of TMJ, pain and dislocations. Healthcare professionals assured me that my symptoms are related to hypermobility, which is partially true, but I did not experience these issues prior to trauma. None of the medical professionals I met referred me to physiotherapy or gave me clear guidance how I should proceed with my rehabilitation.

This thesis was originally meant for dentists and other interested healthcare professionals. The aim was to increase knowledge of possibilities of physiotherapy and conservative/noninvasive treatment methods in TMD patient treatment. However this changed quite late in the thesis writing process after I discovered more information regards DC/TMD.

The process of looking for evidence-based research in the domain of TMD in relation to physiotherapy was tedious as evidence is scarce for sound guidelines that fit all populations. Consequentially, I included also some research apart of the four articles initially found through PubMed and Sciencedirect as to provide more treatment options and clarity to DC/TMD based on the current standards. One of the initial four articles (Ohrbach & Dworkin 2016) discussed about moving away from research diagnostic criteria of TMD (RDC/TMD) to DC/TMD, which made it clear that the DC/TMD is currently the standard for TMD diagnosis. The four articles about DC/TMD and Gil-Martínez et all.2018 article about pain management were not initially included.

Finally, it is critical for the future of TMD treatment to undergo extensive research and scrutiny before it is included as in the physiotherapeutic management. I did not include in this thesis physiotherapeutic examination, because there is no updated guidelines for it. Furthermore, there is already theses that cover the said topic and it would have been redundant. My recommendation is to pay attention to consistency with measuring in order to keep the examination results comparable and reproducible.

One of the challenges of my thesis is lack of quality research regards of TMDs. What we think about TMDs today can completely change when further research is concluded. Certain populations or conditions have been topics of TMD research and even if these studies had promising results we cannot say, they are valid for all populations regardless of their health background, age and environment. (Slade et all. 2016, 1091) Micro traumatic events such as hypermobility, jaw dislocations and bruxism do not have an abundance of scientific evidence, and are as of now, of a causal nature with their relationship to TMD. However, they are often associated as common risk factors for TMD in the literature.

Understanding based on the current evidence of the cervical spine's relation to TMD has strengthened its importance. Nevertheless, TMD related studies focusing on improving the resistance of cervical spine stabilizers are lacking to say the least. Such studies could further strengthen the importance of exercise therapy in TMD treatment. (Gil-Martínez et all.2018, 575). Studies assessing the application of DC/TMD in physiotherapeutic settings would be beneficial.

The OPPERA studies have given important information about the pain mechanisms behind the TMD. However, these studies as well as other chronic pain studies have made it clear that in the future we have to add axis III (genetics, epigenetics and neuroscience) to current DC/TMD model. (Slade et all. 2016, 1091; Ohrbach & Dworkin 2016, 1098)

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