Systematic review
http://dx.doi.org/10.1590/1678-7757-2022-0298

JAOS
JOURNAL OF APPLIED ORAL SCIENCE

Are exercises with or without occlusal splints more effective in the reduction of pain in patients with temporomandibular disorders of myogenic origin? A systematic review

Jessica Fernanda de Oliveira Lima BATISTA[1]
Taciana Emília Leite VILA-NOVA[2]
Sandra Lúcia Dantas MORAES[2]
Eduardo Piza PELLIZZER[3]
Belmiro Cavalcanti do Egito VASCONCELOS[4]
Jéssica Marcela de Luna GOMES[5]
Cleidiel Aparecido Araújo LEMOS[6]
Mônica Vilela HEIMER[7]

Abstract

Temporomandibular disorders (TMD) is a term used to describe a set of clinical conditions that may compromise the temporomandibular joint (TMJ) and masticatory muscles and/or associated structures, considered the most frequent cause of orofacial pain of non-dental origin. In recent years, many forms of physical therapy have been used in the treatment of TMD to reduce pain and improve the range of mandibular movement present in this impairment. Among these resources are kinesiotherapy (exercise), electrothermal and manual therapy, acupuncture, training posture, mobilizations, and biofeedback. Objectives: To determine if exercises with or without occlusal splints are effective in reducing pain in patients with temporomandibular disorders (TMD) of myogenic origin. Methodology: This systematic review was registered in the International Prospective Register of Systematic Reviews (CRD 42019134244). Controlled trials published in PubMed, Scopus, and Cochrane Library following PRISMA guidelines up to April 2022 were randomized and included. The population above 18 years, which evaluated the effectiveness of exercise with or without occlusal splints in reducing pain in patients with TMD of myogenic origin, diagnosed through the Research Diagnostic Criteria for Temporomandibular Disorders, was also included. There was no restriction on the period of publication. Cochrane risk of bias analysis was performed. Results: Of the five included articles, all showed a reduction of pain, but without significant differences between the interventions performed. Additionally, studies that evaluated the quality of life and mandibular movements showed a reduction in pain, but no significant differences between therapies. Conclusion: The analyzed studies showed no difference in the improvement of pain, quality of life, and mandibular movements between the groups that performed only exercises or the associated treatments.

Keywords: Temporomandibular joint dysfunction syndrome. Occlusal splints. Physical therapy.

Received: August 2, 2022
Revised: November 8, 2022
Accepted: November 30, 2022

Corresponding address:
Sandra Lucia Dantas de Moraes
Universidade de Pernambuco (UPE) - Faculdade de Odontologia - Departamento de Reabilitação Oral - Recife - Brasil. Av. Governador Agamenon Magalhães - SN - Santo Amaro - 50100-010 - Recife - PE - Brasil.
Phone: +55(81) 988506972
e-mail: sandra.moraes@upe.br

[1]Universidade de Pernambuco (UPE), Faculdade de Odontologia, Santo Amaro, Recife, PE, Brasil.
[2]Universidade de Pernambuco (UPE), Faculdade de Odontologia, Departamento de Reabilitação Oral, Santo Amaro, Recife, PE, Brasil.
[3]Universidade Estadual Paulista (UNESP), Faculdade de Odontologia de Araçatuba, Departamento de Materiais Dentários e Prótese Dentária, Araçatuba, SP, Brasil.
[4]Universidade de Pernambuco (UPE), Faculdade de Odontologia da Recife, Departamento de Cirurgia Bucomaxilofacial da Pernambuco, Santo Amaro, Recife, PE, Brasil.
[5]Centro Universitário FACOL-UNIFACOL, Vitória de Santo Antão, PE, Brasil.
[6]Universidade Federal de Juiz de Fora, Departamento de Odontologia, Campus Governador Valadares, Governador Valadares, MG, Brasil.
[7]Universidade de Pernambuco (UPE), Faculdade de Odontologia, Departamento de Odontopediatria, Santo Amaro, Recife, PE, Brasil.

Introduction

Temporomandibular disorders (TMD) is a term used to describe a set of clinical conditions that may compromise the temporomandibular joint (TMJ) and masticatory muscles and/or associated structures,[1-3] considered the most frequent cause of orofacial pain of non-dental origin.[3,4] The signs and symptoms of TMD are sensitivity to palpation of the masticatory muscles, pain, restrictions of joint movement, noise in the temporomandibular joint (TMJ) headache, and tinnitus, among others.[4,6-9]

While TMD is uncommon in childhood, its prevalence increases in adolescence and young adulthood, affecting people mainly in the age range of 20 to 40 years. Females are the most affected, presenting greater symptom severity and experiencing more difficult recoverying.[7,8] Its etiology is multifactorial, involving genetic, individual, and environmental factors. Studies showed that increased stress is associated with the appearance of muscular tension, which affects the functioning of the stomatognathic system and TMJ.[8,10]

TMD is a multifactorial pathogenesis, and its treatment must be interdisciplinary, combining a conservative approach, cognitive behavioral therapy, physical therapy, and pharmacology intraoral devices where applicable.[11] Occlusal splints (OS), which promotes the relaxation of the masticatory muscles, has been widely used aiming to restore neuromuscular balance. Moreover, it repositions the mandibular condyles and normalizes the proprioception of the periodontal ligament, providing a correct alignment of the temporomandibular joint. Such removable device is made of acrylic resin with polymer and can be used during the day or at night.[3,5,13-16]

In recent years, many forms of physical therapy have been used in the treatment of TMD to reduce pain and improve the range of mandibular movement present in this impairment. Although the literature lacks consensus on the best treatment for this disorder, some therapies such as kinesiotherapy (exercise), electrothermal and manual therapy, acupuncture, training posture, mobilizations, and biofeedback can be used in the management of TMD.[6,7,11,17]

Orofacial exercises have been one of the main interventions in the management of TMD. Aiming to promote the proper functioning of the cranio-cervico-mandibular region, strength, mobility, coordination, the relaxation of the jaw muscles, the increase of range of motion of the TMJ, proprioception, and muscle relaxation, this intervention brings positive effects on pain. The exercises must be part of an individualized program, in addition to the need for verbal and written instructions.[18,19,20]

This study aimed to perform a systematic review of the literature to verify if exercises with or without the OS are effective in the reduction of pain in patients with TMD of myogenic origin. The hypothesis of the study is the physical therapy exercises associated with the occlusal splint are more effective in the treatment of pain in myofascial TMD.

Methodology

Protocol and registration

This systematic review was conducted based on studies published in PubMed, Scopus, and Cochrane Library that followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) guidelines[21] and were registered in PROSPERO under protocol No. CRD 42019134244.

Eligibility criteria

The problem, intervention/indicator, comparison, and outcome of interest (PICO) question guiding this study was the following: *"Are exercises with or without the OS effective in reducing pain in patients with TMD of myogenic origin?"* Here, "P" was "patients with TMD of myogenic origin"; "I" was "physical therapy exercises"; "C" was "use of the OS + physical therapy exercises"; and "O" was "pain assessment (primary) and quality of life and mandibular movements (secondary)."

Inclusion criteria

Randomized clinical trials published up to April 2022 with a population above 18 years, which evaluated the effect of exercise with or without occlusal splints (made of acrylic) in the reduction of pain in patients with TMD of myogenic origin, diagnosed using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), were included. There was no restriction on the period of publication.

Exclusion criteria

Studies that used other tools for TMD diagnosis,

assessed TMD unrelated to muscle origin, or included patients with diseases that could affect masticatory muscles or the TMJ, were excluded.

Search strategy

Two authors (JFOLB and JMLG) independently performed the electronic search in the databases PubMed/MEDLINE, Cochrane Library, and SCOPUS. The keywords and MeSH descriptors were combined with Boolean operators for each database, as in Figure 1. A manual search was performed in the references of the articles included and in journals in the field of pain, rehabilitation, and temporomandibular dysfunction: "Head & Face Medicine," "The Journal of Pain," and "Journal of Oral Rehabilitation."

Study selection

The selection process was conducted in two phases. In the first phase, two independent evaluators (JFOLB and JMLG) read the titles and summaries of the studies identified in the databases searched. Studies that did not meet the inclusion criteria were discarded. In the second phase, the same researchers applied the eligibility criteria to the full text of the articles. During the searches, disagreements were resolved by a third reviewer (MVH).

Inter-examiner evaluation (kappa test) was performed to verify the level of agreement between the

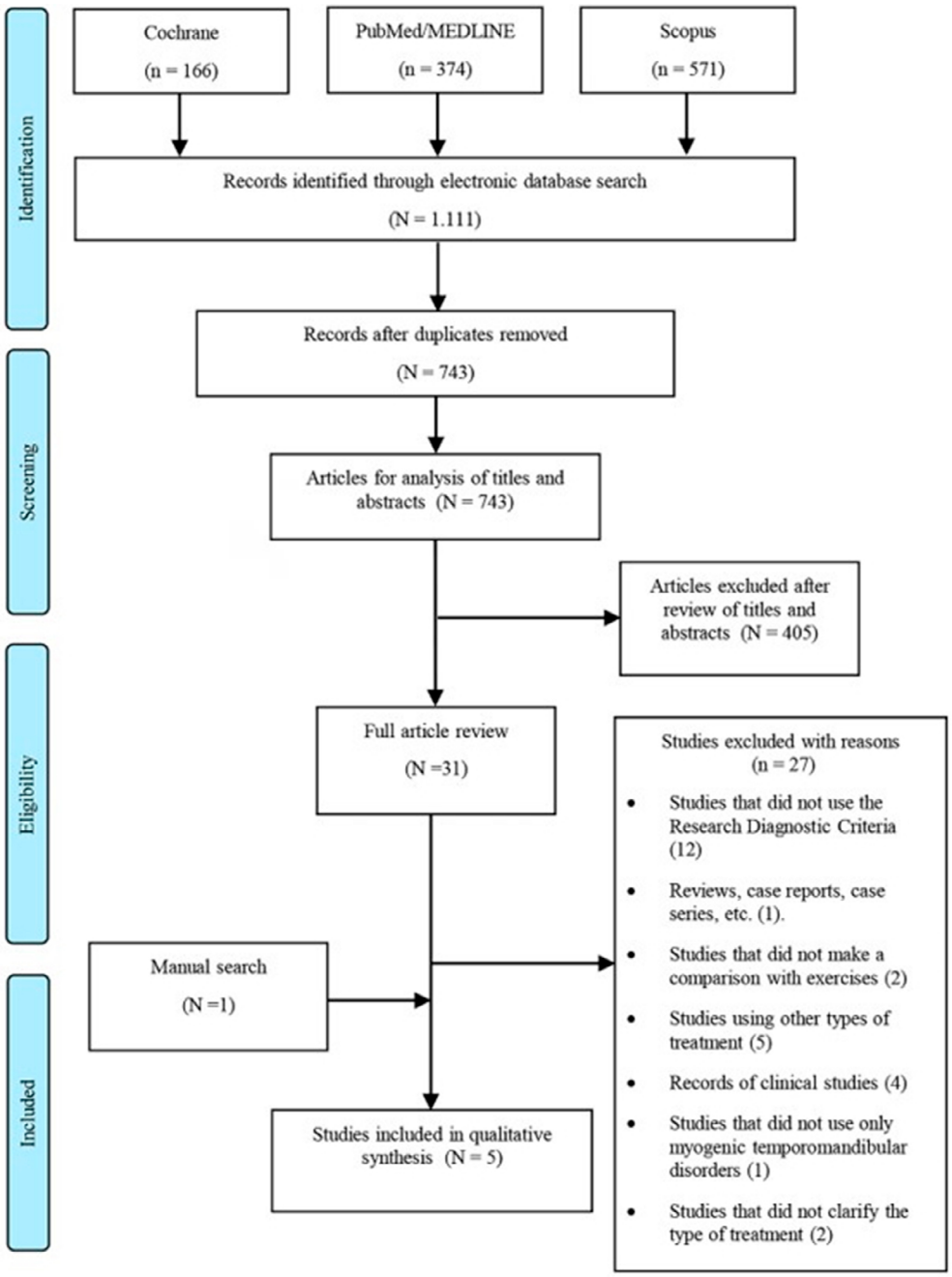

Figure 1- PRISMA flow diagram of study selection

authors during the search and selection of the articles.

Data collection

One author (JFOLB) collected the relevant data from the articles, which were then verified by two other authors (JMLG and MVH). The qualitative data collected included author/year/country, study design, follow-up, age group, intervention (types of exercises, habit counseling, and occlusal splints), assessment instrument for pain outcome, results (pain, quality of life, and mandibular movements), conclusion, and effect.

Risk of bias

The bias risk analysis was performed by two independent authors (BCEV and SLDM) using the Cochrane risk of bias tool. For each manuscript, the items' allocation confidentiality, the possibility of randomization, blinding, and patient loss were examined. Finally, the studies were categorized according to the level of risk of bias as "low," "medium," or "high".

Results

Selection of studies

The database search yielded a total of 1.111 studies in the databases as follows: 374 Pubmed/ MEDLINE, 166 Cochrane Library, and 571 SCOPUS. After the exclusion of duplicated studies (368), 743 studies were evaluated through the reading of titles and abstracts. Among the 31 articles remaining for full-text evaluation, after applying the eligibility criteria, 27 were excluded for several reasons. Manually searching, we found one article that met the inclusion criteria. Finally, five articles were part of the data extraction and qualitative synthesis. Figure 2 shows the process of identification, inclusion, and exclusion of studies.

The inter-examiner test (kappa) showed "moderate" to "almost perfect" agreement according to the criteria (K=0.88) for each database.

Characteristics of the studies

Figure 3 summarizes the articles, highlighting the authors, year of publication, country of origin, age group, sample, follow-up, intervention, assessment instrument for pain outcome, results, and conclusion. As for the temporal distribution, studies were conducted in 2012,[22] 2013,[21] 2015,[22] 2017,[27] and 2018.[24] Regarding geographic distribution, one study was conducted in Brazil, while the others were conducted in Finland,[20,24] the Netherlands,[27] and India.[21] The age range of the study populations was broad, covering both young and adults.[20,21,22,24,27]

The follow-up period varied among the studies: one month,[20] five months,[22] six months,[21] and one year.[24] In one study,[27] the follow-up time, dependent on the rate of symptom improvement, differed for each patient. Regarding the treatments performed, four studies associated exercise with occlusal splints,[20-22,24] and only one study[27] used separate therapies and compared the groups. Additionally, all studies[20-22,24] included advice on parafunctional habits, diet, and pain management.

In our review, we found that there was a reduction in pain between the initial assessment and after the

Database	Search strategy	Filters
Pubmed/ MEDLINE	((“temporomandibular joint dysfunction syndrome” [MeSH Terms] OR (“temporomandibular” [All Fields] AND “joint” [All Fields] AND “dysfunction” [All Fields] AND “syndrome” [All Fields]) OR “temporomandibular joint dysfunction syndrome” [All Fields]) OR (“temporomandibular joint dysfunction syndrome” [MeSH Terms] OR (“temporomandibular” [All Fields] AND “joint” [All Fields] AND “dysfunction” [All Fields] AND “syndrome” [All Fields]) OR “temporomandibular joint dysfunction syndrome” [All Fields] OR (“tmj” [All Fields] AND “syndrome” [All Fields]) OR “tmj syndrome” [All Fields]) OR (“temporomandibular joint dysfunction syndrome” [MeSH Terms] OR (“temporomandibular” [All Fields] AND “joint” [All Fields] AND “dysfunction” [All Fields] AND “syndrome” [All Fields]) OR “temporomandibular joint dysfunction syndrome” [All Fields] OR (“temporomandibular” [All Fields] AND “joint” [All Fields] AND “syndrome” [All Fields]) OR “temporomandibular joint syndrome” [All Fields])) AND ((“occlusal splints” [MeSH Terms] OR (“occlusal” [All Fields] AND “splints” [All Fields]) OR “occlusal splints” [All Fields]) OR (“occlusal splints” [MeSH Terms] OR (“occlusal” [All Fields] AND “splints” [All Fields]) OR “occlusal splints” [All Fields] OR (“occlusal” [All Fields] AND “splint” [All Fields]) OR “occlusal splint” [All Fields])).	no
SCOPUS	(TITLE-ABS-KEY ("temporomandibular joint dysfunction syndrome") OR TITLE-ABS-KEY (tmj) OR TITLE-ABS-KEY ("tmj syndrome") AND TITLE-ABS-KEY ("occlusal splint") OR TITLE-ABS-KEY ("occlusal splints"))	No
Cochrane	temporomandibular joint dysfunction syndrome OR tmj OR tmj syndrome in All Text AND occlusal splint OR occlusal splints in All Text	Trials

Figure 2- Search strategy for each database

AUTHOR, YEAR, COUNTRY	STUDY DESIGN	FOLLOW-UP	AGE	INTERVENTION	RESULTS	CONCLUSION	EFFECT
Niemelä, et al.[23] (2012) Finland	Start: SG: 39 CG: 41	One month: SG: 39 CG: 37	> 20 years	SG: splint + counseling + exercises CG: counseling + exercises	The SG showed improvement in mandibular movements. Pain on palpation increased in the GP while it decreased in the CG, but the difference in change of any of the variables between groups was not statistically significant (p = 0.05).	The study did not demonstrate that splint treatment in combination with exercise has a greater benefit in relieving facial pain and increasing joint mobility when compared to only exercise over a short period.	NONE
Katyayan, et al.[24] (2013) Índia	Start: SG: 40 CG:40	Six month SG: 40 CG: 40	20-56 years	SG: splint + counseling + exercises CG: counseling + exercises	The SG and the CG showed a statistically significant reduction in pain and in the number of painful sites after 6 months of treatment. The GP had greater pain reduction when compared to the CG after treatment, but this measure was not statistically significant.	The results showed that there is no additional benefit of performing the treatment with occlusal splint + exercises + counseling in relieving pain in TMD of myogenic origin when compared to the treatment with exercises and counseling in a period of 6 months.	NONE
Costa, et al.[25] (2015) Brazil	Start: SG: 30 CG: 30	Five month: SG: 24 CG: 17	18-50 years	SG: splint + counseling + exercise instructions CG: counseling + exercise instructions	There was a significant reduction in headache intensity for both groups between onset and after two and five-month follow-ups (p < 0.001). There was no difference in the reduction of pain intensity between two and five months both within and across groups.	In patients with headache attributed to TMD, counseling was effective in improving pain, but the addition of the occlusal appliance did not offer an additional therapeutic effect.	NONE
Van Grootel, et al.[26] (2017) Holand	Start: SG: 35 CG: 37	The follow-up time was individual and depended on the success of the treatment.	Two groups: ≤ 32 years ≥ 32 years	SG: splint + counseling CG: counseling + exercise instructions Additional groups Physiotherapy possibly followed by splint therapy Success rate: 80.4% (m=1) 65.7% (m= 0.5)	Pain intensity between the baseline and last after-treatment measurement decreased, being lower for CG patients than SG patients.	Occlusal splint therapy and physical therapy have similar efficacies. The association of therapy do not promoted statistical difference.	NONE
Kokkola, et al.[27] (2018) Finland	Start: SG: 35 CG: 32	One year: SG: 29 CG: 14	≥ 20 years	SG: splint + counseling + exercise instructions CG: counseling + exercise instructions	There was no difference between the groups regarding the quality of life related to oral health (QLROH during follow- up. After one year, the facial pain and discomfort when feeding reduced.	There was improvement in the QLROH during one year of follow-up, regardless of the treatment performed, in terms of physical pain and psychological discomfort.	NONE

Figure 3- Characteristics of included studies

intervention, but no significant difference regarding whether the studies used the occlusal splints with exercises[20-22,24] or isolated therapies.[27] Only one study[24] evaluated the quality of life related to oral health (QLROH), observing an improvement in the dimensions of physical capacity and eating discomfort, regardless of the treatment used. Niemelä, et al.[22] (2012) and Katyayan, et al.[21] (2013) evaluated mandibular movements and reported that the splints treatment was not more effective than exercises for increased mandibular mobility.

Risk of bias

All included studies were classified as low risk of bias according to the Cochrane risk of bias tool,[27] although none of them met all the criteria for methodological quality since some information was unclear. Figure 4 shows a graph on the risk of bias and Figure 5 shows a more detailed analysis of each study.

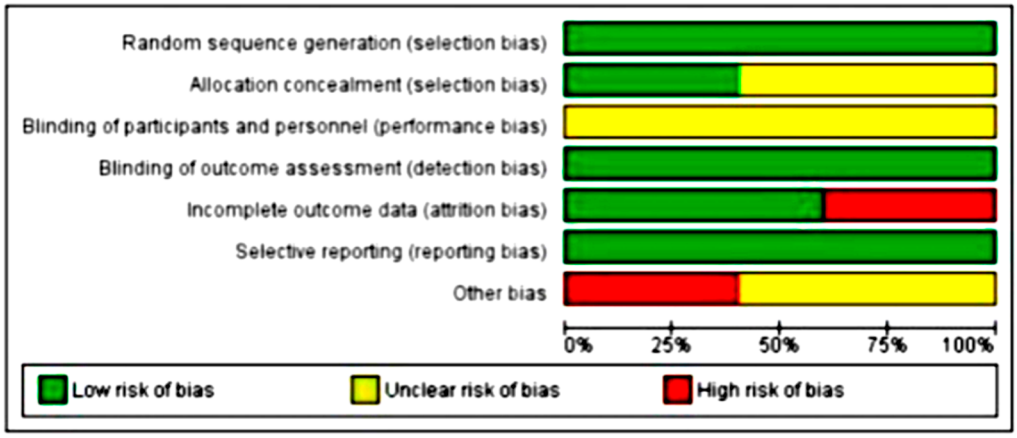

Figure 4- Risk of bias assessed by the Cochrane risk of bias tool

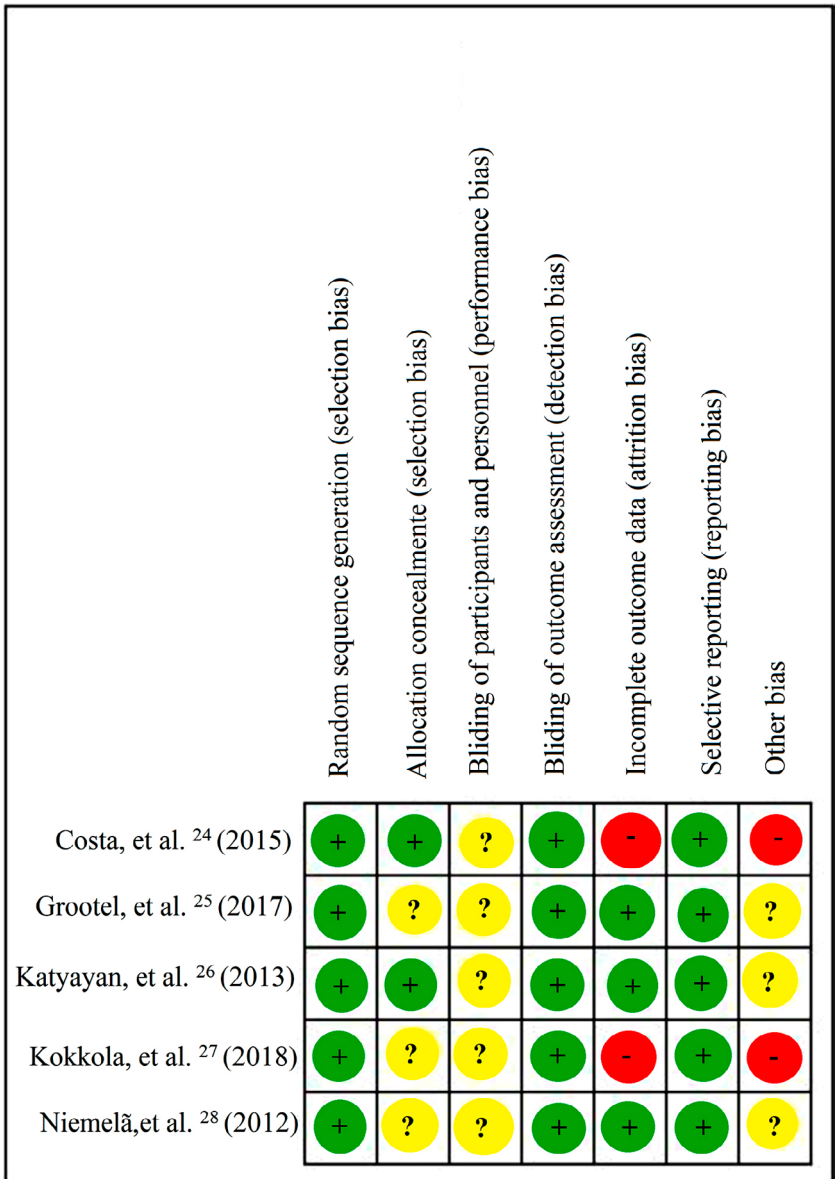

Figure 5- Risk of bias assessed by the Cochrane risk of bias tool

Discussion

This study aimed to verify whether exercises alone or associated with occlusal splints are effective in reducing pain in patients with TMD of myogenic origin. Therefore, RDC/TMD was used as the inclusion criterion, since it is considered the gold standard for diagnosis of TMJ dysfunction and is the protocol used

over the diagnosis.[27,28] The OS used in studies[22-26] was made from heat-cured acrylic. According to Conti, et al.[12] (2012) the occlusal splints promotes central, peripheral, and behavioral changes, reduces muscle activity, and improves occlusal stability. Melo, et al.[16] (2020) also states that OS restores neuromuscular balance by promoting balanced condylar contact of the TMJ.

Regarding the protocol of splints use, patients were instructed to use it overnight, except for one study that advised that the splints should be used as long as possible or for at least 10-12 hours at night.[29] Deregibus, et al.[3] (2021), in their randomized clinical trial (RCT), guided participants to use it at night, for at least 8 hours, while Melo, et al.[16] (2020) stated that OS can be used in the morning or at night, depending on the patient's clinical condition, which must be analyzed by a specialist. We should note that the Finnish guidelines recommend that splints should be used at night because it is uncomfortable to use during the day owing to work activities, school, and feeding.[30] However, the literature lacks consensus about the optimal period and time of occlusal splints usage.

Regarding the exercises used, Kokkola, et al.[26] (2018), Niemelä, et al.[22] (2012) and Katyayan, et al.[23] (2013) implemented the protocol proposed by Carlsson and Magnusson[30] (1999). This program consists of mouth opening, lateralization, and protrusion, actively and with maximum maintenance of the positions for a few seconds; it is, essentially, exercises that incorporate resistance from the patient's fingers. These exercises are repeated from seven to ten times and performed two to three times per day. Costa, et al.[24] (2015) used stretching and elongation exercises three to five times per second. Already Van Grootel, et al.[25] (2017) performed the Jacobson method, which promoted the relaxation of the mandible muscles in addition to stretching, mandibular movement, and self-massage.

Fernández-de-las-Peñas and Piekartz[31] (2020) state that mandibular exercises should be individualized aiming to improve muscle coordination, increase the range of motion, and relax strained muscles. There is no standardization of the exercises used to treat TMD, as to patient compliance with therapy, appropriate dosage, and exercise frequency. Despite this, it is possible to compare studies because of commonalities regarding relaxation, active movements, and stretching.

A common point in all studies[22-26] was the use of guidelines, advice, and instructions on the etiology and prognosis of the disease, diet, and parafunctional habits to avoid. Costa, et al.[24] (2015) stressed the importance of sleep hygiene and the application of hot cushions on painful muscles. They also stated that counseling and behavioral changes were effective in relieving headaches attributed to TMD because the use of the occlusal splints did not offer any additional therapeutic effect. This reinforces the need for a more comprehensive protocol, involving professional intervention as well as counseling strategies and behavioral changes since these approaches are reported to be a valuable tool for the management of myofascial pain.[12] Studies observed that patients with masticatory muscular pain have alterations in respiratory patterns, depression, and sleep disorders. Therefore, interventions that address bio-behavioral strategies, alone or in combination with other therapies, could help alleviate pain.[31,32]

The studies combining OS and exercises, making a comparison with only exercises,[22-24,26] as well as the study comparing individual therapies, that is, only the OS compared with exercises,[25] concluded that the treatments were effective in improving pain. However, no significant difference was observed between the treatment group and control groups.[22-26] We should highlight that OS and exercise therapy have similar success rates,[18] with their efficacy being confirmed through follow-ups.[28] Therefore, according to Van Grootel, et al.[25] (2017) the key to the choice of treatment is patient compliance and preference.

The impact of pain on the quality of life in patients with TMD was assessed only by Kokkola, et al.[26] (2018), who found that although the patients experienced an improvement in physical pain and discomfort when eating, no difference was observed between the interventions (OS and exercises vs exercises). However, TMD-related pain has a greater impact on QLROH than dental problems, and it is also known that patients with TMD suffer more, especially regarding the physical pain of TMD.[33,34]

Mandibular movements were evaluated by Niemelä, et al.[22] (2012) who observed improvement after one month of treatment. However, there was no difference between the interventions performed (exercises + orientation vs OS + exercises + orientation). The improvement in movements was achieved in both groups and cannot be attributed only to the OS.

Therefore, the improvement was more likely achieved because of the information received and the positive effects of both treatment methods used. The author also reported an adverse effect—increased pain upon palpation—in the splints group.

Katyayan, et al.[23] (2013) also observed an improvement in mandibular movements between the beginning and after six months of treatment, but no significant difference between the groups. The author also emphasizes the need for further studies with sufficient sample sizes to assess the effectiveness of treatment with an occlusal splints on symptoms in TMD of myogenic origin.

Some methodological limitations in the included studies are that the samples were patients who intentionally sought treatment or who had been referred from orofacial pain centers. Additionally, the studies did not use the same treatment protocol for both exercise and splints use. Because of the heterogeneous nature of the data, which made quantitative synthesis difficult, performing a meta-analysis was impossible.

Conclusion

The analyzed studies showed no difference in the improvement of pain, quality of life, and mandibular movements between the groups that performed only exercises or the associated treatments. Due to the heterogeneity of the studies analyzed, further research is needed.

Acknowledgements

This study was conducted with the support of the Coordination of Higher Education and Graduate Training – Brasil (CAPES) – Financial Code 001.

Conflict of interest

The authors declare no conflict of interest.

Data availability statement

All data generated and analyzed during this study are included in this published article.

Authors' contributions

Batista, Jessica: Conceptualization (Equal); Data curation (Equal); Formal analysis (Equal); Investigation (Equal); Methodology (Equal); Writing – original draft (Equal). **Vila-Nova, Taciana:** Methodology (Equal); Writing – review & editing (Equal). **Moraes, Sandra Dantas:** Writing – review & editing (Equal). **Pellizzer, Eduardo Piza:** Writing – review & editing (Equal). **Vasconcelos, Belmiro:** Writing – review & editing (Equal). **Gomes, Jéssica Luna:** Data curation (Equal); Methodology (Equal); Writing – review & editing (Equal). **Lemos, Cleidiel Aparecido:** Writing – review & editing (Equal). **Heimer, Mônica Vilela:** Conceptualization (Equal); Data curation (Equal); Formal analysis (Equal); Project administration (Equal).

References

1- Özkan F, Özkan NC, Erkorkmaz Ü. Trigger point injection therapy in the management of myofascial temporomandibular pain. Agri. 2011;23(3):119-25. doi: 10.5505/agri.2011.04796

2- American Academy of Orofacial Pain. What is orofacial pain? [internet]. Oceanville, NJ: AAOP; 2015 [cited April 16, 205]. Available from: https://aaop.clubexpress.com/content.aspx?page_id=22&club_id=508439&module_id=107327

3- Deregibus A, Ferrillo M, Piancino MG, Domini MC, De Sire A, Castroflorio A. Are occlusal splints effective in reducing myofascial pain in patients with muscle-related temporomandibular disorders? A randomized-controlled trial. Turk J Phys Med Rehabil. 2021;67(1):32-40. doi: 10.5606/tftrd.2021.6615

4- Alves GA, Gondim YR, Lima JA, Silva MA, Florêncio DS, Almeida LN, et al. Effects of photobiomodulation associated with orofacial myofactional therapy on temporomandibular joint dysfunction. Codas. 2021;33(6):e20200193. doi: 10.1590/2317-1782/20202020193

5- Gomes CA, Politti F, Andrade DV, Souza DF, Herpich MC, Dibai-Filho AV, et al. Effects of massage therapy and occlusal splint therapy on mandibular range of motion in individuals with temporomandibular disorder: a randomized clinical trial. J Manipulative Physiol Ther. 2014;37:164-9. doi: 10.1016/j.jmpt.2013.12.007

6- Stechman-Neto J, Porporatti AL, Toledo IP, Costa YM, Conti PC, Canto GL, et al. Effect of temporomandibular disorder therapy on otologic signs and symptoms: a systematic review. J Oral Rehabil. 2016;43(6):468-79. doi: 10.1111/joor.12380

7- Sobral AP, Godoy CL, Fernandes KP, Bussadori SK, Ferrari RA, Horliana AC, et al. Photomodulation in the treatment of chronic pain in patients with temporomandibular disorder: protocol for cost-effectiveness analysis. BMJ Open. 2018;8(5):e018326. doi: 10.1136/bmjopen-2017-018326

8- Bilici IŞ, Emes Y, Aybar B, Yalçın S. Evaluation of the effects of occlusal splint, trigger point injection and arthrocentesis in the treatment of internal derangement patients with myofascial pain disorders. J Craniomaxillofac Surg. 2018;46:916-22. doi: 10.1016/j.jcms.2018.03.018

9- Kütük SG, Özkan Y, Kütük M, Özdaş T. Comparison of the efficacies of dry needling and botox methods in the treatment of myofascial pain syndrome affecting the temporomandibular joint. J Craniofac Surg. 2019;30(5):1556-9. doi: 10.1097/SCS.0000000000005473

10- Pihut ME, Margielewicz J, Kijak E, Wiśniewska G. Evaluation of articular disc loading in the temporomandibular joints after prosthetic and pharmacological treatment in model studies. Adv Clin Exp Med. 2017;26:455-60. doi: 10.17219/acem/62216

11- Madani AS, Mirmortazavi A. Comparison of three treatment options for painful temporomandibular joint clicking. J Oral Sci. 2011;53:349-54. doi: 10.2334/josnusd.53.349

12- Conti PC, Alencar EN, Mota Corrêa AS, Lauris JR, Porporatti AL, Costa YM. Behavioural changes and occlusal splints are effective in the management of masticatory myofascial pain: a short-term evaluation. J Oral Rehabil. 2012;39:754-60. doi: 10.1111/j.1365-2842.2012.02327.x

13- Ekberg E, Sabet ME, Petersson A, Nilner M. Occlusal appliance therapy in a short-term perspective in patients with temporomandibular disorders correlated to condyle position. Int J Prosthodont. 1998;11:263-8.

14- Okeson JP. Occlusal appliance therapy: management of temporomandibular disorders and occlusion. St Louis: Mosby; 2003.

15- Torii K, Chiwata I. Relationship between habitual occlusal position and flat bite plane induced occlusal position in volunteers with and without temporomandibular joint sounds. Cranio. 2005;23:16-21. doi: 10.1179/crn.2005.004

16- Melo RA, Resende CM, Rêgo CR, Bispo AS, Barbosa GA, Almeida EO. Conservative therapies to treat pain and anxiety associated with temporomandibular disorders: a randomized clinical trial. Int Dent J. 2020;70(4):245-53. doi: 10.1111/idj.12546

17- Al-Moraissi EA, Conti PC, Alyahya A, Alkebsi K, Elsharkawy A, Christidis N. The hierarchy of different treatments for myogenous temporomandibular disorders: a systematic review and network meta-analysis of randomized clinical trials. Oral Maxillofac Surg. 2022;26(4):519-33. doi: 10.1007/s10006-021-01009-y

18- Idáñez-Robles AM, Obrero-Gaitán E, Lomas-Vega R, Osuna-Pérez MC, Cortés-Pérez I, Zagalaz-Anula N. Exercise therapy improves pain and mouth opening in temporomandibular disorders: a systematic review with meta-analysis. Clin Rehabil. 2022:2692155221133523. doi: 10.1177/02692155221133523

19- Dickerson SM, Weaver JM, Boyson AN, Thacker JA, Junak AA, Ritzline PD, et al. The effectiveness of exercise therapy for temporomandibular dysfunction: a systematic review and meta-analysis. Clin Rehabil. 2017;31(8):1039-48. doi: 10.1177/0269215516672275

20- Geneen LJ, Moore RA, Clarke C, Martin D, Colvin LA, Smith BH. Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews. Cochrane Database Syst Rev. 2017;4(4):CD011279. doi: 10.1002/14651858.CD011279.pub3

21- Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7):e1000097. doi: 10.1371/journal.pmed.1000097

22- Niemelä K, Korpela M, Raustia A, Ylöstalo P, Sipilä K. Efficacy of stabilization splint treatment on temporomandibular disorders. J Oral Rehabil. 2012;39:799-804. doi: 10.1111/j.1365-2842.2012.02335.

23- Katyayan PG, Katyayan MK, Shah RJ, Patel G. Efficacy of appliance therapy on temporomandibular disorder related facial pain and mandibular mobility: a randomized controlled study. J Indian Prosthodont Soc. 2013;14(3):251-61. doi: 10.1007/s13191-013-0320-4

24- Costa YM, Porporatti AL, Stuginski-Barbosa J, Bonjardim LR, Speciali JG, Conti PC. Headache attributed to masticatory myofascial pain: clinical features and management outcomes. J Oral Facial Pain Headache. 2015;29:323-30. doi: 10.11607/ofph.1394

25- Van Grootel RJ, Buchner R, Wismeijer D, van der Glas HW. Towards an optimal therapy strategy for myogenous TMD, physiotherapy compared with occlusal splint therapy in an RCT with therapy-and-patient-specific treatment durations. BMC Musculoskelet Disord. 2017;18:76. doi: 10.1186/s12891-017-1404-9

26- Kokkola O, Suominen AL, Qvintus V, Myllykangas R, Lahti S, Tolvanen M, et al. Efficacy of stabilization splint treatment on the oral health-related quality of life-a randomised controlled one-year follow-up trial. J Oral Rehabil. 2018;45:355-62. doi: 10.1111/joor.12622

27- Carvalho AP, Silva V, Grande AJ. Avaliação do risco de viés de ensaios clínicos randomizados pela ferramenta da colaboração Cochrane. Diagn Tratamento. 2013;18:38-44.

28- Dworkin SF, Huggins KH, Wilson L, Mancl L, Turner J, Massoth D, et al. A randomized clinical trial using research diagnostic criteria for temporomandibular disorders-axis II to target clinic cases for a tailored self-care TMD treatment program. J Orofac Pain. 2002;16:48-63.

29- Ferreira MC, Porto de Toledo I, Dutra KL, Stefani FM, Porporatti AL, Flores-Mir C, et al. Association between chewing dysfunctions and temporomandibular disorders: a systematic review. J Oral Rehabil. 2018;45:819-35. doi: 10.1111/joor.12681

30- Carlsson GE, Magnusson T. Treatment modalities. In: Bywaters LC, ed. Management of temporomandibular disorders in the general dental practice. Chicago: Quintessence; 1999. p. 93-103.

31- Fernández-de-Las-Peñas C, Von Piekartz H. Clinical reasoning for the examination and physical therapy treatment of temporomandibular disorders (TMD): a narrative literature review. J Clin Med. 2020;9(11):3686. doi: 10.3390/jcm9113686

32- Carlson CR, Reid KI, Curran SL, Studts J, Okeson JP, Falace S, et al. Psychological and physiological parameters of masticatory muscle pain. Pain. 1998;76:297-307. doi: 10.1016/S0304-3959(98)00063-3

33- Papagianni CE, van der Meulen MJ, Naeije M, Lobbezoo F. Oral health-related quality of life in patients with tooth wear. J Oral Rehabil. 2013;40:185-90. doi: 10.1111/joor.12025

34- Almoznino G, Zini A, Zakuto A, Sharav Y, Haviv Y, Hadad A, et al. Oral health-related quality of life in patients with temporomandibular disorders. J Oral Facial Pain Headache. 2015;29:231-41. doi: 10.11607/ofph.1413