

A Comparative Approach to Treatment Methods for Myofacial Pain and Internal Derangement of the Temporomandibular Joint

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ABSTRACT

The temporomandibular joint (TMJ) is the site of articulation between the mandibular fossa of the temporal bone and condylar head of the mandible. The TMJ is a synovial joint that has a cartilaginous disc between two articular surfaces. It can perform rotation and translation. A group of muscles (primarily masseter, temporalis and pterygoids) and ligaments are involved in jaw movement. The group of disorders that encompasses dysfunction of these structures is called “temporomandibular disorders (TMD)”. This research primarily focuses on myofacial pain, dysfunction and internal derangement of the TMJ (anterior disc displacement (ADD) with and without reduction). Treatments include conservative and invasive interventions. Conservative treatment consists of behavioural/psychosocial therapy, physiotherapy, pain management, occlusal splint therapy, low-level laser therapy and transcutaneous electric nerve stimulation therapy. Conservative treatment provides very effective results for pain relief and significant improvement of jaw function, however follow-up periods in studies were short-term (not more than three months). Continuous improvement was observed in occlusal splint therapy as it leads to sustained behavioural change, helpful in alleviating pain by reducing stress put on the masticatory muscles and correcting jaw function. Exercise and physiotherapy have also resulted in considerable pain reduction and restoration of jaw function. Evidence showed that botulinum-toxin type A provided an immediate alleviation of pain effective for 3 months, however decreased maximal incisal opening as its mechanism of action is inhibiting muscle activity. One might argue that occlusal splint therapy and exercise therapy are more effective in maintaining pain reduction without significant side effects. Evidence showed that

arthrocentesis and arthroscopy were safe and effective for TMD symptom control. One might also argue from the evidence that arthrocentesis and arthroscopy provide longer-term and significantly more improvement in a minimal amount of time in ADD cases and should be offered as an initial treatment. Open surgery is indicated if previous treatments have failed.

INTRODUCTION

The temporomandibular joint (TMJ) is composed of the connection of the mandibular fossa and articular tubercle of the temporal bone, with the condylar process of the head of the mandible.¹ The TMJ is a unique synovial joint; the articular surfaces of the temporal and mandibular bones are covered by fibrocartilage, not by hyaline cartilage.¹ There is an articular disc attached to the capsule that assists jaw movements and protects the joint from increased pressure.

This joint perform translation and rotation that assists lateral excursion, elevation, depression, protraction and retraction of the jaw with muscles of mastication and associated ligaments.¹ All mastication muscles are innervated by the mandibular branch of the trigeminal nerve (CNV3), with the exception of geniohyoid, which is innervated by the hypoglossal nerve (CNXII) and posterior belly of digastric muscle, which is innervated by the facial nerve (CNVII).

During elevation, the mandibular condyle moves forward towards the articular tubercle of the temporal bone. During depression the mandibular condyle moves backwards into the mandibular fossa of the temporal bone.² It can also perform translation and rotation for the other movements of the jaw.¹

Name of the Muscle	Origin	Attachment	Movement
<i>Digastric</i>	Digastric fossa of the mandible, Mastoid notch of temporal bone	Hyoid bone	Depression, retraction
<i>Geniohyoid</i>	Mandible	Hyoid bone	Depression retraction
<i>Lateral Pterygoid</i>	Greater wing (infratemporal fossa) and pterygoid plate of sphenoid bone	Mandibular condyle	Protrusion, excursion
<i>Masseter</i>	Zygomatic arch	Ramus of mandible	Elevation
<i>Medial Pterygoid</i>	(deep) Pterygoid process and pyramidal process of palatine bone, (superficial) maxilla and palatine bone	Mandible	Elevation, excursion, assists protraction
<i>Mylohyoid</i>	Mandible	Hyoid	Depression
<i>Temporalis</i>	Temporal fossa	Coronoid process and ramus of mandible	Elevation, retraction

Table 1: Muscles of mastication

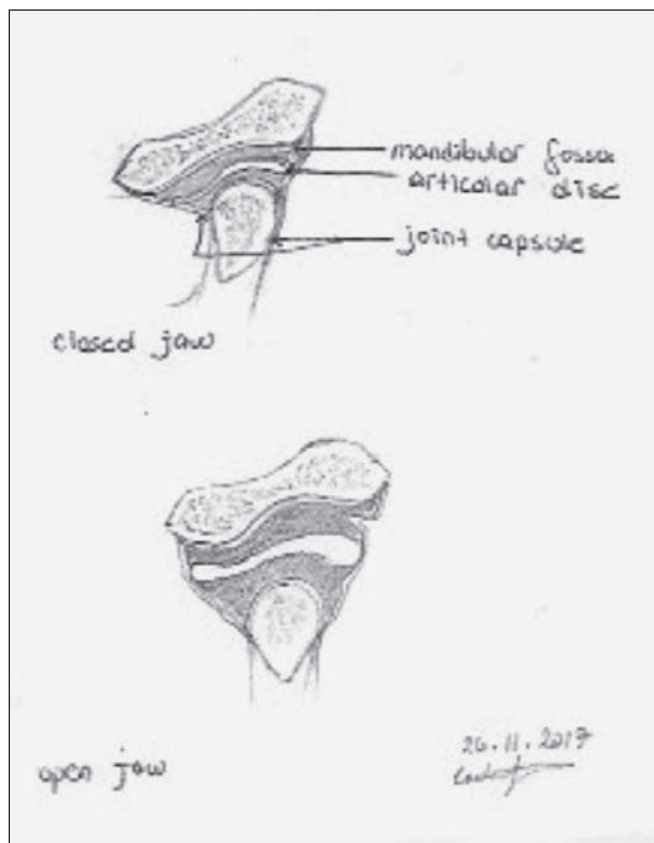


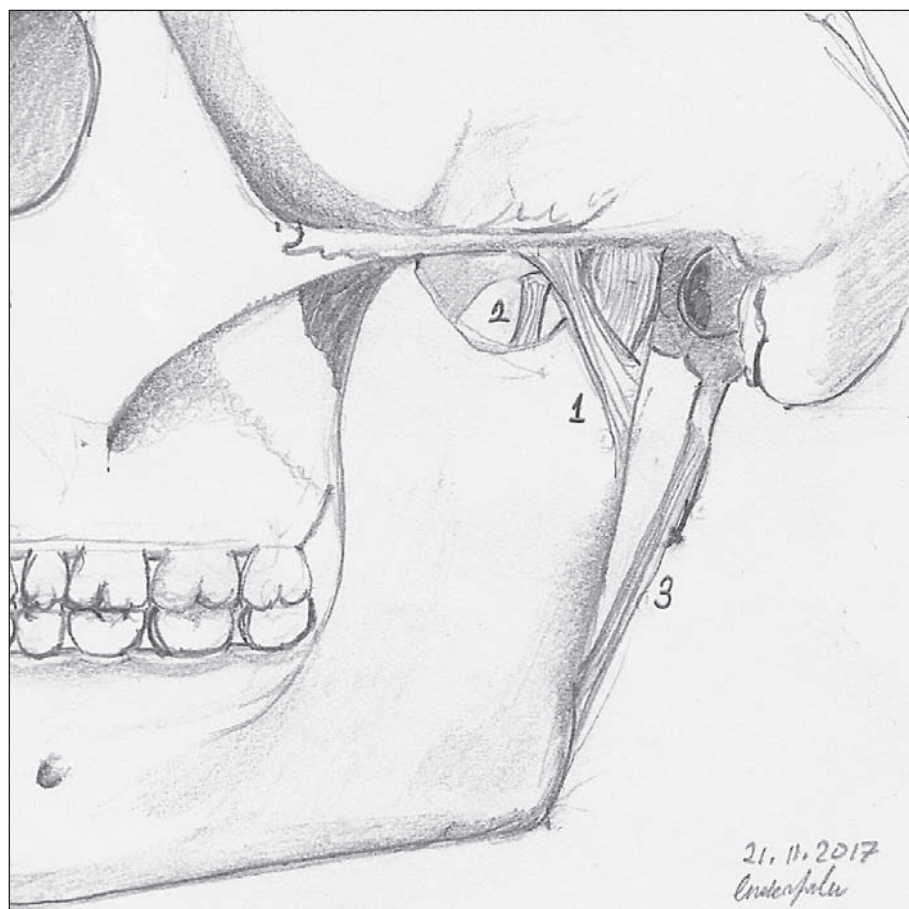
Figure 1: TMJ movements during elevation and depression

There are 3 major ligaments involved in jaw movements of the TMJ:

1. Lateral ligament attaching the articular tubercle of temporal bone to ramus of the mandible
2. Sphenomandibular ligament attaching the spina angularis of the sphenoid bone to lingula of the mandible
3. Stylomandibular ligament attaching the styloid process of the temporal bone to the mandible.

The TMJ is one of the most active joints and therefore is subject to many types of stress. The group of disorders that encompass the temporomandibular joint and the associated structures is called “temporomandibular disorders (TMDs)”. There are various classifications of TMDs. The first classification proposed by Dworkin and LeResche in 1992⁴ defined 3 groups in the research diagnostic criteria for TMDs (RDC/TMD): muscle disorders, disc displacements and other joint disorders. Currently, TMDs can be classified more accurately under⁵

1. myofascial pain and dysfunction (MPD)
2. internal derangement (disc displacements with and without reduction)
3. degenerative diseases of TMJ (osteoarthritis, rheumatoid arthritis)
4. chronic recurrent dislocation
5. ankylosis of TMJ
6. neoplasia and infection



MPDs usually present with diffuse myofascial pain that can radiate from the preauricular region to the jaw and to the neck.⁶ Muscle sites can be painful on palpation.¹ Myofascial pain is mainly due to prolonged contraction of mastication muscles. Stress, clenching teeth and malocclusion are found to play a significant role in this particular disorder.⁶

Internal derangement is defined as an abnormal relationship of the articular disc with the joint.⁵ Internal derangement presents as anterior disc displacement (ADD), when the articular disc becomes situated anterior and medial to the condylar process when the jaw is closed (shown in Figure 1.04).^{5,6} Clinical features include clicking and crepitus of the joint on exertion and deviation of the jaw on opening to the affected side.⁶ The criteria for the severity of symptoms for internal derangement is determined with Wilkes stages.⁵

Figure 2: TMJ and associated ligaments:³ 1. Lateral ligament. 2. Sphenomandibular ligament. 3. Stylomandibular ligament

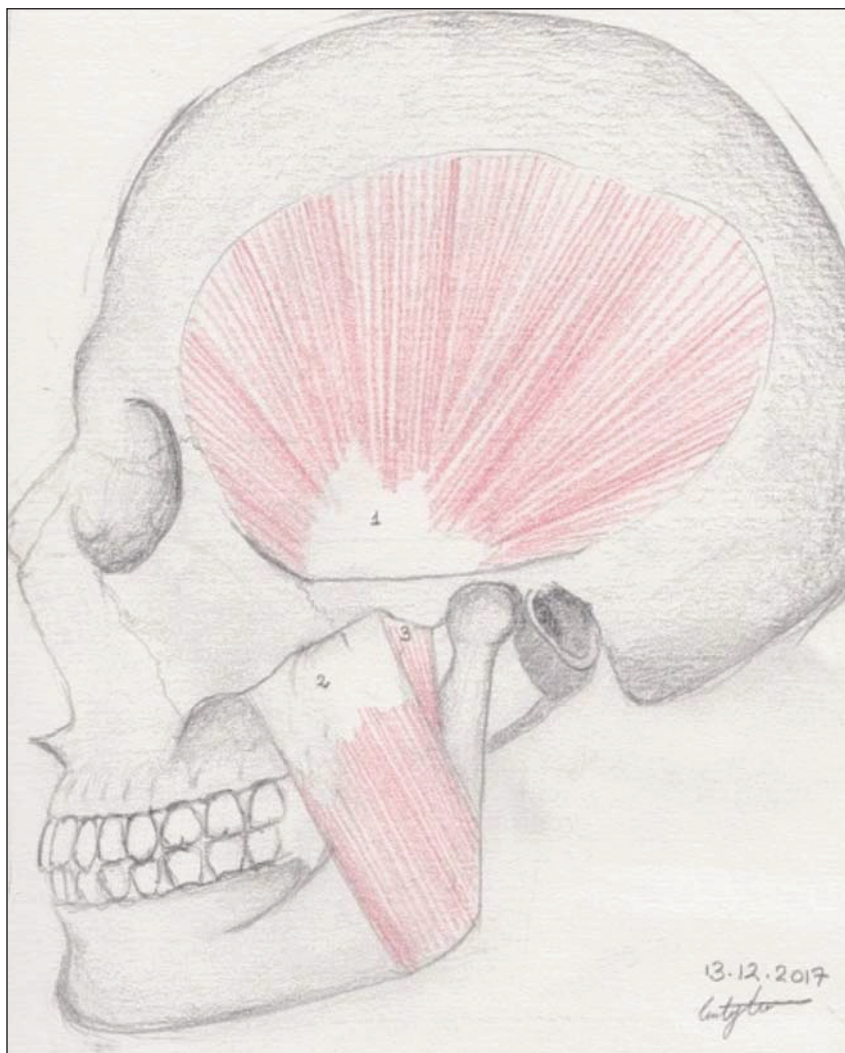


Figure 3: Muscles affected by bruxism. 1. Temporalis muscle. 2. Superficial masseter muscle. 3. Deep masseter muscle

Stage	Clinical	Imaging	Surgical
I - Early	Normal mouth opening, painless clicking	Disc slightly anterior to the condylar process (with reduction), normal articular disc	Slight ADD, normal articular disc
II - Early/ Intermediate	Painful clicking, occasional locking	Disc slightly anterior to the condylar process (with reduction), slightly deformed disc	ADD, thickened disc
III - Intermediate	Limited mobility, frequent pain, frequent locking, tenderness on palpation	ADD (with/without reduction), thickened disc	ADD, deformed disc, no changes of the bony structures
IV - Intermediate/ Late	Chronic pain, limited mobility	ADD (without reduction), abnormal disc, changes of the bony structures	Degenerative processes of the bony structures, adhesions, deformed disc (without perforation)
V - Late	Painful on movement, variable pain, TMJ crepitus	ADD (without reduction), markedly deformed disc (with perforation), degenerative changes of bony structures	Significant degenerative changes of the disc (with perforation) and bony structures, multiple adhesions

Table 2: Wilkes Stages of internal derangement of TMJ⁷

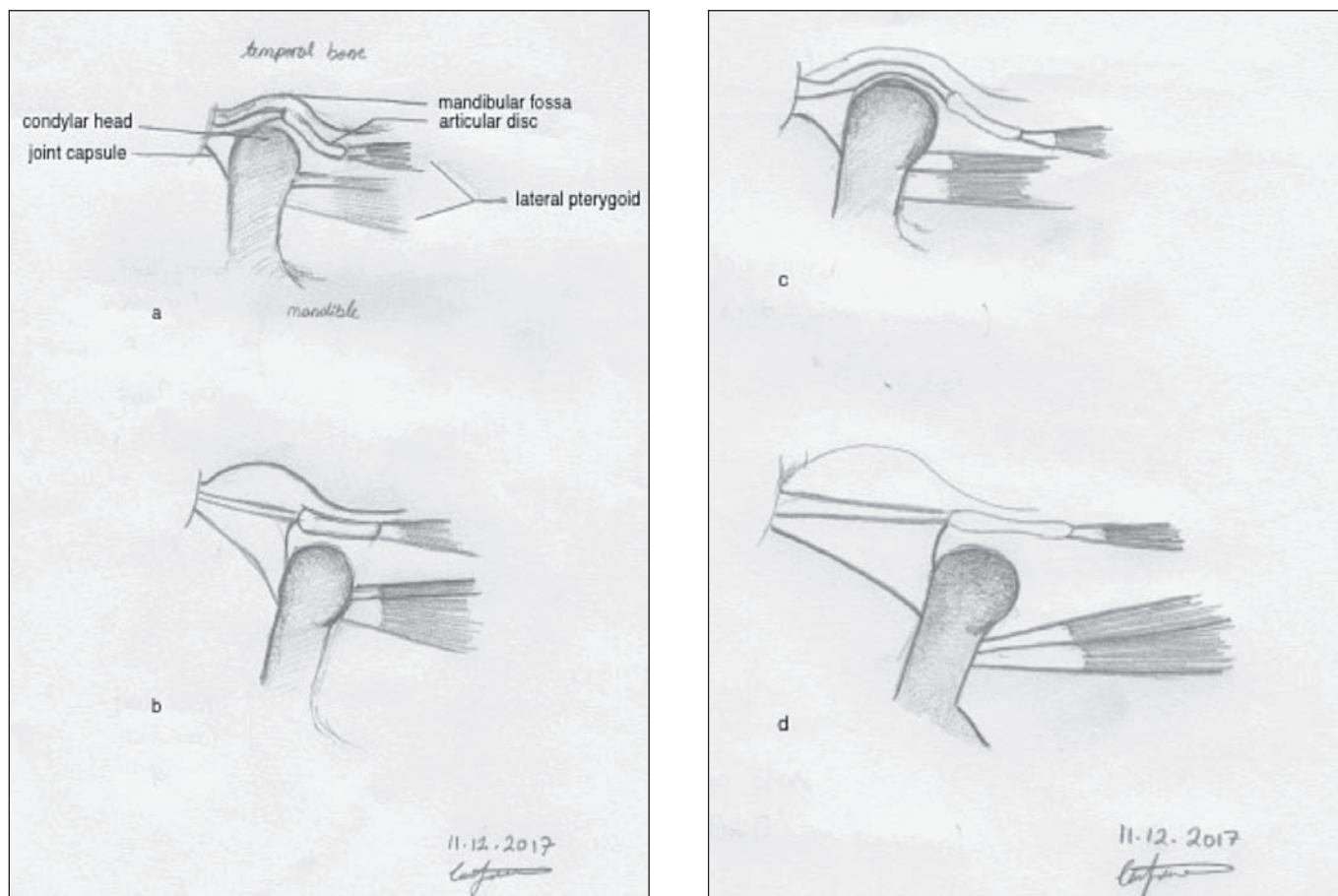


Figure 4: a. normal closed jaw, b. normal open jaw, c. anterior disc displacement with reduction closed jaw, d. anterior disc displacement with reduction open jaw

Degenerative diseases of the TMJ (e.g. osteoarthritis) are usually consequences of tissue injury, most commonly by trauma, and affects the joint unilaterally.⁵ Systemic inflammatory diseases such as rheumatoid arthritis can also involve the TMJ. Synovial tissue proliferates, and pannus formation occurs. Rheumatoid arthritis usually involves the joint bilaterally and at an earlier age,⁵ this can present with reduced jaw movement and localized pain on the joint. Crepitus can be heard during movement.

Temporomandibular ankylosis can be described as the stiffness of the joint and may present in two ways: intracapsular (true) and extracapsular (false).⁵ Intracapsular ankylosis is the actual fusion of the joint that can lead to severe loss of function and even complete loss of mobility. This is most commonly caused by trauma to the joint and TMJ fractures.

Type I	Partial loss of joint space and fibrous adhesions
Type II	Increased loss of joint space and lateral bony fusion with fibrous adhesions
Type III	Bony bridging between zygomatic process of temporal bone and ramus of the mandible
Type IV	Total bony fusion of the joint

Table 3: Sawhney Classification of TMJ ankylosis⁸

Extracapsular ankylosis involves structures around the joint, usually the temporalis muscle and the coronoid process. Causes include coronoid hyperplasia, infection of the muscle and trauma. The presentation is usually with partial loss of mobility and deviation to the affected side.⁵

Dislocation of the TMJ is usually reduced by itself, however, if not, medical attention is required.⁵

TMDs, most commonly presenting with myofascial pain, have a high prevalence affecting up to one third of the population, of which a quarter present to health services for treatment. Although the age range is very variable depending on aetiology, myofascial pain is more prevalent in young adult and adult populations. Women are more frequently affected by TMDs than men during reproductive age, which suggests a hormonal effect (oestrogen) on the TMJ and associated structures.⁹

TMDs have high implications for the patients' psychosocial wellbeing as they can often lead to chronic pain, aggravating the prognosis.¹⁰ RDC/TMD has therefore two axes for diagnosis: Axis I focuses on the clinical implications of TMDs whereas Axis II assesses "pain-related disability and psychological status".⁴

Although TMDs are significantly prevalent in world population, treatment options and their effectiveness are very variable. This paper will include a summary of current treatment, particularly for MPD and internal derangement of TMJ, a review of different approaches to management and will try to identify advantages and

disadvantages of current approaches to management with regards to aetiology. The reviews exclude paediatric treatment.

METHODS

This structured review was carried out by researching and reviewing articles from Medline, Pubmed, Onesearch and Web of Science with key words “temporomandibular disorders”, “non-invasive”, “treatment”, “low-level laser therapy”, “botulinum toxin A”, “splint therapy”, “arthroscopy”, “arthrocentesis” and “meniscopexy”. Inclusion criteria were “English”, “full text”, “human” and “temporomandibular disorders”.

RESULTS AND DISCUSSION

The main goal of TMD treatment should be to maximise jaw movement and eliminate pain, using the least invasive method. Most of the time conservative treatment is sufficient for MPD and internal derangement, as the tissue present can adapt to function without any invasive procedures.

Conservative Treatment of MPD and internal derangement

Myofacial pain and dysfunction is most commonly caused by certain habits that hyper-mobilise mastication muscles (e.g. biting nails, nocturnal bruxism).¹⁰ Non-invasive management is found to be quite sufficient. It is important to address the psychosocial causes of this condition, affecting the young female population. Current treatment consists of patient education and self-management.¹⁰ Pharmacologic support is added for pain management. In addition to this, cognitive behavioural therapy is advised in order to address the psychological aspect of this problem.¹⁰

Self-management usually consists of a number of jaw exercises. In a study by Nicolakis *et al.*¹¹ on 20 patients (16 female, 4 male) experiencing myofacial pain for at least 3 months and with no previous evidence for osteoarthritis of the joint, therapy included active and passive jaw movements, postural correction and relaxation exercises. Active movements aim to strengthen the muscle, whereas passive movements support normal movement of the jaw. The study showed significant improvement of pain in 85%, and of jaw movements in 65% of participants at 6 months' follow-up. Another study was conducted by Yoshida *et al.*¹² on the effect of jaw exercises for internal derangement. This study evaluated 148 women with TMD symptoms: previous clicking and limitation of mouth opening after the clicking stopped. The results revealed up to 67.6% improvement of jaw movements (depression, lateral movement and protrusion). Evidence suggests that exercise therapy is very helpful in pain reduction and regaining jaw function for both myofacial pain and internal derangement of the TMJ. The studies reviewed had a short-term follow-up period (up to 3 months), which might not be sufficient to demonstrate a definitive resolution, maintaining improvement. However, it is important to take into consideration that exercise therapy is a self-managed treatment. This therapy, not requiring

tools or a healthcare setting and which is economical and relatively easy, therefore may be useful and have longer-term effects on controlling TMD symptoms.

A non-invasive treatment option currently in use for TMDs is occlusal splint therapy. A research carried out by Glaros *et al.*¹³ showed significant improvement in myofacial pain after the use of maxillary interocclusal splints, 20 hours a day for 6 weeks. The study consisted of 2 groups: one splint avoiding contact with lower teeth, one maintaining contact. At the end of 6 weeks, there was around a 42% improvement in myalgia in the “avoid contact” group, and 37% in the “maintain contact” group. The argument was that the main mechanism of splints is reducing teeth contact, therefore alleviating the pressure on masticatory muscles. A group of patients with TMD symptoms (unilateral and bilateral) anterior disc displacement were evaluated¹⁴ following a three month splint therapy (maxillary interocclusal splint), used at night. Results demonstrated a significant reduction in TMJ discomfort and pain. Another study¹⁵ comparing laser therapy and occlusal splint therapy also showed significant progressive improvement in myofacial pain, for three weeks, following the three-week trial of wearing maxillary occlusal splints, 12 hours a day. Stabilisation splints are more common for TMD symptom control and treatment. A newly approved splint is nociceptive trigeminal inhibition tension suppression system splint, which covers the anterior maxillary incisors and targets muscle relaxation of muscles causing the clenching of teeth. However, evidence suggests that it is not as effective as stabilisation splints.¹⁶ It is important to take into account that the studies discussed for occlusal splint therapy had short-term or non-existent follow-up periods. There is evidence of improvement of jaw function and myofacial pain in the short-term. Trends point to ongoing, progressive improvement, which may be linked to behavioural change of grinding and clenching teeth following the intervention. However, research is needed to determine long-term effects of occlusal splint therapy for myofacial pain.

Dental therapies for TMDs also include occlusal modification, however evidence is not sufficient to prove effectiveness.

A newly developing treatment for myofacial pain and anterior disc displacement with reduction (ADDR) is injection of botulinum toxin type A (BTXA) to the affected area.¹⁷ BTXA acts by blocking muscle activity and has an analgesic effect as a result of muscle relaxation.¹⁷ The mechanism of action is the blocking of acetylcholine secretion into the neuromuscular synapse, thus inhibiting muscle contraction.¹⁸ An experimental study¹⁸ involving BTXA injection bilaterally into the temporalis and masseter muscles after failure of TMD symptom control with pharmacotherapy, physiotherapy and behavioural intervention, revealed immediate reduction in pain and tenderness in the muscles, yet the improvement in disability score was less promising. There was around a 10% shift to lower levels of disability, however 57% still experienced high-level disability. A prospective study was performed by Pihut *et al.*¹⁹ on the effectiveness of BTXA on patients who have tension-type headache linked to TMDs, myofacial pain and internal derangement. Results showed decreased myofacial pain and headache

2-4 weeks after the injection of BTXA into both bellies of the masseter muscle. Another study by Emara *et al.*²⁰ including 6 patients (11 joints) with only clicking of the TMJ due to ADDR, without myofacial pain, involved injection of BTXA, 0.7 ml at a concentration of 5.0 U/0.1ml, into the lateral pterygoid muscle. Follow-up was extended to four months after the first injection. There was rapid improvement of joint clicking in around 91% of the joints a week after the injection, and 100% after the second week, until the third month, when clicking of the joint resumed. It is important to note that maximum inter-incisal opening decreased by 50% in the first week and gradually increased throughout four months to 90%. There is controversy about BTXA due to its side effects (difficulty in mastication), also, as seen from the study above, its duration, lasting only 3 months; although there is significant short-term alleviation of TMD symptoms, including myofacial pain and clicking. Quality of life of the patient should be taken into consideration for this treatment, weighing pain alleviation and conservation of function of the jaw against each other. It is also important to emphasize that repetitive therapy may be needed. Exercise and occlusal splint therapy, as well as being non-invasive methods and conserving muscle function, may have more evidence for maintaining pain reduction, therefore may be more suitable as first line treatments for myofacial pain and dysfunction and internal derangement of the TMJ.

Another new treatment that is “en vogue” is low-level laser (LLL) therapy. LLLT penetrates the tissues, induces “biostimulation”, increasing cellular metabolism and replication.¹⁵ A number of studies have shown considerable reduction in pain caused by TMDs by LLLT. A placebo-controlled study by Demirkol *et al.*¹⁵ comparing occlusal splints and LLLT, demonstrated similar results in pain reduction by LLLT as occlusal splints. 30 participants were divided into three groups: group one receiving LLLT, group two receiving occlusal splint therapy and a placebo group. Measurements were taken before and immediately after the LLLT procedure, and after three weeks for group one, before therapy and immediately after three weeks of occlusal splint therapy ended for group two. There was 67% reduction in pain score by the visual analogue scale (VAS) in both the LLLT and OST groups. The reduction in pain was maintained over the three-week follow-up period. This study does not have a long term-follow-up period. Research was carried out comparing LLLT with transcutaneous electric nerve stimulation (TENS) for myofacial pain and maximum incisal opening.²¹ TENS is also a newly developing method to control TMD symptoms. It helps hyperactive muscles to relax and provides an analgesic effect by electric stimulation to targeted areas. The research conducted by Seifi *et al.*²¹ compared 4 groups (2 control, 2 study groups). There were 4 interventions in total and a one-month follow-up period. The results demonstrated significant reduction in the VAS pain score and increase in maximum incisal opening. However, follow-up period measurements showed no significant change from the measurements taken before the interventions. This study suggests LLLT and TENS may be short-term solutions for controlling

TMD symptoms-more specifically for myofacial pain, TMJ/masticatory muscle tenderness and mouth opening-, but do not provide sustainable improvement.

Invasive treatment for myofacial pain and internal derangement

Arthroscopy and arthrocentesis are the two most common surgical interventions for TMD that are least invasive. Invasive treatment is usually not indicated for myofacial pain and dysfunction but may be for internal derangement (anterior disc displacement with and without reduction). There are different techniques of performing arthroscopy. Usually it involves the insertion of three canals that allow imaging of the joint in detail, operation and outflow. Outflow operation is called arthrocentesis and is performed under arthroscopy. It is realized by inserting two hypodermic needles to the upper joint cavity, which allows removal of inflammatory material.²² Attempts to reposition the disc can be done under arthroscopy⁵. The operation is mostly performed under general anaesthesia, but can also be done by local anaesthesia. A retrospective research by Abboud *et al.*²² studied 47 chronic closed-lock patients that had undergone TMJ arthroscopy, measuring the maximum incisal opening. Results after the intervention and follow-up period (5-24 months) showed success in 89% of patients with a mean increase of 33% in incisal opening (from 27 mm to 38 mm). A prospective study²³ on 39 patients who underwent arthroscopic lysis and lavage showed improvement of joint function and decreased VAS pain score, with 86% satisfactory clinical outcome, without significant difference between Wilkes stages. Most of these outcomes show long-term improvement in joint function and pain. In these studies, the operations did not have high rates of complications (around 4%), and they resolved within two weeks, the longest. The results provide evidence for efficient, long-term and safe treatment with arthroscopy and arthrocentesis for internal derangement. There is some controversy around preferring conservative treatment over arthrocentesis, as it is clinically less invasive and more economic, however long-term benefit for the patient and the safety of this procedure should be considered.

The last treatment option if there is failure to control TMD symptoms is open surgery of the joint, which usually involves meniscectomy, discectomy and/or total joint replacement.

Meniscectomy aims to place and stabilise the disc in its correct anatomical position, whereas discectomy is the total removal of the disc. A study by Sharma *et al.*²⁴ revealed an overall 42% improvement in incisal opening post-meniscectomy, with 3 cases of relapse in the study group of 10 cases. Although this procedure needs further evidence to establish its effectiveness, this paper provides long term (1 year) outcomes and a clear improvement of jaw function is demonstrated. Discectomy, which is the surgical removal of a non-functional or deformed articular disc, may be another option for treatment of internal derangement and may be preferred to meniscectomy if there is severe anatomical deformity of the joint.^{5, 24}

Total joint replacement is another surgical option for TMJ management. This operation, however, is an expensive procedure, which has highly variable outcomes determined by the technique used. Consequently, this option is not commonly offered unless there are specific indications and conditions included in the guideline for TMJ replacement prepared by Sidebottom *et al.*²⁵ These are:

- Failure of conservative treatment (and arthroscopy)
- Diagnostic imaging completed with CT or MRI,
- Presence of condylar bone loss

There is a range of complications that can occur after invasive procedures of TMJ. These include complications arising from general anaesthetics, significant postoperative pain and discomfort, and nerve injury. 80% of TMJ incidences can be treated conservatively, however if there is recurrent failure by non-invasive methods and/or an anatomical deformity/dysfunction of the joint, invasive treatment should be considered.

CONCLUSION

One can conclude from this structural review of different treatment methods for myofacial pain, dysfunction and internal derangement of the TMJ, that there is a wide range of options available. NICE guidelines²⁶ currently recommend beginning treatment with conservative therapy, unless a disc displacement without reduction causing closed lock is suspected, or there is fracture/trauma related injury to the joint. Both conservative and surgical treatments of MPD and internal derangement, most commonly ADD, evidently offer significant improvement after intervention. Most non-invasive therapies aim for symptom control and have shorter-term improvements. Surgical interventions have longer-term effects yet come with a risk of complications. There is lack of evidence on the long-term effects of conservative treatments for TMDs and further research is needed to deliver conclusive recommendations.

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