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COMPARISON OF PHYSICAL THERAPY AND OCCLUSAL SPLINTS THERAPY IN MYOFASCIAL TMD

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ABSTRACT

The aim of this systematic review is to assess which is the most effective treatment between physical therapy and occlusal appliance, in subjects affected by myofascial temporomandibular disorders (mTMD).

MEDLINE and PEDro electronic databases were consulted, searching for randomized controlled trials (RCT) applying manual therapy techniques compared to occlusal appliances. Later, because literature is scarce on this subject, the author has divided the study into two separate researches comparing these two treatments with other kinds of intervention or no-intervention.

The research was restricted to Italian and English language studies, published from 2006 to April 2016. The author himself extracted data and PEDro scale was used to assess methodological quality of the studies.

Twenty potentially relevant RCTs were identified, among which only seven met the inclusion criteria.

There is evidence that intraoral myofascial release on masticatory muscles is more effective than education alone, but intraoral myofascial release associated with education and self-care is more effective than myofascial release alone. Global postural reeducation (GPR) is not more effective than static stretching exercise, but they both are similarly effective in treating myofascial TMD. GPR is used because it seems that subjects with TMD have postural alterations, in local and distal segments, so this technique is applied in order to normalize these alterations.

There is inadequate evidence to either support or refuse the use of occlusal splints, it seems that splint therapy results in a more rapid improvement of the symptoms of TMD and that there is no difference in the effects of different types of splints associated with education, so clinicians should consider the least expensive conservative and least aggressive treatments.

In this review there are no studies that directly compare occlusal appliances to manual therapy.

In conclusions, there is widely varying evidence about manual therapy techniques and occlusal appliances in managing myofascial TMD. Further studies should consider using standardized evaluations and diagnosis and better study design to strengthen clinical relevance.

INTRODUCTION

Temporomandibular disorders (TMD) embraces a variety of clinical dysfunctions of the masticatory muscles and the temporomandibular joint (TMJ), with the associated structures. (1 Okeson 2006).

In 1934, Costen was the first author that gave a description of stomatognathic system problems. He perceived the presence of backward condyle in patients with auricular problems and he supposed a compression of auditory canal by the condyle that caused symptoms like otalghia, joint noise and retroauricolar pain. Then other authors gave their definitions of temporomandibular problems, untill Bell proposed temporomandibular disorders (TMD) in 1990. Nowadays the scientific community uses TMD commonly and this term includes both temporomandibular joint dysfunctions and functional disorders of masticatory system. (2 Testa e Zimoli 2014).

TMD are considered a major public health problem, as they are the main source of chronic orofacial pain and the most prevalent category of non-dental chronic pain condition in orofacial region. They interfere with daily activities and can significantly impact quality of life, diminishing patients' capacity for work and/or ability to interact with their social environment. (3 McNeely C 1993). In addition, TMD have been considered to have a great economic individual impact and burden, like back pain and severe headache. (4 Drangsholt M, LeResche L 1999).
For the reasons listed above, in order to achieve adequate evaluations, knowledge of diagnostic, classifying and therapeutic elements related to TMD appears crucial if experts are to assess the presence and the causal relationship of the above mentioned elements in cases of trauma and/or odontostomatological professional liability. (5 Bucci MB 2013).

The classically described triad of clinical signs for TMD is: muscle and/or TMJ pain; TMD sounds; and restriction, deviation, or deflection of the mouth opening path (6 Laskin DM 1969).
There is a multitude of signs and symptoms, such as earache, headache, neuralgia, and tooth pain, that may also be present as TMD-related or unrelated ancillary findings and that need to be considered in the differential diagnostic process (7 Manfredini D 2010).

The actual prevalence of TMD at population level is a matter of debate, due to the lack of homogeneity in the diagnostic criteria adopted by various research groups, and there is evidence that the prevalence of TMD sign and symptoms may also be high in non-patients populations. (8 Dworkin SF, Huggins KH et al. 1990).
The prevalence of TMD in general population ranges from 1% to 75% for objective signs and from 5% to 33% for subjective symptoms. (9 Fricton JR, Schiffman EL 1995). TMD symptoms are considered to have a gaussian distribution in general population, with a peak in the age range between 20 and 40 years for the most common forms and a lower prevalence in younger and older people. Females seems to be predominantly affected by these disorders but, even though the reported numbers of females are relatively high in patient populations, it seems that no significant gender differences exist with regard to the prevalence of TMD signs at general population level (7). Probably they look for treatment more often than males.

An international consortium described three categories of TMD: *Group I* muscles disorders, including myofascial pain with and without limited mandibular opening; *Group II* disk displacement with or without reduction of mandibular opening , *Group III* arthralgia, arthrosis, arthritis (Diagnostic Criteria for Temporomandibular Disorders). (10 International RDC-TMD consortium 2007, 11 Medlicott MS, Harris SR 2015).
Before them, Dworkin and LeResche had dealt with this subject in 1992 and proposed the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), which were clinically validated by the work of Schiffman few years later. (12 Dworkin SF, LeResche L 1992).
A recent systematic review reported prevalence rates for TMD categories in patients populations: Group I 45,3%, Group II 41,1%, Group III 30,1%. (13 Manfredini D, Guarda-Nardini L et al. 2011).

There is no place for a single etiologic factor or for a sole etiopathogenetic theory, that might be responsible for TMD. (14 Greene C 2001). Indeed, a multifactorial etiology has been repeatedly described and different factors are likely to have a rilevant role in the etiopathogenesis of different TMD symptoms. (15 Suvinen TI, Reade PC e al. 2005).
The principal etiological factors include gender, hormonal factors, ligamentous laxity, trauma, stress and psychological factors, parafunctions and occlusal factors. (14, 16 Testa M, Michelotti M et al. 2013).

The heterogeneity and complexity of TMD make it essential to use a diagnostic and classification system as RDC-TMD, see above, which were revised in 2010 with the inclusion of new categories and diagnostic algorithms, more valid and reliable than previous ones. (17 Schiffmann et al. 2010). Moreover, this classification was further revised in 2014 by Schiffman and his collaborators, leading to the establishment of the Diagnostic Criteria for Temporomandibular Disorder (DC/TMD). (18 Schiffman et al. 2014).

Even though the authors consider of primary utility a classification that contains both a functional framework (axis I) and the integration of psycho-affective component of pain (axis II), they say that these are to be integrated with the proposed classification by American Academy of Orofacial Pain (AAOP). (19 Okeson 2014).

These two classifications are designed for different purposes.

The AAOP classification distinguishes TMD into two groups: *TMJ articular disorders* and *masticatory muscle disorders*. Part of the first group are congenital and developmental disorders, disc derangement disorders, TMJ dislocation, inflammatory disorders, non-inflammatory disorders, ankylosis and fracture; in the second group there are local myalgia, myofascial pain, centrally mediated myalgia, myospasm, myositis, myofibrotic contracture and masticatory muscle neoplasia. This classification is most commonly used in the clinical setting and contains several references to the etiopathogenetic origin of different disorders, so the AAOP guideline provides very useful information in this context.

On the other hand the RDC/TMD or DC/TMD is designed to be used for research, in order to standardize the diagnostic process and to allow the comparison between different studies.

For these reasons, these two classifications can coexist and they are considered the gold standard in their respective settings. (7).

TMD, sometimes, requires complex diagnostic and therapeutic approach, which usually involves multidisciplinary management (20 Martins WR et al. 2015), where more professionals are involved simultaneously; in this context, the physical therapist becomes an important figure in the team that deals with the patient with TMD. (17).

Physical therapists are commonly involved in the management of TMD, in collaboration with dentists (11).

The non-invasive therapy is the first step in the treatment of TMD and it commonly includes physical therapy, occlusal splints, medications, cognitive-behavioral therapy and patient education in a biopsychosocial context. (7, 11).

The main goals in the management of TMD are: to increase mandibular range of motion, to decrease joint and masticatory muscle pain and inflammation and to prevent further degenerative changes in joint tissues, including direct or indirect joint damage (21 Tanaka E, Detamore MS et al. 2008).

Physical Therapy

To achieve the above mentioned goals, physical therapists use several techniques including joint and soft tissue mobilization, trigger point dry needling, friction massage, therapeutic exercise, electrotherapy, education, biofeedback, relaxation and postural corrections. (11, 22 Shaffer SM, Brismée et al. 2014).

All techniques are focused on patient-specific clinical variables and clinicians must consider the irritability level of patient's symptoms.

Patient education is a central component of TMD management. First, it is necessary to reduce parafunctional habits, to address psychosocial factors and to provide pain science education. Afterwards, physical therapists should educate the patient to comply with certain rules as food consistency, laterality of clenching and symptom behavior.

Joint mobilization techniques are addressed to impairments and are fully controlled by the therapist. They are used because they contribute to inhibition of pain and muscle spasm, as well as to improvement of range of motion. It seems that joint mobilization may decrease spinal excitability of nociceptive pathways, thus indicating a down-modulation of central sensitization. Furthermore, the self-mobilization seems to be useful as an integral part of home management program.

Soft tissue mobilization is important to the management of TMD patients. The therapist should determine on which muscle to perform this technique on a case by case basis, depending on patient’s characteristics. The muscles generally treated with this method are: temporalis, masseter and medial pterygoid; moreover accessory muscle of mastication and cervical spine muscles can benefit from the use of soft tissue mobilization.

When TMD are associated with trigger points (TrP), the TrP dryneedling should be considered as a treatment strategy. For this variable, friction massage and ischemic compression are also used adequately. (17, 22).

There are different exercise programs: the most known are Rocabado 6x6 and those proposed by Kraus, but there are also other generic exercise that are used in TMD management (22). Nevertheless, each case must be treated individually, so that treatment decisions about the use of therapeutic exercise are based on clinical characteristics of the patients.

About electrical stimulation, both interferential current (IFC) and transcutaneous electrical nerve stimulation (TENS) are used, as they seem to produce an analgesic effect. Recent studies show that electrical stimulation in patients with acute and chronic pain leads to an improvement of symptoms in the short-term; moreover, it appears to further improve the range of motion (ROM), rather than pain, in patients with TMD. (22, 23 McNeely ML et al. 2006). Even though electrical stimulation has a secondary role in the management of TMD patients, yet it could be necessary in patients with high irritability.

Biofeedback is also used in the treatment of TMD. The biofeedback electrodes are placed unilaterally or bilaterally over masseter muscle and over anterior temporalis. This technique is used to improve perception of muscle contraction and to train muscles in order to obtain maximal relaxation; in particular, it is used in the management of patients with TMD who show altered muscular activation and static bruxism habit (22).

Oral Appliances

Based on the most current scientific evidence, the occlusal splints maintain a leading role in the management of TMD patients, and their mechanism of action has been better understood. Occlusal splints are a minimally invasive and reversible treatment: they work to establish balance in the occlusion and TMJ, they may be used to achieve the most stable and least joint-traumatizing bite position. The ultimate goal of splints is to minimize pain in TMJ and masticatory muscles by establishing stability. Furthermore, they are used to control bruxism, which has been associated with tooth attrition, malocclusion, myofascial pain, and masticatory muscle strain, fatigue and fibrosis. (24 Murphy MK, MacBarb RF 2013).

In clinical practice different types of splint are used: each of them is intended to eliminate a specific etiologic factor and in order to choose the most suitable type it is necessary to have first identified the factor that causes the problem. Therefore, the importance of a thorough history, clinical examination and diagnosis becomes evident. (1).

There are essentially three types of splints: relaxation or stabilization splints, distraction splints and repositioning splints.

Relaxation or *stabilization splints* are used to treat bruxism, as well as in the management of arthrogenic and myogenic TMD. Also known as Michigan splints, they are commonly considered the gold standard of all oral appliances. They are called stabilization splints because they should contribute to occlusal stability through the contacts of the opposing teeth with the appliance, in this way helping to determine a stable position of the teeth and the splint. (7). The purpose of this treatment is to eliminate the instability between occlusal position and joint position. (1).

Distraction splints or *pivot splints* are used in arthroses, perforation of disc and anterior disc dislocation without reduction.

This device covers the entire arch and ensures a single rear contact, in general this contact must be established the most posterior as possible. A force directed downwards, applied under the chin, tends to close the front teeth and to make down tilt the condyle around the rear pin. (1).

There are conflicting studies about this kind of splint and it will require more scientific research to better understand its rationale and to understand if it might have some utility in dental practice.

The only application that can usually distract the condyle from the fossa is the application of unilateral pin. When a unilateral pin is positioned in the region of second molar, the closure of the jaw on it transmits load to the controlateral joint and the ipsilateral slightly is distracted, increasing the disc space.

Repositioning splints are used in the management of anterior displacement of articular disc with reduction. (25 Badel T, Marotti M).

This type of splint is an interocclusal device that brings the mandible to assume a more forward position with respect to the maximum intercuspidation. It is used in disc dislocation because an anterior position of the condyle could allow a better relationship condyle-disc so that the tissues can adapt and regenerate. The objective is to temporarily change the mandibular position to obtain an adaptation of retrodiscal tissues. (1)

Occlusal splints work because they allow a change in the distribution of articular load vectors and in the recruitment of muscle fibers. (5, 7). So, their effectiveness is due to the fact that in patients with bruxism it is sufficient to move the articular loading areas and the muscular fatigue exhaustion areas. This is achieved by changing the vertical dimension by using any kind of occlusal splints; and this simple observation seems to explain the probable lack of superiority of a type of splints, with respect to the other, in terms of clinical efficacy. (26 Turp JC, Schindler HJ 2010).

The current literature is devoid of studies comparing these two therapeutic approaches to manage this type of TMD and there is confusion on how to treat such patients. Indeed, it is not clear whether they are to be sent to the dentist or if they are the sole competence of physical therapist, or if they are to be treated by combining the two therapies.
The purpose of this report is to perform a systematic review of relevant literature in order to establish which therapy, manual therapy/therapeutic exercise or occlusal splints, presents a better efficacy profile for muscle disorders (Group I of Axis I RDC-TMD).

METHOD

A systematic review of the literature was conducted in agreement with PRISMA statement and checklist (27 Liberati et al. 2015).

DATA SOURCES AND SEARCH

The search was conducted using Medline and Pedro.
Boolean operators and Mesh terms were used on Medline and in particular this search string was used: ((manual therapy[mesh term]) OR (physical therapy[mesh term]) OR (exercise therapy[mesh term])) AND (oral splint OR oral appliance OR occlusal splint OR occlusal appliance) AND (temporomandibular (disorders OR dysfunction OR disease OR syndrome)).
Later on, since the initial search had no results, the research was structured to consider manual therapy/physical therapy separately from occlusal splint, in the awareness of possible different relevance of the results.
The following search strings were used:

- ((manual therapy[mesh term]) OR (physical therapy[mesh term]) OR (exercise therapy[mesh term])) AND (temporomandibular (dysfunction OR disorder OR pain)).
- (occlusal (splint OR appliance)) OR (oral (splint OR appliance)) AND (temporomandibular (dysfunction OR disorder OR pain)).

The limits used in the research were:

- Date of publications (from 2006 to April 2016)
- Language (English and Italian)
- Human species

STUDY SELECTION

The study selection was carried out by a single reviewer. After a first reading of titles and then of abstracts, the studies not related to the subject of the review were excluded. The articles of uncertain interest were read completely and those not related to and not meeting the inclusion/exclusion criteria were excluded.

ELIGIBILITY CRITERIA

TYPE OF STUDY. In the review only Randomized Controlled Trials (RCTs) were included and therefore other kind of study were excluded. Studies were considered eligible for inclusion if they compared the effectiveness of physical therapy to that of splint therapy. Because literature that compare manual therapy and splint therapy in temporomandibular disorders is still lacking, was decided to perform two separate searches. The first search included trials on the use of manual therapy, while the second search included trials on splint therapy.

PARTECIPANTS. Trials with patients presenting sign and symptoms of temporomandibular disorders of muscle origin, classified according to the RDC/TMD in group I of axis I were included. Studies in which patients have muscle pain associated with other diseases, such a fibromyalgia, headache, disc dislocation, osteoarthritis and other joint disorders were excluded. Trials in which subjects have no symptoms were also excluded.

TYPE OF INTERVENTION. In the first search there were included trials in which physical therapy was compared to a reference group (placebo intervention, controlled comparison intervention, standard treatment or other treatment), while in the second search there were included trials that compared splint therapy to a reference group or to a different kind of splint.

OUTCOME MEASURES. Trials reporting outcomes related to pain, range of motion (ROM), pressure pain threshold (PPT) of masticatory muscles, disability or function were included.

QUALITY ASSESSMENT

The PEDro (Physiotherapy Evidence-Based Database) scale was used to assess the methodological quality of the studies included in this review.

The trials collected in PEDro already had a score that was maintained. The studies non-indexed from PEDro were evaluated by one reviser (A.M.).

The studies with a score higher or equal to 6 on PEDro scale where included in this review, while articles with a lower score were excluded.

RESULTS

STUDY SELECTION

The search string provided 119 articles on manual therapy and 85 on occlusal splint therapy. The final selection process resulted in three included studies (28-30) on manual therapy and four included studies (31-34) on occlusal splint, for evidence synthesis.

The majority of the studies was excluded because of unspecified or mixed diagnosis of patients. Details of the selection process are presented in Fig. 1 and in Fig. 2.

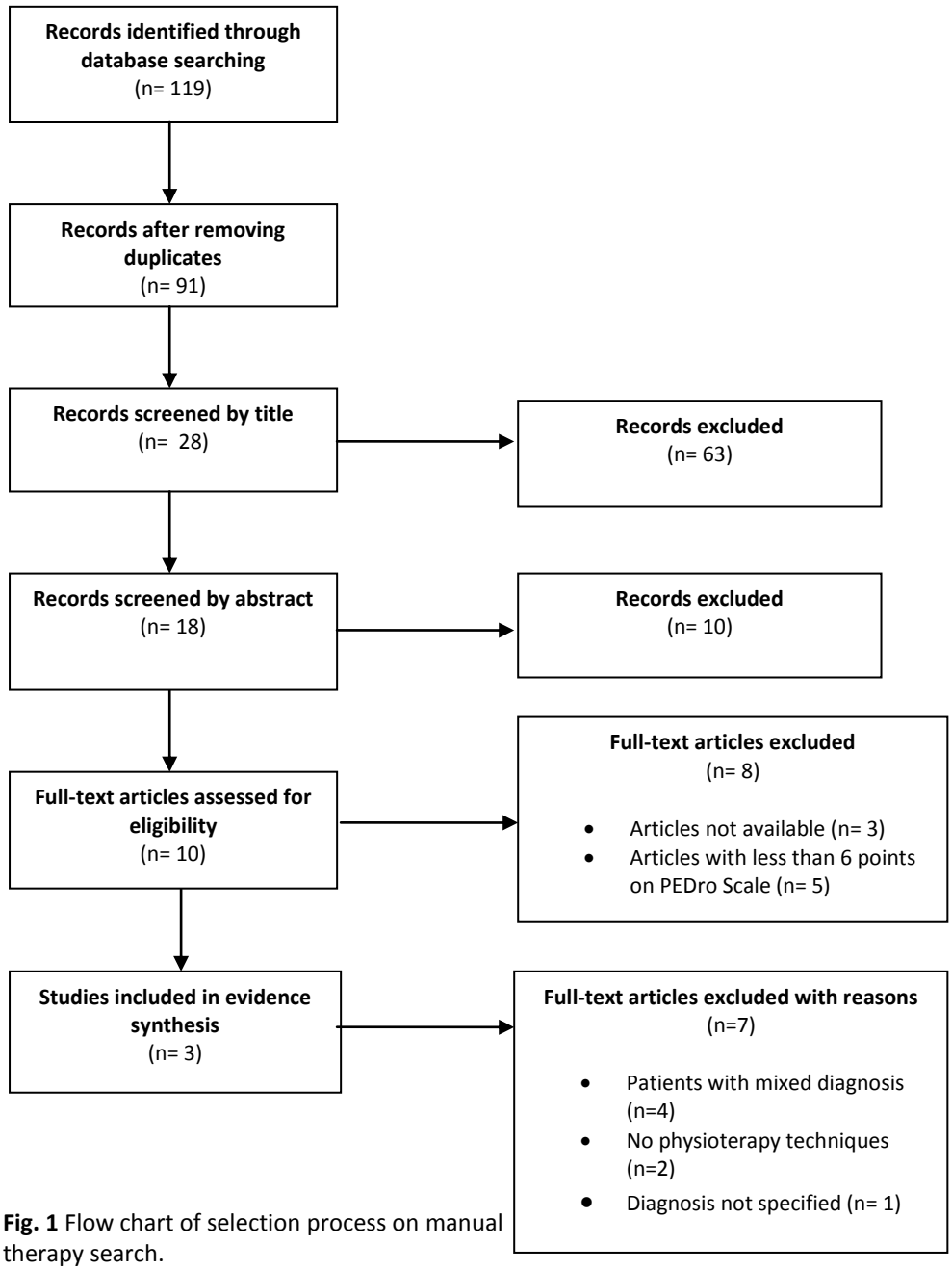

Fig. 1 Flow chart of selection process on manual therapy search.

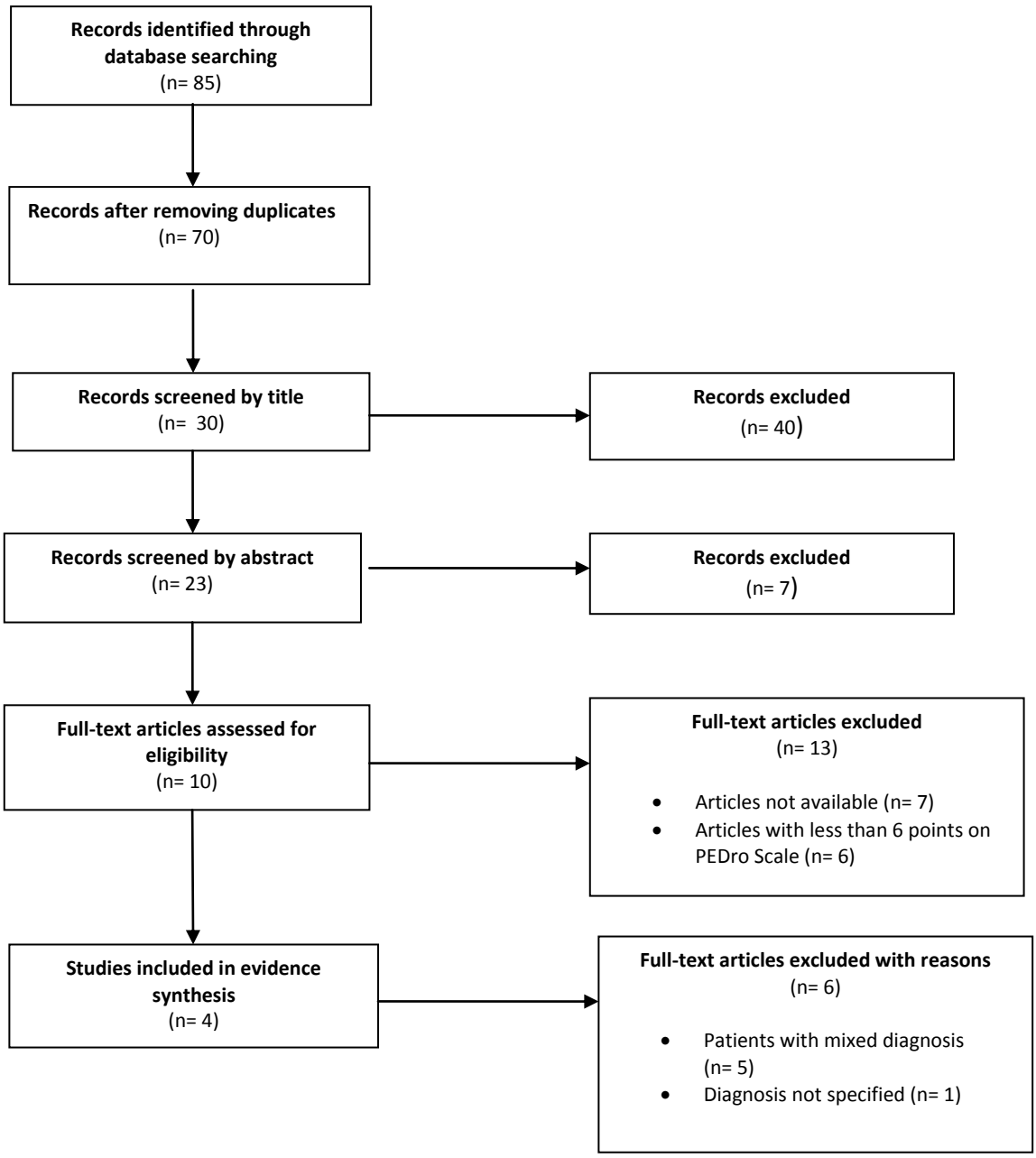

Fig. 2 Flow chart of the selection process on occlusal splint search.

QUALITY ASSESSMENT

Only three studies presented high methodological quality (PEDro Scale was greater than o equal to 7). The mean PEDro total score obtained for the studies was 6,6. The majority of studies were classified as moderate methodological quality (31-33, 29).

Four study (31-34) were not indexed by PEDro Scale, so the reviewer had to assess their methodological quality.

STUDIES CHARACTERISTICS

The characteristics of the seven trials included are presented in Table 1 and Table 2.
All included studies about manual therapy were RCT, but there was difference in the applied protocols regarding the number of sessions, the frequency of therapy application and the evaluation after treatment. Only one study performed a longer follow up after treatment (28), the two remaining studies performed a six weeks follow up (30) and an eight weeks follow up (29). Two studies applied a protocol of two sessions per week for five weeks (28-29), while the other one (30) applied a treatment protocol of a session per week.
All included studies about splint therapy were also RCT, but there was difference in the application protocols of the splints and in follow up. Only one study (33) performed a longer follow up, while the other studies used 7, 30, 60, 90 days follow up (34), two and five months follow up (31) and two, six weeks and three months follow up (32). In all the included studies the use of splint was limited at night, except for one (34) where it was used all day in the first week of treatment and then only at night.

OUTCOME MEASUREMENT TOOLS

In all the studies about manual therapy, jaw pain intensity at rest was evaluated through the visual analogue scale (VAS). Two of those studies also reported jaw pain intensity upon maximal active opening and upon clenching (28, 30). Maximal Mouth Opening (MMO) measurements were taken in all the studies except for one (29), while PPT and EMG were measured only in one study (29).
In the studies about splint therapy, pain intensity was evaluated as follow: in two studies it was assessed through the visual analogue scale (VAS) (32, 33); in one study (34) subjective pain was assessed with Mod-SSI, while objective pain was reported with muscle palpation.
In another study (33) the main outcome measures were overall improvement according to a 6 point rating scale, physical functioning (GCP severity), functional limitation of the jaw (JFLS) and emotional functioning (modified SCL-90-R), while in another study there were (31) symptoms of

anxiety and depression (HADS) and pain catastrophizing (Pain related Self-Statement Scale). PPT evaluation and registration of occlusal contacts were performed only in one study (32).

CHARACTERISTICS OF THE SUBJECTS INCLUDED IN THE PRIMARY STUDIES

The total number of subjects included in the studies ranged from 28 to 93. All the participants were adults, ranging from a minimum age of 18 to a maximum age of 50-65 and older.
Five studies (28, 30-33) used the standardized evaluation protocol Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TDM) (10) and all the subjects included had a myogenic disorder. One study (34) applied the standardized clinical examination of the Diagnostic Criteria of American Academy of Orofacial Pain (AAOP) (19), while the last one (29) adopted a non-standardized evaluation protocol.
All the studies reported their exclusion criteria, the most frequently adopted criteria were the use of dentures, history of malignancy, physical contra-indications such as active inflammatory arthritis, fractures, dislocations, known instability of the jaw or neck, metabolic, connective tissue, haematologic and rheumatologic diseases. Other exclusion criteria, related to splint study, were temporomandibular joint pain, previous treatment with oral appliance, periodontal problems, presence of idiopathic orofacial pain and major psychological disorders.

Table 1. Characteristics of primary studies about manual therapy considering study design, subjects, interventions and outcomes.

TRIAL	SUBJECTS	INTERVENTION	CONTROL	OUTCOME AND RESULTS	FOLLOW UP
Kalamir et al (30)	Patients with myogenous TMD (RDC/TMD) and daily history of periauricular pain with or without joint sounds for at least 3 months duration and a minimum baseline graded chronic pain score of 3 Age: 18-50 years N: 46	(A) Two session per week for five weeks of intra-oral temporalis release, intra-oral medial and lateral pterygoid (origin) technique, intra-oral sphenopalatine ganglion technique	(B) Two session per week for five weeks of short talks about anatomy, physiology and biomecanichs of the jaw plus instructions and supervision of self-care exercise (guided controlled jaw excursions, post-isometric stretches (lateral deviation and opening))	Jaw pain at rest (RP), maximal active opening (OP), clenching (CP)(VAS) -A vs B (98,3% CI) RP -0.88(-1.44, -0.31) OP -1.16 (-1.80, -0.53) CP -1.10 (-1.81, -0.38) -P-value RP <0.001 OP <0.001 CP <0.001 Maximal voluntary interincisal opening (millimetres) -No significant difference in opening range between A and B	After five weeks of intervention
Kalamir et al. (28)	Patients with myogenous TMD (RDC/TMD) and daily history of periauricular pain with or without joint sounds > 3 months in duration and a minimum baseline graded chronic pain score of 3 Age: 18-50 years N: 93	(A) 10 sessions of intra-oral temporalis release, intra-oral medial and lateral pterygoid (origin) technique, intra-oral sphenopalatine ganglion technique (B) group A + instructions + home exercise	(C) control group	MMO (calliper) Jaw pain at rest, maximal active opening, clenching (VAS) -There were statistically significant differences in RP, OP, CP, opening scores and global reporting of change (P<0.05) in A and B compared with C at 6 months and 1 year -there was also significant difference between A and B at 1 year in favor of B	Five weeks, six months and a year after intervention

Table 1. (continued)

TRIAL	SUBJECTS	INTERVENTION	CONTROL	OUTCOME AND RESULT	FOLLOW UP
Maluf et al. (29)	Patients with myogenous TMD with > 3 months duration with parafunctional habits Age: 19-40 years N: 28	(A) One session per week of global postural reeducation (muscle global chain stretching)	(B) One session per week of conventional static stretching exercise for the cervical spine, head, upper limbs and mandibular muscles	Pain at TMJ, headache, cervicalgia, teeth clencing, ear symptoms, restricted sleep, difficulties in mastication (VAS) PPT of masseter, anterior temporalis, upper trapezius, sternocleidomastoid muscles (algometer) EMG activity of masseter, anterior temporalis, upper trapezius, sternocleidomastoid muscles -no significant differences with the exception of severity of headache ($P<0.024$) -no significant differences in PPT and EMG ($P>0.05$)	After two months of intervention and further 8 weeks

Table 2. Characteristics of primary studies about occlusal splints considering study design, subjects, intervention and outcomes.

TRIAL	SUBJECTS	INTERVENTION	CONTROL	OUTCOME AND RESULTS	FOLLOW UP
Costa et al. (31)	Patients with myofascial pain (RDC/TMD) with pain duration of at least 3 months Age: 18-50 years N: 60	(A) Counselling	(B) group A + occlusal splint	Symptoms of anxiety and depression (HADS) -improvement of anxiety and depression in group B ($P<0.05$) Pain catastrophizing (Pain related Self-Statement Scale) -significant reduction in pain catastrophizing in A and B ($P<0.05$)	Two and five months after treatment
Conti et al. (32)	Patients with myofascial pain (RDC/TMD) with or without jaw opening limitation with pain intensity of at least VAS 5/10 Age: from 18 years up N: 51	(A) stabilization splint + couselling (B) NTI appliance + counselling	(C) Counselling	Pain (VAS) -significant decrease in reported pain in A, B, C ($P<0.05$) PPT of temporalis and masseter muscles (algometer) Registration of occlusal contacts (ribbon and Miller clamp) -no significant difference in PPT values and in number of occlusal contacts ($P>0.05$)	Two, six weeks and 3 months after intervention

Table 2. (continued)

TRIAL	SUBJECTS	INTERVENTION	CONTROL	OUTCOME AND RESULTS	FOLLOW UP
Doepel et al. (33)	Patients with myofascial pain (RDC/TMD) with or without limited opening with duration of pain of at least 3 months and self-assessed worst myofascial pain of at least 4/10 in NRS Age: from 18 years up N: 66	(A) prefabricated appliance (frontal plateau covering the edges of the incisors and canines with a palatal extension of about 1 cm)	(B) Stabilization splint	Pain intensity (VAS) Overall improvement (6 point rating scale) -no statistically significant difference between A and B in pain and overall improvement Physical functioning (GCP severity) -significant changes in physical functioning in A and B at 6 and 12 months follow up (P<0.001, P<0.001) Functional limitation of the jaw (JFLS) Emotional functioning (modified SCL-90-R) -no significant difference between A and B in JFLS and emotional functioning	After six and 12 months of intervention
Alencar et al. (34)	Patients with myofascial pain with reproduction of the chief complaints with palpation of a trigger points in the masseter muscle Age: 18-65 years N: 45	(A) splint with at least 3 mm thickness of acrylic between the maxillary and mandibular posterior teeth (B) splint with a resilient mouth guard material, with 3 mm thickness	(C) splint fabricated with chemical activated acrylic resin and stainless wires	Subjective pain report (Mod-SSI) Objective pain report (Muscular palpation of masseter, temporalis and pterygoid muscles) - significant differences between baseline and 90 days follow up in A, B, C for muscular palpation and Mod-SSI -no significant differences between groups	7, 30, 60, 90 days after splint insertion

DISCUSSION

MANUAL THERAPY

Exercise therapy and manual therapy has long been used in the treatment of TMD patients. Therapeutic exercise interventions are prescribed to address specific TMJ impairments and to improve the function of TMJ. Most exercise protocols are designed to improve muscular coordination, to relax muscles and to increase range of motion and muscular strength.

The most useful techniques in the management of masticatory muscles disorders are manual therapy, muscle stretching and strengthening exercise (23).

Two of the three studies included in this review applied intra-oral myofascial release techniques(IMT) on masticatory muscles, while the other one applied a global postural reeducation (GPR).

Kalamir et al. (30) showed superiority of intra-oral myofascial techniques if compared to education and self-care in the short-term; in particular, both groups achieved statistically significant pain reduction, but only the IMT group obtained clinically significant reduction of at least two points for each of the three pain outcomes (pain at rest, opening pain, clenching pain).

Kalamir et al. (28) demonstrated that IMT techniques are more effective than no-treatment at six weeks, six months and a year, but IMT associated with education and self-care showed general clinical superiority over the treatment-only group at one year, when this group showed some signs of regression. A possible reason may be that the treatment effects caused by IMT were maintained from education and self-care. It has been suggested that patients beliefs about the value of self-care, their attitude and their compliance to self-care programs are influenced by their condition. The value of self-care jaw exercises in chronic TMD has been well established. It seems that home exercises may encourage self-management and improve the coping ability of the patients (35 Michelotti A 2004).

These two included studies have a limitation: the evidence in support of the intraoral sphenopalatine ganglion technique is lacking, it seems it is not applicable because the above mentioned ganglion is not anatomically accessible.

Nevertheless, the potential use of this technique upon masseter, pterygoids and temporalis muscles has made it possible its inclusion in the study. The authors asserts that this technique can be safely used and it is well tolerated by patients as demonstrated by the absence of any adverse reactions reported by the subjects.

The use of myofascial therapies such as the trigger-points treatment, as proposed by Travell and Simons is quite common nowadays. (36 Travell JG, Simons DG 1999).

Maluf and his colleagues (29) made a comparison between the use of static stretching (SS) and the use of Global Postural Reeducation (GPR). SS is used in conventional physical therapy and it consists in stretching a single muscle up to a tolerable point and maintaining the position for a specified time; this technique is repeated for three time after 10 second of rest for a single muscle or for a small group of muscles.

The GPR is based on the recognition of two different muscle chains, anterior and posterior chains, and proposes a global muscle stretching obtained by maintaining two different postures for 15 minutes each.

There are not many studies on the use of this technique in TMD. The authors justify the use of GPR because it seems that subjects with TMD have postural alterations, in local and distal segments, like lower limbs, so they apply this technique in order to normalize these alterations.

It seems that there is a relationship between pain and postural EMG activity of upper trapezius and sternocleidomastoid muscles in mTMD, and this suggests a functional link between cervical and masticatory muscles, probably due to a coactivation mechanism. (37 Pallegama RW, Ranasinghe AW 2004, 29).

Maluf established that there is no evidence that global postural reeducation (GPR) is more effective than static stretching exercise in treating TMD with muscle component; it seems that they both equally reduce pain intensity, increase pain threshold and decrease EMG activity.

There is to say that this study has some limitations: the absence of a control group that would allow to better understand the natural course of the disease and the lack of literature evidence about stretching and about the GPR in managing myogenic TMD.

OCCLUSAL SPLINT THERAPY

Occlusal appliances are well documented in the literature as an effective practice in the management of masticatory muscle pain. Their possible mechanisms of action are listed as follows: greater stability of the joint components; re-establishment of a more favorable occlusal relationship and a stable physiological mandibular posture; reorganization of neuromuscular activity; reduction of hyperactivity of the masticatory muscles; restoration of balanced muscle

function; cognitive effect, making the patient aware of parafunctional habits; placebo effect (32, 38 Gomes CA 2014).

The actual results are likely due to a combination of all these mechanisms.

Costa et al., through their study, (31) showed that occlusal splint associated with counselling (information about TMD, diet modifications, use of reminders to avoid parafunctional habits, stretching and self-massage of masticatory muscles) produced an improvement of the psychological aspects in patients with TMD. Moreover, it seemed that, the use of splints in particular hastened the manifestation of these effects and gave additional effects. This study asserts that occlusal splints are effective as behavioural intervention rather than as a purely mechanical device and that their effects exceed those of peripheral modifications in masticatory system. Furthermore, these results support the theory of psychological disorders being consequence of masticatory myofascial pain, indicating a bidirectional cause-effect relationship between pain and psychological factors.

Conti et al. (32) also showed that the use of splints combined to education produces an earlier improvement, especially in terms of reported pain. In this study, all three groups (stabilization splint + counselling, NTI system + counselling, counselling alone) produced improvement of pain, and this suggested the importance of education as counselling, behavioural changes and avoidance of parafunctional habits in treatment protocols, making education a necessary element of conservative treatment.

The importance of education is also shown in another review (39 Wieckiewicz M 2015). The authors assert that education is the most important stage of a treatment protocol and it consists in cognitive awareness training and relaxation therapy as well as self-observation by patients themselves. They advice to explain the background of the disorders to the patients and to warn them about habitual parafunctional activities.

Counselling and self-management techniques are used because they stimulate the patient to change his/her behavior and stress the importance of emotional self-control.

In the study of Conti et al. (32) it is shown that there is no evidence supporting NTI as more effective than stabilization splint for TMD treatment. Furthermore, in this study, 25% of the NTI-group reported tooth sensitivity in the region of mandibular incisors, 12.5% reported lack of coordination of mandibular movements, whereas 18% of the sample reported the appliance falling out or being taken out unconsciously during the night. The short-term evaluation and the small

number of subjects are limitations of this study and they need to be taken into consideration; the NTI system requires more studies to examine its effectiveness and safety.

Doepel et al. (33) proved that the effects of prefabricated oral appliance is not different from that of stabilization splints, but the first one is more easily accepted by patients probably because it is smaller and it does not seem to provoke gag-reflex. Actually, both the appliances led to an improvement of the four outcome domains. In particular more than 70% of the patients achieved 30% pain relief at 12 months, while 81% in prefabricated group and 64% in the stabilization group reported themselves to be “better symptom-free”, considering that more than 30% of pain reduction appears to reflect moderate clinically important differences (MCID).

Therefore, according to this study, the prefabricated oral appliance can be equally recommended as the stabilization splint for treating myofascial TMD, also taking into account its low manufacturing cost.

Alencar and Becker (34), through their study, showed that there are no differences in the application of three different kinds of splints (hard splint, soft splint, non-occluding splint), associated with counselling in the management of patients with mTMD. Their outcome measures are the Modified Symptom Severity Index (Mod-SSI) and tenderness to palpation: they both improved over time in all three groups.

Several factors could have affected these results. First, in this study the authors did not use splints alone, but always associated with counselling and self-care, and this may introduce bias in the results. Another factor could be that non-occluding splints, like stabilization appliances, actively increased the cognitive awareness of behavioural change. Furthermore, the fluctuating natural course of TMD including myofascial pain might have an effect in improving symptoms.

The results of this study (34) suggests that clinicians should consider low-cost therapies such as counseling and self-care in treating myofascial TMD and that the type of splint and its material does not affect the expected results.

On the basis of this systematic review it is not possible to say whether there is evidence or not supporting the use of splints, as their actual effect is not well known; in some studies it seems that their use produces early improvements and adds benefits, in other studies it seems that their effects depend on the simultaneous counselling.

However, it is to say that the improvement in symptoms and signs of mTMD after treatment may also be attributed to increased cognitive awareness, regression to the mean, natural fluctuation and placebo effect.

STUDY LIMITATION

This review has several limitations that must be highlighted.

The purpose of this systematic review was to evaluate which therapy, whether physical therapy or occlusal splints, has a better efficacy profile in treating myofascial TMD, but literature in this regard is still lacking in studies that directly compare these two therapies. There is also heterogeneity among studies about TMD diagnosis, study intervention and comparison/control intervention; as a consequence the aim of this study could not be completely pursued.

Another limitation is that literature search, study selection, data abstraction, interpretation of results and assessment of methodological quality were carried out by a single reviser, and this could cause variability in the results.

Since only articles in Italian and English were included, and because ten articles have not been retrieved, it is possible that this review is not a complete representation of available evidence.

CONCLUSIONS

Implications for Practice

The results of this systematic review assert that the first step in the conservative management of myogenic TMD is patients' education as counselling, cognitive awareness training, relaxation therapy, information about disease background and warning on parafunctional habits. There is also moderate support about the use of intraoral myofascial release, in spite of its limitations in the sphenopalatine ganglion technique, and about the use of stretching, but there is not any information about exercise protocols to reduce signs and symptoms of TMD.
There is inadequate evidence to either support or reject the use of occlusal splints in treating TMD. However, the combination of these conservative therapies leads to reduction in signs and symptoms of TMD and, in addition, they should be taken into consideration because of low risk of side effects.

Implication for Research

There is clear need for well-designed RCTs studying physical therapy techniques and occlusal appliances in managing TMD, particularly focusing on a specific type of TMD, for example myofascial TMD or disc displacement. Trials should be large enough to be clinically meaningful, adequately powered, they should include valid and reliable outcome measures and have appropriate follow-up.
Authors should improve external validity using a standardized protocol, like RDC/TMD or AAOP's one, in order to evaluate and diagnose the dysfunction; in this way could further improve methodological quality and internal validity.
Further studies would also be necessary, and interesting, to compare directly the two treatments (physical therapy and occlusal appliance) evaluated in the review, which was not possible due to the scarcity of literature.

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