

# Occlusal splints pretreatment for long-term complete denture wearers: A systematic review

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## ABSTRACT

The aim of this systematic review was to answer the focused question: “Would the use of occlusal splints be beneficial prior to the rehabilitation of long-term complete denture wearers?” Electronic searches were performed until November 2016 in MedLine (PubMed), ISI Web of Science, Scopus, Scielo, Lilacs, Ibics and the Cochrane Library. As eligibility criteria, any prospective or retrospective clinical trials that evaluated the use of occlusal splints in long-term complete denture wearers was selected. It was evaluated the extent of mandibular movements, pain symptomatology, intra-articular space, vertical dimension, and muscle activity. A total of 1152 potentially relevant records were identified from all databases. After title and abstract examination, 577 studies were excluded. Only 4 studies fulfilled all the selection criteria. All studies were longitudinal, and the period using the occlusal splints ranged from 30 to 360 days. Electromyography was the main evaluation method used, but pain scales and electrognathography were also used in two studies. There is scientific evidence supporting that occlusal splints pretreatment should be considered for patients whose long-term denture wearing experience is associated with compromised mandibular movements and vertical dimension of occlusion.

**Keywords:** complete denture, facial pain, occlusal splints, review.

## Pré-tratamento com placas oclusais para usuários de prótese total durante longos períodos. Uma revisão sistemática

### RESUMO

O objetivo desta revisão sistemática foi responder à questão: “Seria benéfico o uso de placas oclusais antes da reabilitação de usuários de próteses totais durante longo período?”. Foram realizadas buscas nas bases eletrônicas MedLine (PubMed), ISI Web de Ciência, Scopus,

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SciELO, Lilaçs, Ibecs e a Cochrane Library até novembro de 2016. Incluíam-se nos critérios de elegibilidade qualquer ensaio clínico prospectivo ou retrospectivo avaliando o uso de placas oclusais em usuários de prótese total durante longos períodos. Foi avaliada a extensão dos movimentos mandibulares, sintomatologia da dor, espaço intra-articular, dimensão vertical e atividade muscular. Um total de 1152 registros potencialmente relevantes foram identificados nos bancos de dados. Após a leitura do título e resumo, 577 estudos foram excluídos. Apenas 4 estudos preencheram todos os critérios de inclusão. Todos os estudos incluídos eram longitudinais, e o período em que usavam as placas oclusais variou de 30 a 360 dias. A eletromiografia foi o principal método de avaliação utilizado, mas as escalas de dor e a eletrognatografia também foram utilizadas em dois estudos. Há evidências científicas para suportar o uso de placas oclusais como pré-tratamento de pacientes que apresentam movimentos mandibulares e a dimensão vertical de oclusão comprometidos devido ao uso de próteses totais durante longos períodos.

**Palavras-chaves:** prótese total, dor facial, placas oclusais, revisão sistemática.

## INTRODUCTION

Despite the improvements observed in oral health conditions, the need for rehabilitation has increased along with the increase in life expectancy (1). The literature reports high prevalence of tooth loss among older people (1,2). Dental implants have become the treatment of choice for edentulous patients; (3) however, conventional complete dentures are still widely used (4).

Previous studies showed that long-term complete denture wearers often present loss of vertical dimension of occlusion (VDO) and unstable dentures associated with wearing artificial teeth and progressive residual ridge resorption on both the maxilla and mandible (5,6). Indeed, older age and long-term use of complete dentures were linked to limited reestablishment of VDO and range of mandibular motion after new rehabilitation (3).

These disharmonies can adversely affect temporomandibular joint (TMJ) culminating or not in temporomandibular disorders (TMD) (7,8). TMD is the most common cause of orofacial pain, characterized by painful symptoms in facial structures, uncoordinated and limited mandibular movement, and TMJ symptomatic or asymptomatic bone degenerative diseases and sounds (9,10).

Occlusal splints constitute the most used treatment in dentate patients with signs and symptoms of TMD because they are considered a conservative, reversible and non-invasive treatment (9-13). These devices are designed to reestablish intra-articular space and maxillomandibular relationship, as well as to reduce or eliminate pain symptoms by decreasing in muscle hypertonicity (14,15). Consequently, although this intervention has been poorly assessed in edentulous patients, consideration should be given to occlusal splints pretreatment prior the new rehabilitation.

Indeed, the relining intervention is a non-surgical and cost-effective adjunctive intervention that improves denture stability and masticatory function.<sup>8</sup> Because of this, long-term complete-denture wearers should received the proper care of relining and replacing their dentures regularly at shorter recommended intervals to maintain the health

of the stomatognathic system because the duration of closed-denture use has a greater effect on VDO and extent of mandibular movement than does duration of edentulism (3,10,11).

Based on above aforementioned, the aim of this study was to systematically review the literature to evaluate the effectiveness of occlusal splints use in long-term complete denture wearers prior to rehabilitation based on the following outcomes: the extent of mandibular movements, pain symptomatology, intra-articular space, vertical dimension, and muscle activity. The hypothesis tested was that the outcomes evaluated would be influenced by the use of occlusal splints.

## METHODS

This systematic review was performed according to the PRISMA statement (16) and was registered with the international prospective register of systematic reviews of the PROSPERO network (registration number: CRD42014009919). To formulate question in evidence based practice it was used the following PICOT format: (i) Population: complete denture wearers in at least one arch; (ii) Intervention: the use of occlusal splints; (iii) Comparison: before and after treatment; (iv) Outcomes: the extent of mandibular movements, pain symptomatology, intra-articular space, vertical dimension and muscle activity; (v) Type of study: prospective or retrospective clinical trials. The research question was: Would the use of occlusal splints be beneficial prior to the rehabilitation of long-term complete denture wearers?

### Systematic literature search

The literature search was performed by two independent reviewers until November 2016 (without limit for start date). Seven databases were screened: MedLine (PubMed), ISI Web of Science, Scopus, Scielo, Lilacs, Ibecs and the Cochrane Library. The keywords related to the search strategy are listed in Table 1. The references cited in the included papers were also checked. After the identification of articles in the databases, the articles were imported into Endnote X7 software (Thompson Reuters, Philadelphia, PA, USA) to remove duplicates.

TABLE 1 – Search strategy used in PubMed (MedLine).

Search Terms	
#4	Search #1 AND #2 AND #3
#3	Search Retrospective Studies OR Studies, Retrospective OR Study, Retrospective OR Retrospective Study OR Prospective Studies OR Prospective Study OR Studies, Prospective OR Study, Prospective OR Clinical Trial OR ((clinical[Title/Abstract] AND trial[Title/Abstract]) OR clinical trials[MeSH Terms] OR clinical trial[Publication Type] OR random*[Title/Abstract] OR random allocation[MeSH Terms] OR therapeutic use[MeSH Subheading]) OR (randomized controlled trial[Publication Type] OR (randomized[Title/Abstract] AND controlled[Title/Abstract] AND trial[Title/Abstract]))

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## Search Terms

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- #2 Search "Occlusal Splints"[Mesh] OR Occusal Splints OR Splints, Occlusal OR Occlusal Splint OR Splint, Occlusal OR Interocclusal appliance OR Interocclusal Splint OR Splint Therapy OR Acrylic Splint OR occlusal device OR Device, occlusal OR Interocclusal Device OR Device, Interocclusal
- #1 Search "Dentures"[Mesh] OR Dentures OR Denture, Complete OR Complete Denture OR Complete Dentures OR Dentures, Complete OR Denture, Complete, Lower OR Denture, Complete, Upper OR Prosthesis total OR Total, prosthesis OR Mouth, Edentulous OR Edentulous Mouth OR Edentulous Mouths OR Mouth, Toothless OR Toothless Mouth OR Jaw, Edentulous OR Edentulous Jaw OR Edentulous Jaws OR Jaws, Edentulous OR Denture wear OR Wear, denture OR "Dental Restoration Wear"[Mesh] OR Wear, Dental Restoration OR Occlusal Wear, Restoration OR Restoration Occlusal Wear OR Wear, Restoration Occlusal OR Restoration Wear, Dental OR Denture, Partial OR Dentures, Partial OR Partial Denture OR Partial Dentures OR Dental Bridgework OR Dental Bridgeworks OR Bridgeworks, Dental OR Bridgework, Dental OR Denture, Partial, Removable OR Removable Partial Denture OR Denture, Removable Partial OR Dentures, Removable Partial OR Partial Denture, Removable OR Partial Dentures, Removable OR Removable Partial Dentures
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## Study selection

Two review authors independently assessed the titles and abstracts of all of the documents. Any clinical trial, prospective or retrospective, and that evaluated the use of occlusal splints in complete denture wearers in at least one arch was selected. Studies published in a language other than English, Spanish or Portuguese were excluded; however, no limit of publication year was applied. The eligibility criteria are described in Figure 1.

Full copies of all of the potentially relevant studies were identified. Those appearing to meet the inclusion criteria or for which there were insufficient data in the title and abstract to make a clear decision were selected for full analysis. The full-text papers were assessed independently and in duplicate by two review authors (Figure 2). Any disagreement regarding the eligibility of included studies was resolved through discussion and consensus or by a third reviewer. Only papers that fulfilled all of the eligibility criteria were admitted.

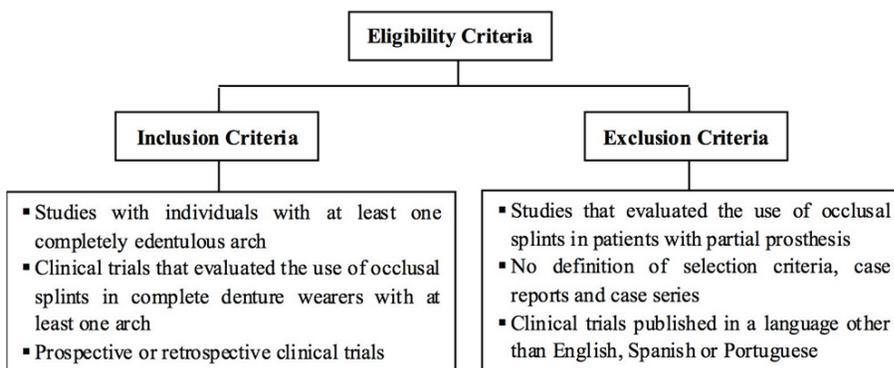


FIGURE 1 – Eligibility criteria.

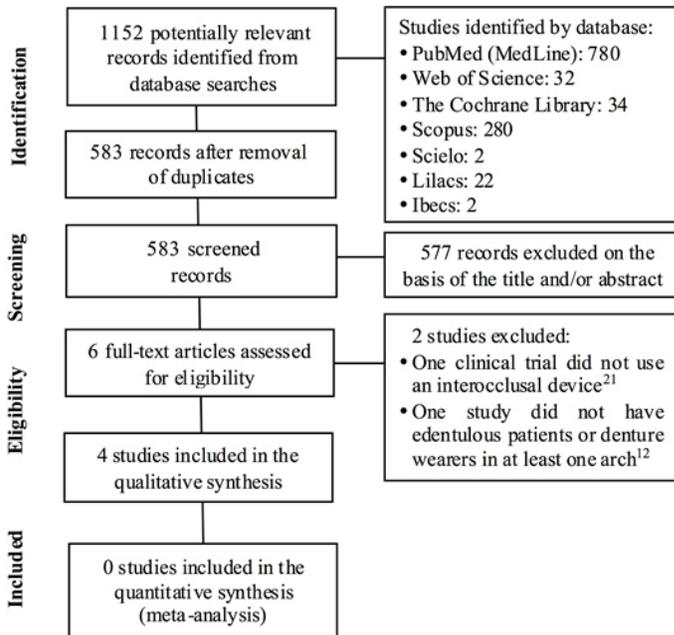


FIGURE 2 – Search flowchart according to PRISMA Statement (16).

## Data extraction

The data were extracted using a standardized form in Microsoft Office Excel 2013 software (Microsoft Corporation, Redmond, WA, USA). If there was some information missing, the authors of the included papers were contacted via e-mail to retrieve any missing data. If no answer was received within 2 weeks after the first e-mail message was sent, then a second e-mail was sent.

The reviewers tabulated data of interest for the composition of a spreadsheet in Excel format, with all of the trial documents containing demographic data (year, type of study), type of edentulism, and length of follow-up after intervention (Table 2). The characteristics of the included studies, such as the period using occlusal splints, the evaluation method used and the main conclusion, were also tabulated (Table 3). Additionally, the reviewers analyzed the scientific evidence regarding the use of interocclusal devices in denture wearers based on the following outcomes: pain symptomatology, extent of mandibular movements, intra-articular space, vertical dimension, and muscle activity (Table 4). Due to the high degree of heterogeneity in terms of different studies, a meta-analysis was considered to be inappropriate.

TABLE 2 – Demographic data of the included studies.

Author	Year	Type of study	Number of patients	Sex		Age	Mean Age	Type of edentulism	
				Male	Female			Maxillary	Mandibular
Almeida (8)	2016	RCT	30	6	24	45-74	70	Edentulous	Edentulous
Casseli (5)	2007	LCT	16	6	10	NS	53	Edentulous	Edentulous
Fonseca-Silva (23)	2007	LCT	8	1	7	45-60	54	Edentulous	Edentulous
Zanatta (22)	2006	LCT	16	13	3	33-67	52	Edentulous	Partly edentulous

RCT, Randomized Clinical Trial, LCT, Longitudinal Clinical Trial; NS, not specified.

TABLE 3 – Characteristics of the included studies and related outcomes.

Characteristic	Almeida (8)	Casseli (5)	Fonseca-Silva (23)	Zanatta (22)
<b>Mean time of use of the denture</b>	14 years	More than 10 years (Average not reported)	15 years	Not reported
<b>Temporomandibular disorders (TMD)</b>	No TMD	No TMD	Signs and symptoms of TMD	Signs and symptoms of TMD
<b>Intervention</b>	Occlusal splints	Occlusal splints	Occlusal splints	Occlusal splints
<b>Evaluation method</b>	Digital images and intraoral gothic arch trace	Electrognathography and intraoral gothic arch trace	Electromyography	Pain scale
<b>Period using occlusal device</b>	30 days	30 days	70 days	150 days
<b>Evaluation periods</b>	Before and 30 days after occlusal splint installation, and 6-week after new denture installation	30 days after occlusal splint installation; 60 days after new denture installation; and 60 days after occlusal vertical dimension increase	Before and 70 days after using occlusal splints	Fortnightly consultations from the installation of the occlusal splints up to 150 days of treatment
<b>Main conclusion</b>	The use of occlusal splint provided the highest vertical dimension of occlusion reestablishment and demonstrated the highest increase in the extend of mandibular movements.	The presence of a free-way space at the end of the treatment confirmed the importance of its existence for maintaining the balance of the masticatory system, assuming the occurrence of postural repositioning.	The use of occlusal splints promoted a significant increase in the electrical activity of the orbicularis oris.	The therapy used was effective in decreasing painful symptomology over 150 days of treatment.

TABLE 4 – Scientific evidence for possible outcomes related to interventions with occlusal splints in complete denture wearers.

Outcomes	Characteristics of clinical trial	Scientific evidence
<b>Pain symptomatology</b>	A study evaluated the evolution of painful symptomology in patients submitted to treatment with flat occlusal appliances with fortnightly consultations (23).	The pain scale recorded a significant reduction in the signs and symptoms of temporomandibular disorders initially recorded (23).
<b>The extent of mandibular movements</b>	A randomized clinical trial evaluated the extend of mandibular movements with digital images of intraoral gothic arch and anteroposterior (x axis) and laterolateral (y axis) movement were measures (8). Another study evaluated the cycle of maximal mouth opening and closure and final mandibular closing. The patients were instructed to remain at rest for a period of approximately seven seconds. After this period, the operator asked the patient to perform three subsequent movements of mandibular closing, from rest to maximum intercuspitation covering all the dimensions	The use of occlusal splints promoted the highest increase in the extend of mandibular movements (8). No significant differences were found during opening and closing. When the cycle of maximal opening and closing was observed, the maintaining of a constant vertical dimension opening, considering an occlusal vertical dimension increase of approximately 8-10 mm (clinically measured), revealed the great capacity that the muscles had to alter their longitudinal height. Hence, they had the capacity to adapt to a condition of vertical dimension, regardless of whether it was clinically favorable or not (5).

Outcomes	Characteristics of clinical trial	Scientific evidence
<b>The intra-articular space</b>	No clinical trials included evaluated this outcome.	No scientific evidence was available.
<b>The vertical dimension</b>	A randomized clinical trial evaluated the vertical dimension of occlusion with posed frontal images obtained with digital images (5). The mandibular movement pattern was investigated by another study. The patients used occlusal splints and were rehabilitated with new dentures, preserving a free-way space of 3 mm. After 60 days, the occlusal vertical dimension was increased, and the modified inferior dentures were used for another 60 days. <sup>5</sup>	A significant decrease in free-way space between the first and the last evaluations was observed. The free-way space attempted to establish itself within the most economical and healthy dimension for every established occlusal vertical dimension. In addition, it was not a safe reference for determining occlusal vertical dimension, and its maintenance at the end of the treatment emphasized the occurrence of postural repositioning (5).
<b>Muscle activity</b>	One clinical trial analyzed the influence of occlusal splints on the electromyographic activity of two portions — the upper and lower orbicularis oris muscles — during yogurt suction (23).	The use of occlusal splints promoted a significant increase in the electrical activity of the orbicularis oris (23).

## Quality assessment

The methodological quality of each included study was independently assessed by the two reviewers (RCCRA and WLOR) based on the checklist created by Downs and Black (17). The studies were evaluated to provide a framework for judging the methodological quality of the clinical trials and the power of the scientific evidence. This checklist assessed the quality of both randomized and non-randomized studies of health care interventions, and it consisted of 27 questions divided into 5 sections: reporting, external validity, internal validity–bias, internal validity–confounding, and power. According to previous systematic reviews (18,19) the scoring for question 27, which addresses statistical power, was simplified to a choice of awarding either 1 point or 0 points, depending on whether there was sufficient power to detect a clinically important effect. The scores of the Downs and Black checklist can be grouped into four quality levels<sup>19</sup>: ≤14; poor; 15–19, fair; 20–25, good; and 26–28, excellent (Table 5). The evidence for each outcome was graded according to the GRADE working group of evidence using Grade Profiler 3.6 (20).

TABLE 5 – Quality assessment using the Downs and Black Scale.

Author	Reporting										External validity		Internal validity										Power	Total						
	1	2	3	4	5	6	7	8	9	10	11	12	Bias					Confounding							27					
Cassell <sup>6</sup>	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	1	0	15
Fonseca-Silva <sup>14</sup>	1	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	13	
Zanatta <sup>22</sup>	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	14	
Zuccolotto <sup>7</sup>	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	1	0	15	

## **RESULTS**

### **Search strategy**

A total of 1152 potentially relevant records were identified from all of the databases. Figure 2 is a flowchart that summarizes the article selection process according to the Prisma Statement (16). After the title and abstract examination, 577 studies were excluded because they did not meet the eligibility criteria. Of the 6 studies retained for detailed review, 2 were not included because one did not use occlusal splints, (21) and in the other, the patients were not edentulous in at least one arch (12). A total of 4 studies fulfilled all of the selection criteria and were included in this review.

### **Characteristics of included studies**

A total of 70 patients, aged between 52 and 70 years old, were evaluated in included clinical studies. All of the studies were longitudinal, (5,8,22) and only one (8) was randomized controlled clinical trial (Table 2). The included studies evaluated thermolimerized acrylic occlusal splint made over old maxillary denture with a flat occlusal surface against the antagonist arch in centric relation and without canine and anterior guidance in excursive movements, respecting the configuration of the occlusal plane in the antero-posterior and latero-lateral direction. The period of occlusal splints use ranged from 30 to 150 days. Electromyography, electrognathography, digital images, intraoral Gothic arch trace and pain scales were the evaluation methods used. Yet, there was heterogeneity in the results provided, and they were classified according to the previously planned outcomes presented in Table 4.

### **Quality assessment**

The included articles in this review scored between 13 and 15 on the Downs and Black (17) scale, with a mean of  $14.5 \pm 0.96$  and high index of agreement (Kappa = 0.9076) between the 2 reviewers. The results indicate that the quality of the studies varied among poor, (22,23) slightly fair (5) and excellent (8). The studies scored particularly poorly on the following items: descriptions of adverse events, sample representativeness, patient and assessor blinding, adjustment for confounding factors in the analysis, and power. The strength of evidence obtained by GRADE related to pain symptomatology and muscle activity was subsequently downgraded to very low due to risk of bias mainly in studies limitations, imprecision and inconsistency. In contrast, regarding extent of mandibular movements and vertical dimension of occlusion the quality of evidence was high.

## DISCUSSION

The hypothesis of this review was partially accepted because there is scientific evidence only supporting occlusal splints pretreatment in long-term complete denture wearers regarding extent of mandibular movements and vertical dimension of occlusion. Nonetheless, the findings of this review should be interpreted with caution because only 4 clinical studies were included, and each one assessed only one or two possible outcomes of interest. Yet, another limitation was the low degree of scientific evidence obtained from the majority of the included studies that were non-randomized and/or controlled, corroborating the poor quality levels obtained by the Downs and Black scale. There was just one randomized controlled clinical trial in the included studies, (8) characterized by excellent quality.

Based on included studies, it was possible to note that long-term complete denture wearers could adapt themselves to their unsatisfactory prostheses. This occurs probably because the muscles have great capacity to alter their longitudinal height, thus adapting to decreased VDO, regardless of whether such conditions are clinically favorable or not (21). Because of this, these individuals could need additional time and pretreatment prior to new complete denture insertion. Occlusal splints are recommended to optimize harmonious occlusal plane levels and masticatory muscle function; (5,8) while relines are prescribed to readapt dentures' intaglio to their supporting tissues (24).

Thus, it seems that the use of occlusal splint could be the first logical step toward rehabilitating edentulous individuals with clinical signs suggesting articular, muscular, or occlusal changes (22). Nonetheless, it is also important to emphasize that in the current dental literature there is a lack of homogeneity in the treatment with occlusal splints. This heterogeneity could culminate in different findings regarding the efficacy of this treatment, thus jeopardizing comparisons due to differing methodologies (e.g., type of edentulism, age, sex, study design) and clinical scenarios, as well as differing periods of examination and reexamination.

According to the methodologies used in the included studies, it seems that the evaluation of pain symptomatology (22) is one method that alone does not necessarily reflect the efficacy of the rehabilitation implemented because changes in the stomatognathic system are often asymptomatic. Yet, the prevalence of TMD pain is reduced in elderly populations, and anamnestic indices are not helpful for excluding painless TMDs (11). Although some authors have indicated occlusal splints use as the first option to facilitate diagnosis and control of painful symptomatology, (25) the assessment of the effectiveness of this intervention has been clinically obtained based on the subjective quantification of the intensity and frequency of the related signs and symptoms. Indeed, proper care of relining and replacing of dentures have been poorly evaluated.

In contrast, the graphic records of intraoral Gothic arch tracing were used for two studies (5,8) to record the extent of mandibular movements. The layout of the arch tracing is a simple clinical method for assessing muscle functional integrity (5). Besides, arch tracing can be used as standard protocol that has been acknowledged as one of the

most reliable means of recording centric relation and to determine the centric relation for purposes of education and research (26,28) as well as to record the extent of antero-posterior and lateral-lateral mandibular movements (6,13). Digital images were used in one study (8) using a software to measure the vertical dimension of occlusion with higher accuracy and precision.

Another study (23) used electromyography (EMG), which is a graphic recording of the electrical potential of muscles. The basic EMG technique involves the insertion of either surface or intramuscular electrodes into the muscles being studied and the detection and amplification of the motor unit action potentials of the muscles (12). Nonetheless, there is still only limited knowledge regarding the causes of variations in both static and dynamic muscle function and other related parameters of the stomatognathic system. Yet, the limitations and the sensitivity of EMG measurements must be understood when collecting and analyzing data (29,30) because improvement in both symptoms and EMG parameters occur also after denture renewal without the need of a pretreatment with an occlusal appliance. Because of these requirements, EMG should correlate muscle testing with other objective and subjective and particularly pain-related assessments, thereby observing the multifactorial principle (9). It appears that measurement instruments used in the majority of studies analyzed were questionable, and these limitations could influence the level of scientific evidence and clinical relevance of the included studies.

Systematic reviews are invaluable tools for clinical practice, providing a critical approach of the scientific knowledge regarding some subjects. These tools aim to answer a clinically relevant question based on the best scientific evidence available or the lack of it, and point out improvement and standardization methodologies for further research. Thus, considerable improvements must be made in terms of the quality of research regarding the topic of this review. Further researches are recommended to specifically address the outcomes and benefits related to using any pretreatment performed prior to the rehabilitation of long-term complete denture wearers. Furthermore, it is critical to conduct randomized, controlled trials with appropriate designs for more concrete evidence.

## **CONCLUSION**

This systematic review showed that there is scientific evidence supporting occlusal splint pretreatment should be considered for patients whose long-term denture wearing experience is associated with compromised mandibular movements and vertical dimension of occlusion prior to prescribing new dentures. Nonetheless, the measurement instruments used were questionable and the scientific evidence level found was weak regarding effectiveness of the use of occlusal splints on pain symptomatology and muscle activity; and finally, there is no scientific evidence available regarding the intra-articular space. The quality of the included studies emphasized the need for well-designed, randomized and controlled clinical trials to highlight the real benefits of occlusal splints use in these clinical situations.

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