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Review Article

Is nonsurgical management effective in temporomandibular joint disorders? – A systematic review and meta-analysis

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ABSTRACT

Background: Various nonsurgical interventions have been used for the management of patients with temporomandibular joint (TMJ) disorders, but their clinical effectiveness remains unclear. Hence, the purpose of this systematic review and meta-analyses was to assess the evidence of the effectiveness of nonsurgical interventions in the management of TMJ disorders.

Materials and Methods: A literature search on five databases such as PubMed, PubMed Central Cochrane, TRIP, NGCH databases and hand searching was conducted for a period from October 1995 to 2015. Randomized control trials (RCTs) on the nonsurgical management of TMJ disorders were included and reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The quality of the articles was assessed by JADAD scoring. Finally, out of 23 RCTs, 11 articles having any of the primary outcomes (pain pressure threshold [PPT], pain, maximal pain-free mouth opening, and level of dysfunction) were selected. The extracted data were analyzed using NCSS software.

Results: The results showed the evidence of pain reduction (P = 0.00), maximal pain-free mouth opening (P = 0.0138), and decrease in level of dysfunction (P = 0.0007) but no improvement in PPT to a significant level (P = 0.6600).

Conclusion: Our results suggest that the simplest, cost-effective nonsurgical treatments have a positive therapeutic effect on the initial management of TMJ disorders. However, a consistent methodology recording both the objective and subjective outcomes would be a better choice for added reliability.

Key Words: Managment, meta-analysis, nonsurgical, systematic review, temporomandibular joint disorders

INTRODUCTION

The phrase "temporomandibular disorders (TMDs)" is a collective term embracing a number of clinical problems that involve the masticatory musculature, the temporomandibular joint (TMJ) and associated structures, or both.[1] Symptoms of TMDs occur in approximately 6%–12% of the adult population.[2] The epidemiologic predilection of TMDs in women is striking. In the general population, TMDs are two times more prevalent in women than in men, whereas in patient population, these diseases have a female-to-male preponderance as high as 10:1.6.[3] A

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large proportion of women with TMDs are between 18 and 45 years of age.[4]

Due to a poor understanding of the etiology or pathogenesis of TMDs and the lack of definitive diagnostic or therapeutic approaches, patients often have to tolerate the symptoms, including debilitating pain, which substantially impact their quality of life over extended periods of time.[5] The treatment of TMD can be divided into two main groups. The first one being the nonsurgical therapy that includes treatments such as counseling, physiotherapy, pharmacotherapy, and occlusal splint therapy.[6] The other is the surgical therapy, and it ranges from TMJ arthrocentesis and arthroscopy to more complex open joint surgical procedures, referred as arthrotomy.[7] Narrative reviews indicate that the success rate of nonsurgical treatment is approximately 70%,[6] and the surgical treatment success is approximately 83%,[7] whereas other studies report approximately 40%–70% self-improvement without any treatments.[8] Systematic reviews, however, paint a different picture indicating that there is a lack of high-quality evidence to make informed clinical decisions. Yet, some systematic reviews do offer treatment guidance amidst some controversies about the most effective treatments.[9]

Various interventions have been suggested for TMDs, but to date, the most efficacious/effective approach is still unclear, which may result in a management based more on experience than evidence. The purpose of the current study, therefore, is to investigate the effectiveness of various nonsurgical interventions used in the management of TMDs.

MATERIALS AND METHODS

QUORUM guidelines [Appendix 1] were used to design, conduct, and analyze this systematic review and meta-analysis.

Aim

The aim of the study was to investigate the effectiveness of various nonsurgical interventions used in the management of TMJ disorders.

Objectives

The objectives of the study were to investigate different nonsurgical therapeutic options for the management of TMDs in terms of pain pressure threshold (PPT), pain, pain-free maximal mouth opening, and level of dysfunction by randomized controlled trials (RCTs).

Search strategy

PubMed, PubMed Central, Cochrane, TRIP, National Guideline Clearing House (NGCH) databases and hand searching of the reference lists of the included studies.

Inclusion criteria

This systematic review and meta-analysis were limited to RCTs for evaluating the efficacy of nonsurgical management of TMDs. All full-text RCTs that evaluated any type of nonsurgical management of TMDs against a placebo or sham or no treatment that were published in any language between October 1990 and 2015 with no previous surgery done in TMJ region.

Exclusion criteria

All other types of studies such as observational, non-RCTs, reviews, articles not indicating the treatment of TMDs, and interventions post-TMJ surgery were excluded from the study.

Data extraction

Full-text copies of all relevant and potentially relevant studies were obtained and assessed independently. All irrelevant records were excluded, and the reasons for their exclusion were noted.

Data analysis

The data analysis was performed using NCSS software (Kaysville, USA) to compare the effects of different interventions.

Outcomes assessed

Main symptoms and the reason for seeking treatment are pain, difficulty in maximum mouth opening, dysfunction in daily activity and reduced pain tolerance. For this reason, these outcomes were selected for determining the relative benefit of the study interventions.

Quality assessment

Each study was evaluated using 5-point JADAD scale[10] to assess the completeness and quality of reporting of RCTs as well as to assess potential bias in the trial. A trial scoring at least 3 out of 5 is considered to be of strong quality, whereas a score below 3 is considered to be methodologically weak.

RESULTS

Search

The search strategy identified a total of 7476 records from all databases ([435 – PubMed, 5732 – PubMed

Central, 10 – Cochrane, 1217 – TRIP, 60 – NGCH, and hand searching – 22]). Of these, the full texts of 23 potentially eligible papers were retrieved and examined [Table 1]. Figure 1 presents the Preferred Reporting Items for Systematic Reviews and Meta-Analyses format on how the trials were excluded from the meta-analysis.

The systematic review and meta-analysis reviewed 23 full-text RCTs involving 1486 participants. Eleven RCTs in Table 1 had data and methods that allowed meta-analysis of the results comparing nonsurgical management with no treatment, placebo, or sham treatment which served as control. The results varied considerably in terms of PPT, pain, maximal mouth opening, and level of dysfunction.

Assessment of heterogeneity

The clinical and statistical heterogeneities were assessed across the studies before pooling. Clinical heterogeneity was determined by examination of each study's clinical characteristics for any diversity/variation in, for example, technique/delivery of interventions, severity/chronicity of condition, and treatment outcomes. Statistical heterogeneity was assessed by Chi-square test. A significant $P < 0.05$ for Chi-square test were considered substantial heterogeneity. A test for funnel plot asymmetry to assess publication bias was planned but was not performed because of insufficient numbers of studies pooled in the meta-analyses.

DISCUSSION

Meta-analysis of studies comparing two means – Pain pressure threshold

Figure 2 had data that allowed meta-analysis of the results comparing the nonsurgical methods such as acupuncture therapy, occlusal splint therapy, anterior repositioning splint (ARS), and NTI-tss with counseling and measured PPT for right and left TMJ. The results varied considerably.

The studies had proved that PPT can be slightly increased by the use of acupuncture therapy and occlusal splint therapy in 6-month duration for craniomandibular disorder patients,[13] whereas wearing splint alone for 3 months had no significant difference for TMJ disc displacement with reduction (DDWR) and arthralgia patients.[33]

In the forest plot associated with meta-analysis of combined studies, the mean difference between

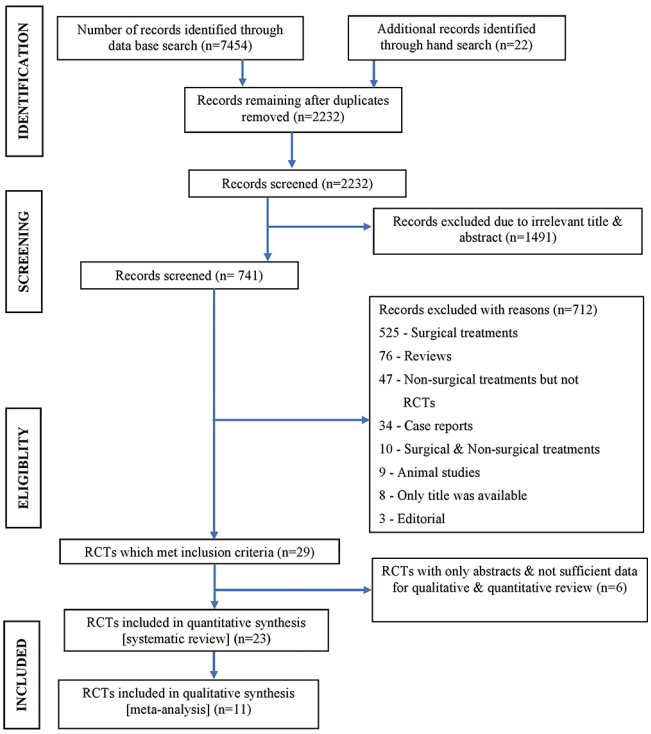
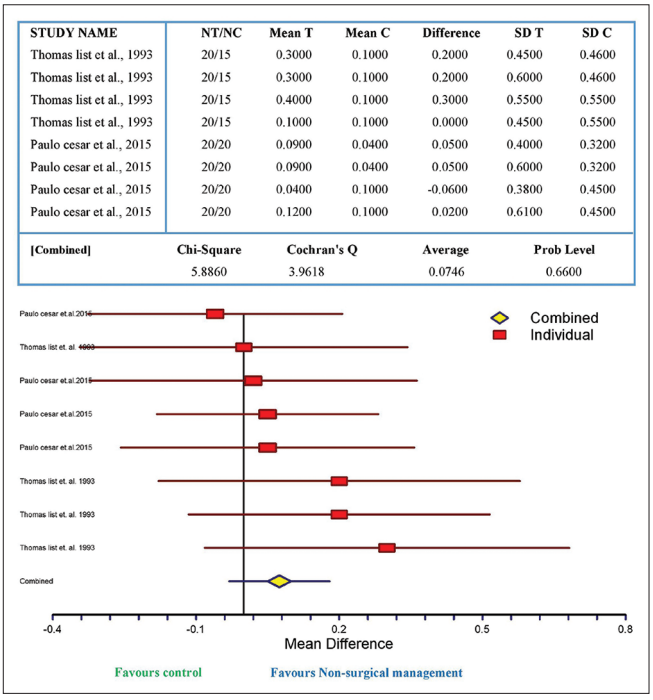


Figure 1: PRISMA flow diagram.



STUDY NAME	NT/NC	Mean T	Mean C	Difference	SD T	SD C
Thomas list et al., 1993	20/15	0.3000	0.1000	0.2000	0.4500	0.4600
Thomas list et al., 1993	20/15	0.3000	0.1000	0.2000	0.6000	0.4600
Thomas list et al., 1993	20/15	0.4000	0.1000	0.3000	0.5500	0.5500
Thomas list et al., 1993	20/15	0.1000	0.1000	0.0000	0.4500	0.5500
Paulo cesar et al., 2015	20/20	0.0900	0.0400	0.0500	0.4000	0.3200
Paulo cesar et al., 2015	20/20	0.0900	0.0400	0.0500	0.6000	0.3200
Paulo cesar et al., 2015	20/20	0.0400	0.1000	-0.0600	0.3800	0.4500
Paulo cesar et al., 2015	20/20	0.1200	0.1000	0.0200	0.6100	0.4500

[Combined]	Chi-Square	Cochran's Q	Average	Prob Level
	5.8860	3.9618	0.0746	0.6600

Figure 2: Meta-analysis of studies comparing two means - pain pressure threshold.

treatment and control group was found to be 0.074 which was statistically insignificant at $P = 0.6600$. This confirmed that there was no significant increase of PPT in patients treated with nonsurgical procedures.

Table 1: Characteristics of included studies

Author	Type of TMDs	Participants (P)	Intervention (I) and comparison (C)	Follow up	Measures	Outcome (O)	JADAD score
Lundh *et al.*, 1992[11]	TMJ DDWOR	*n*=51 (♂=5, ♀=46), age: 14-61 years	G1 (*n*=25): Flat occlusal splints during sleep G2 (*n*=26): No treatment	12 months	Pain-free maximal mouth opening Pain during protrusion Palpatory tenderness of masseter muscle	G1<G2 G1<G2 G1<G2	2
Bertolami *et al.*, 1993[12]	TMDs	*n*=121	G1 (*n*=80): Sodium hyaluronate G2 (*n*=41): Physiologic saline	6 months	Total dysfunction Intracapsular dysfunction Mandibular deviation Improvement in noise Visual analog noise	G1>G2 G1>G2 G1>G2 G1>G2 G1>G2	3
List *et al.*, 1993[13]	Craniomandibular disorder	*n*=55 (♂=9, ♀=46)	G1 (*n*=20): Acupuncture G2 (*n*=20): Occlusal splint during sleep G3 (*n*=15): No treatment, register pain in diaries	6 months	PPT CDS VAS index	G1=G2>G3 G1=G2>G3 G1=G2>G3	1
Wright *et al.*, 1995[14]	Masticatory muscle pain	*n*=30 Age: 19-51 years	G1 (*n*=10): Soft splint appliance 24 h/day G2 (*n*=10): Palliative treatment + self-care instructions G3 (*n*=10): No treatment	4-11 weeks	SSI Maximum pain free opening Pressure algometer score	G1>G2=G3 G1>G2=G3 G1>G2=G3	3
Schiffman *et al.*, 1996[15]	TMJ DDWOR and TMJ capsulitis	*n*=27, (♂=3, ♀=24), age: 16-81 years	G1 (*n*=9): Dexamethasone sodium phosphate+Lidocaine hydrochloride G2 (*n*=9): Lidocaine hydrochloride G3 (*n*=9): Buffered saline Iontophoretic delivery	1 week	SSI Range of motion Pain	G1=G2=G3 G1>G2=G3 G1>G2=G3	3
Komiyama M *et al.*, 1999[16]	MF pain with Myofacial pain with limited opening	*n*=60	G1 (*n*=20): Cognitive behavior intervention G2 (*n*=20): Posture correction G3 (*n*=20): No treatment	12 months	Pain-free unassisted mouth opening Disturbance in daily life	G1=G2>G3 G1=G2>G3	2
Wright *et al.*, 2000[17]	TMD and primary muscle disorders	*n*=60, (♂=9, ♀=51), age: 18-60 years	G1 (*n*=30): Posture training G2 (*n*=30): Self-management instructions	4 weeks	Maximum pain-free opening PPT TMD symptoms Neck symptoms	G1>G2 G1>G2 G1>G2 G1>G2	3
Yuasa *et al.*, 2001[18]	TMJ DDWOR and without osseous changes	*n*=60, age: 16-69 years	G1 (*n*=30): Ampiroxicam+mouth opening exercise G2 (*n*=30): No treatment	15 months	MMO Joint pain at rest Joint pain on movement Joint pain on chewing Interference with daily life	G1>G2 G1>G2 G1>G2 G1>G2 G1>G2	3
Minakuchi *et al.*, 2001[19]	ADDWOR	*n*=69, (♂=6, ♀=63)	G1 (*n*=25): Diclofenac sodium+self-care instructions+flat occlusal appliance during sleep G2 (*n*=23): Diclofenac sodium+self-care instructions G3 (*n*=21): Only explanation regarding prognosis	8 weeks	MMO DAL VAS pain	G1=G2=G3 G1<G2>G3 G1<G2>G3	3
Michelotti *et al.*, 2004[20]	MF pain of the jaw muscles	*n*=70, (♂=8, ♀=62), age: 15-66 years	G1 (*n*=36): Education+Home physical therapy G2 (*n*=34): Education only	12 weeks	PPT VAS for pain Pain-free maximal mouth opening	G1=G2 G1=G2 G1>G2	3
Peroz *et al.*, 2004[21]	TMD	*n*=78, (♂=13, ♀=65), age: 18-84 years	G1 (*n*=36): Pulsed electromagnetic fields G2 (*n*=42): Placebo treatment	4 months	Pain intensity Pain frequency Joint noise frequency Restriction of daily life activities Maximal unassisted opening Maximal assisted opening	G1=G2 G1=G2 G1>G2 G1=G2 G1=G2 G1<G2	4

Contd...

Table 1: Contd...

Author	Type of TMDs	Participants (P)	Intervention (I) and comparison (C)	Follow up	Measures	Outcome (O)	JADAD score
Truelove *et al.*, 2006[22]	TMDs	*n*=200, mean age: 36 years	G1 (*n*=68): Hard acrylic splint during sleep and 2 h during day + conservative self-care strategies G2 (*n*=68): Soft splint during sleep and 2 h during day + conservative self-care strategies G3 (*n*=64): Conservative self-care strategies	12 months	Pain Self-reported TMD symptoms Range of motion Joint sounds Muscle and TMJ palpation pain	G1=G2=G3 G1=G2=G3 G1=G2=G3 G1=G2=G3 G1=G2=G3	3
Conti *et al.*, 2006[23]	TMJ disc displacement and pain	*n*=60 (♂=5, ♀=55), mean age: 29.9 years	G1 (*n*=30): Balanced splint during sleep G2 (*n*=30): Canine guided splint during sleep G2 (*n*=30): Non-occluding splint during sleep	6 months	VAS Mandibular movements Joint sound Muscle tenderness	G1=G2>G3 G1=G2=G3 G1=G2=G3 G1=G2>G3	1
Bergue *et al.*, 2008[24]	MF/TMJP	*n*=51	G1 (*n*=27): Neuroreflexo therapy G2 (*n*=24): Placebo therapy	90 days	Pain Clicking in TMJ Evolution in the use of drug treatment and bite-raising appliance	G1>G2 G1=G2 G1>G2	5
Kurtoglu *et al.*, 2008[25]	MF pain with or without functional disc displacement	*n*=24 (♂=4, ♀=20), age: 16-53 years	G1 (*n*=12): Botulinum toxin A+saline G2 (*n*=12): Saline	28 days	EMG results Pain Disability Psychological status	G1>G2 G1=G2 G1=G2 G1=G2	5
Emshoff *et al.*, 2008[26]	TMJ pain	*n*=52, age: 18-58 years, mean age: 42.9 years	G1 (*n*=26): Low level laser therapy G2 (*n*=26): Placebo laser	8 weeks	VAS pain TMJ pain during function	G1=G2 G1=G2	5
Hiroaki Yoshida *et al.*, 2010[27]	TMJ closed lock	148 (♀=148), age: 19-75 years, mean age: 40 years	G1 (*n*=74): Mandibular condyle exercise G2 (*n*=74): No treatment	NA	MMO Maximum lateral movements on the unaffected side Lateral movements on the affected side Maximum protrusion	G1>G2 G1=G2 G1=G2 G1=G2	2
Birgitta Jahansson Cahlin *et al.*, 2011[28]	TMJ osteoarthritis	*n*=59 (♂=8, ♀=51)	G1 (*n*=10): Glucosamine sulfate G2 (*n*=10): Placebo capsules	6 weeks	VAS VRS Mouth opening with pain Mouth opening without pain	G1=G2 G1=G2 G1=G2 G1=G2	5
Craane B *et al.*, 2012[29]	TMJ ADDWOR	*n*=49	G1 (*n*=23): Physical therapy G2 (*n*=26): No treatment	52 weeks	MMO PPT VAS MFIQ	G1=G2 G1=G2 G1=G2 G1=G2	3
Ficnar *et al.*, 2013[30]	TMDs	*n*=63, median age: 34.66 years	G1 (*n*=21): Semi-finished occlusal splint to wear every night and 2 h during the day + self-exercises G2 (*n*=21): Laboratory-made occlusal splint to wear every night and 2 h during the day + self-exercises G3 (*n*=21) control group: Self-exercises	3 months	Pain-free active vertical movement Active mouth opening Extraoral muscle palpation and pressure sensitive areas	G1=G2>G3 G1>G2=G3 G1<G2=G3	2
Kurita Varoli *et al.*, 2015[31]	Chronic pain in masticatory muscles due to TMDs	*n*=18, age: 35-70 years, mean age: 50 years	G1 (*n*=6): NSAID treatment + flat occlusal splint throughout the day G2 (*n*=6): Panacea treatment + flat occlusal splint throughout the day G3 (*n*=6): Placebo treatment + flat occlusal splint throughout the day	10 days	VAS analysis 11-point numeric scale	G1=G2>G3 G1=G2>G3	3

Contd...

Table 1: Contd...

Author	Type of TMDs	Participants (P)	Intervention (I) and comparison (C)	Follow up	Measures	Outcome (O)	JADAD score
Fornaini *et al.*, 2015[32]	TMD pain	*n*=24 (♂=5, ♀=19), age 17-64 years	G1 (*n*=12): Real LLLT G2 (*n*=12): Inactive laser	2 weeks	VAS	G1>G2	1
Conti *et al.*, 2015[33]	TMJ DDWR and arthralgia	*n*=60	G1 (*n*=20): ARS + counseling G2 (*n*=20): NTI-tss + counseling G3 (*n*=20): Counseling only	3 months	Pain PPT Mandibular range of motion Frequency of joint sounds	G1=G2>G3 G1=G2=G3 G1=G2>G3 G1>G2<G3	2

TMJ: Temporomandibular joint; TMDs: Temporomandibular disorders; ADDWOR: Anterior disc displacement with reduction; MF: Myofascial; TMJP: TMJ pain; DDWR: Disc displacement with reduction; NTI-tss: Nociceptive Trigeminal Inhibition Clenching Suppression System devices; ARS: Anterior repositioning occlusal splints; LLLT: Low-level laser therapy; NSAID: Nonsteroidal anti-inflammatory drugs; CDS: Clinical Dysfunction Scorel; VAS: Visual analog scale; ssi: Symptom Severity Index; EMG: Electromyography; VRS: Verbal Rating Scale; MFIQ: Mandibular Function Impairment Questionnaire; DAL: Daily Activity Limitation, MMO: Maximum Mouth Opening, PPT: Pain Pressure Threshold

Meta-analysis of studies comparing two means – Pain

Five studies compared the various nonsurgical treatment modalities such as acupuncture therapy and occlusal splint therapy, self-relaxation exercises, glucosamine sulfate therapy, gallium-aluminum-arsenide (Ga-Al-As) diode laser therapy, and diclofenac sodium, along with the use of cold/hot packs, soft food diet, and gentle mouth-opening exercise without flat occlusal appliance. Their effectiveness in reducing pain was shown in Figure 3.

A study has proved that craniomandibular disorder pain can be reduced by the use of acupuncture and occlusal splint therapy within 6 months.[13] Medication like diclofenac 25 mg and self-care protocol are required to treat the patients with anterior disc displacement without reduction (ADDWOR).[19] However, it is remarkable that, within 3-month duration, education alone led to a positive outcome impression and can be a good start in treatment of myofascial pain of the jaw muscles.[20] Patients with TMJ osteoarthritis had a greater relief from initial pain with glucosamine sulfate 400 mg and also for placebo capsules.[28] Recently, with the use of Ga-Al-As diode laser therapy, TMD pain was extremely reduced in just 2 weeks.[32]

However, on the contrary, ADDWOR reduction patients did not benefit from taking diclofenac sodium 25 mg along with a flat occlusal appliance during sleeping[19] and also other type of lasers such as helium–neon laser was also not found effective in reducing TMJ pain.[26]

The mean difference between treatment and control group using forest plot associated with meta-analysis of combined studies was 0.5098 which was statistically significant at $P < 0.001$. This implied that the successful outcome of pain reduction occurred in the intervention group than in control group.

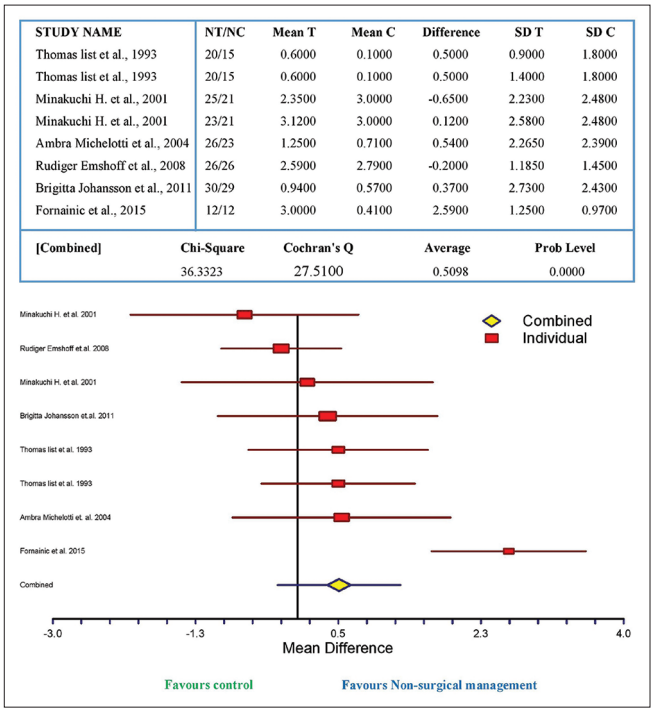


Figure 3: Meta-analysis of studies comparing two means - pain.

Meta-analysis of studies comparing two means – Maximal pain and free mouth opening

Nonsurgical treatment methods such as soft splint, palliative treatment, posture training, glucosamine sulfate 400 mg, ARS with counseling, and diclofenac sodium 25 mg, along with the use of cold/hot packs, soft food diet, gentle mouth-opening exercises, flat occlusal splint, and self-relaxation exercises, are presented in Figure 4 with the meta-analysis which evaluated the efficacy of these methods in producing pain-free maximal mouth opening.

Soft splints,[14] posture training, and TMD self-management instructions[17,20] aids in maximal pain-free mouth opening without producing occlusal changes in cases having masticatory muscle pain.[14]

Patients with ADDWOR benefited from using the combination of diclofenac sodium, self-care protocol along with wearing a flat occlusal splint for 8 weeks.[19] Other study suggested that, irrespective of the medication given, pain-free mouth opening was improved with time in TMJ osteoarthritis.[28] TMJ DDWR and arthralgia patients required the use of ARS to ameliorate the pain during mouth opening.[33]

However, other nonsurgical treatments using diclofenac sodium 25 mg and instructions for a self-care protocol for ADDWOR,[19] NTI-tss along with counseling in patients having TMJ DDWR and arthralgia,[33] and the use of physical therapy program on ADDWOR[29] did not show significant improvement in maximal active and passive mouth opening in the treated group, thus not favoring the case group.

Forest plot associated with meta-analysis of the studies combined showed the mean difference between treatment and control group as 2.0356 which was statistically significant at $P = 0.0138$. This confirmed that the successful outcome of increased pain-free maximal mouth opening was in the intervention group than the control group.

Meta-analysis of studies comparing two means – Level of dysfunction

The studies which allowed meta-analysis and data synthesis are presented in Figure 5 showing the improvement of clinical dysfunction score (CDS) level using various nonsurgical managements such as acupuncture therapy, occlusal splint therapy, soft splint, and palliative treatment consisting of applying moist heat or ice, eating soft diet, decreasing parafunctional habits and caffeine consumption, modifying sleeping posture, and using over-the-counter medications, iontophoretic treatments, diclofenac sodium 25 mg along with the use of cold/hot packs, a soft food diet, gentle mouth-opening exercises without the use of flat occlusal splint.

There is an evidence on the use of occlusal splint therapy to decrease the CDS in craniomandibular disorder patients.[13] The soft splint has the ability to decrease the Symptom Severity Index scores within 4–11 weeks in patients with masticatory muscle pain.[14]

TMJ DDWOR and TMJ capsulitis patients showed an improvement in the level of dysfunction within a week by the use of 0.5 ml of 0.4% dexamethasone sodium phosphate and 1 ml of 4% lidocaine hydrochloride.[15]

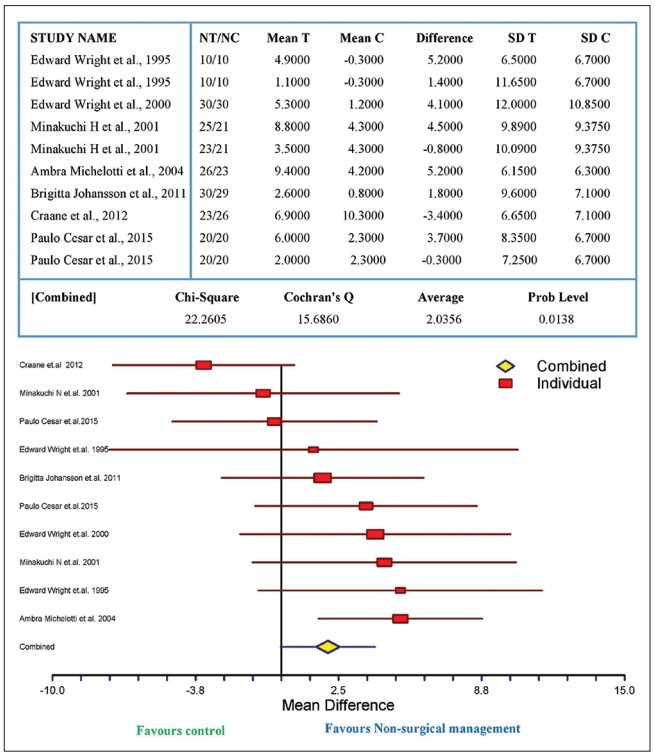


Figure 4: Meta-analysis of studies comparing two means - maximal pain-free mouth opening.

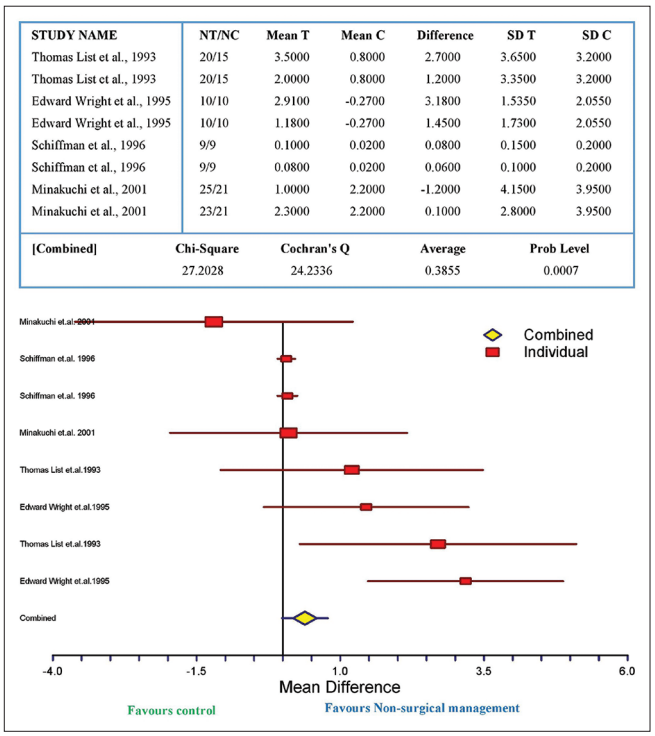


Figure 5: Meta-analysis of studies comparing two means - level of dysfunction.

On the other hand, ADDWOR cases showed no improvement in dysfunction level on using diclofenac sodium 25 mg, self-care protocol along with a flat

occlusal appliance when compared with control group, thus favoring the later.[19]

Using forest plot of meta-analysis of combined studies, the mean difference between treatment and control group was obtained as 0.3855 which was statistically significant at $P = 0.007$. This proved that the successful outcome of improving the level of dysfunction was in the intervention group than in control group.

Review of nonsurgical management that were not included in meta-analysis

Some of the studies in Table 1 could not be combined in meta-analysis due to differing study designs, interventions, and outcome assessed. However, the following nonsurgical treatments' modalities had its own benefits in TMD management.

While managing cases with TMJ disc displacement, balanced splint, canine-guided splint,[23] counseling,[11] adequate pain medication,[11,18] and physical therapy[18] improved the participant's pain. There was also a reduction in muscle tenderness in most of the muscle spots evaluated. Joint sounds, mandibular movements,[23] and discomfort in daily life[18] all seemed to have improved. It was also proved in a study that mandibular condylar exercise had an increased success rate in maximal mouth opening and was as beneficial in the long term as any of the surgical interventions, which supports the importance of rehabilitation treatments before surgical intervention for disc displacement of TMJ.[27] Hence, more aggressive treatment modalities should not be used in the initial phase for such patients.[11]

Studies on TMD showed that a single intra-articular injection of sodium hyaluronate offered clear and consistent benefit of markedly lower incidence of relapse along with improvement in objective dysfunction scores for at least 6 months.[12] The low-cost therapies such as self-care strategies[22] and self-exercises are as effective as that of more expensive splint-based therapy in terms of pain reduction, increased mouth opening,[30] and overall improvement and hence are preferable than the later for TMDs.[22] However, pulsed electromagnetic fields had no specific treatment effects in those patients.[21]

A study on myofascial pain with Myofacial pain with limited opening (MLO) proved that, in addition to the natural course of time, brief cognitive behavior intervention promotes faster rate of improvement[16] and in whom first-line conservative treatment had failed have also been benefited by the use of neuroreflexotherapy.[24] Another study on myofascial pain, with or without functional disc displacement, showed that the patient can achieve a positive effect in pain and psychological status using botulinum toxin A injection within a month.[25]

Recently, it has been proved in a study that, starting a treatment with occlusal splint associated with an adjuvant nonsteroidal anti-inflammatory for a period of 10 days could be very adequate for a chronic masticatory muscle pain.[31]

Methodological limitations

There are several weaknesses in this review that need to be considered. With any systematic review, the validity of results is based on the ability to include all published reviews, the potential biases, and the quality of the RCTs reviewed.

- Despite sincere attempt to include the majority of the published literature in both electronic and manual reviews, some relevant literature might have been missed
- The recent articles that have got published after the commencement of this review might have been missed. Another factor is that the outcome selected was subjective experience such as pain, PPT, and level of dysfunction which are influenced by the patient's experience and relationship to treatment providers. Furthermore, the measurements and its conversion to a comparable measure may have introduced bias into the meta-analysis
- Many other outcome measures including range of movements, deviation of jaw, joint noises, and adverse events were not included in many studies. Hence, the comparison of these outcomes was not possible.

CONCLUSION

From the results of meta-analysis, it can be concluded that nonsurgical treatment methods such as occlusal splints, pharmacological treatments, exercise, posture training, and low-level laser therapy showed evidence of pain improvement, maximal pain-free mouth opening, and a decrease in the level of dysfunction but failed to increase PPT level. Although this review and analysis points to using the simplest, least costly, nonsurgical treatments for the initial or concurrent management of TMDs to achieve a positive therapeutic effect, it is suggested that more studies with consistent methodology should be done for a

definitive conclusion of the efficacy of different types of appliances and their comparative effectiveness relative to other common TMD treatments.

Future perspectives

Subgroup analysis and investigation of heterogeneity

If future studies record sufficient explicit data, a subgroup analysis according to age, gender, and the degree of severity of TMDs can be conducted along with the investigation of heterogeneity.

Sensitivity analysis

In future, if there are sufficient trials, following sensitivity analyses to assess the robustness of their review results, this analysis can be repeated after the exclusion of lower quality trials. In addition, sensitivity analyses to examine the effect of allocation concealment, blinded outcome assessment, and completeness of follow-up can be done.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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APPENDIX

Appendix 1: QUOROM statement checklist

Heading	Subheading	Descriptor	Reported? (yes/no)	Page number
Title		Identify the report as a systematic review	Yes	1
Abstract		Use a structured format	Yes	1
	Objectives	The clinical question explicitly	Yes	1
	Data sources	The databases (i.e., list) and other information sources	Yes	1
	Review methods	The selection criteria (i.e., population, intervention, outcome, and study design); methods for validity assessment, data abstraction, and study characteristics, and quantitative data synthesis in sufficient detail to permit replication	Yes	1
	Results	Characteristics of the RCTs included and excluded; qualitative and quantitative findings (i.e., point estimates and confidence intervals); and subgroup analyses	Yes	1
	Conclusion	The main results	Yes	1
		Describe		
Introduction		The explicit clinical problem, biological rationale for the intervention, and rationale for review	Yes	2
Methods	Searching	The information sources, in detail (e.g., databases, registers, personal files, expert informants, agencies, and hand-searching), and any restrictions (years considered, publication status, and language of publication)	Yes	2
	Selection	The inclusion and exclusion criteria (defining population, intervention, principal outcomes, and study design)	Yes	2
	Validity assessment	The criteria and process used (e.g., masked conditions, quality assessment, and their findings)	Yes	2
	Data abstraction	The process or processes used (e.g., completed independently, in duplicate)	Yes	2
	Study characteristics	The type of study design, participant's characteristics, details of intervention, outcome definitions, and how clinical heterogeneity was assessed	Yes	2
	Quantitative data synthesis	The principal measures of effect (e.g., relative risk), method of combining results (statistical testing and confidence intervals), handling of missing data; how statistical heterogeneity was assessed; a rationale for any *a priori* sensitivity and subgroup analyses; and any assessment of publication bias	Yes	2
Results	Trial flow	Provide a meta-analysis profile summarizing trial flow [Flowchart 1]	Yes	3
	Study characteristics	Present descriptive data for each trial (e.g., age, sample size, intervention, dose, duration, and follow-up period)	Yes	4-6
	Quantitative data synthesis	Report agreement on the selection and validity assessment; present simple summary results (for each treatment group in each trial, for each primary outcome); present data needed to calculate effect sizes and confidence intervals in intention-to-treat analyses (e.g., 2×2 tables of counts, means and SDs, and proportions)	Yes	3, 6-7
Discussion		Summarize key findings; discuss clinical inferences based on internal and external validity; interpret the results in light of the totality of available evidence; describe potential biases in the review process (e.g., publication bias); and suggest a future research agenda	Yes	8-9

SD: Standard deviation; RCTs: Randomized controlled trials