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The Effect Of Occlusal Splint Therapy On Masticatory Muscle Activity-A Systematic Review

Research Article

Suresh Venugopalan[1*], Pravinya Sam[2], Karthikeyan Murthykumar[3]

[1] Professor Department of Prosthodontics Saveetha Dental College, Chennai, India.
[2] Postgraduate Department of Prosthodontics Saveetha Dental college, Chennai, India.
[3] Post Graduate Department of Periodontics Saveetha Dental College, Chennai, India.

Abstract

Occlusal splints are used for the management of mandibular dysfunction, myofacial pain, prevention of tooth surface loss, pre-restorative stabilisation and protection of new restorations from parafunctional habits. Occlusal splint provides the patient with ideal occlusion, with posterior stability and anterior guidance. Different types of occlusal splints have been advocated, such as full or partial occlusal coverage, repositioning or stabilising, maxillary or mandibular. These are also made from different materials. For the clinician to assess the effectiveness of the splint therapy, Electromyogram (EMG) can be used. EMG has been used for evaluation as the occlusal changes are incorporated in the muscle engrams as and when it happens. Different designs and materials have been used in fabrication of splints. It is mandatory for the clinician to have a sound knowledge on this aspect for efficient splint therapy in various clinical scenarios. The databases of PubMed Central, Medline and Google Scholar were searched for related topics. Bibliographies of randomised control trials and reviews, identified in the electronic search, were analyzed for studies published outside the electronically searched journals. Randomised control trials, clinical studies, case control studies and animal studies assessing the effect of occlusal splints on EMG activity of the masticatory muscles were considered. Four studies were identified discussing EMG activity before and after splint therapy and the meta analysis performed revealed an overall effect size z=0.95 (p=0.34) at 95% CI. Two studies reported the difference in EMG activity between Soft and Hard splints and its meta analysis showed an overall effect size z=1.94 (p=0.05) at 95% CI.

Keywords: Electromyography; Muscle Activity; Occlusal Splints.

Introduction

In natural dentition when the teeth are in complete intercuspation the total number of occlusal contact increases [1]. In maximum intercuspation the number of contacts in molar region is significantly higher [2]. Intercuspation is necessary for maintaining the correct position of the teeth.

Changes in the occlusal anatomy cause the teeth to assume a new position of equilibrium [3]. Attrition is the important cause for the change in occlusal anatomy and is a sign of functional wear and bruxism. Tooth wear is typically seen in the elderly and can be referred to as a natural aging process [4].

Tooth wear results in compromised aesthetics and reduction in vertical dimension which can result in collapse of facial height. The loss of clinical crown height makes it difficult to re-establish the collapsed lower facial height [5]. Determining the correct maxillomandibular relationship before analyzing and planning the treatment is important in determining the best treatment option for patients with attrited teeth.

Centric relation is repeatable and elevator muscles show minimal or no discomfort as the condyle disk assembly is properly aligned in centric relation position. The condyle disk assembly is in the most superior position in centric relation position. Centric relation is defined as "The maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their

***Corresponding Author**:
Suresh Venugopalan,
Professor Department of Prosthodontics Saveetha Dental College, Chennai, India.
Email Id: suresh@saveetha.com

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respective disks with the complex in the anterior-superior position against the shapes of the articular eminencies. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superiorly and anteriorly. It is restricted to a purely rotary movement about the transverse horizontal axis (GPT-8). "During full mouth rehabilitation, use of an occlusal splint helps in deprogramming the muscle engrams and helps in positioning the condyle in centric relation position. Many methods are available for guiding the mandible in to its relation with maxilla (Bilateral Manipulation, Anterior bite stops, Anterior deprogramming device, Pankeyjig, best biteappliance, Lucia jig, leaf gauge, Nociceptive trigeminal inhibition etc.) [6].

Evaluating whether guiding the mandible has actually established centric relation position is difficult. The masticatory muscle memory or engrams is a conditionable reflex that adjusts masticatory muscle activity and lasts less than two minutes. Electromyography is used for evaluating and recording the electrical activity by skeletalmuscles [7]. EMG can be used to evaluate whether the splint or the corrected occlusion is really improved.

The clinicians despite using occlusal splints as the most common preliminary treatment (in patients undergoing Full mouth rehabilitation, bruxism patients, patients with orofacial pain related to Temporomandibular joint) lack the basic understanding of how it works. If the occlusal splints are properly designed and fabricated they can be of more help as a tool in evaluating the treatment outcome [8]. However, the evaluation of the effects of splints using EMG recording is an area which still needs to be explored. The aim of the current review is to systematically analyze the scientific evidence of the present and past for articles and studies showing the evaluation of changes in electro my ographic activities of masticatory muscles because of occlusal splints.

Materials and Methods

Review of literature on studies evaluating the effect of occlusal splints on the masticatory muscle activity that have been publishedwas carried out without any filter on publication dates and all articles of the past were retrieved.

Sources Used: For identification of studies included or considered for this review, detailed search strategies were developed for the database searched. The search methodology applied was a combination of MESH terms and suitable key words. The MEDLINE search used the combination of controlled vocabulary and free text terms. The key words employed in this search were broadly classified into four categories PICO analysis describing population, intervention, outcome and the type of study. Key words with in each group were combined using Boolean operator OR and the searches of individual groups were combined using Boolean operator AND to retrieve articles electronically. The search was carried out in PubMed, MEDLINE and Google Scholar database for data retrieval and also hand search was also carried out. Type

Table 1. Information Of Studies Included In The Review.

S.No	Study	Year	Intervention	Design	Sample Size	Outcome Assessment
1	Carlsson et al	1979	Occlusal splint in mandible	Cohort study	6	EMG activity of masticatory muscles
2	Nassar et al	2012	Luciajig	Cohort study	42	EMG activity of masticatory muscles
3	Lickteig et al	2013	Michigan splint	Cohort study	11	EMG activity of masticatory muscles
4	Matsumoto et al	2014	Stabilisation splint with cuspid guidance in maxilla	Cohort study	20	EMG activity of masticatory muscles
5	Okeson et al	1987	Soft splint& Hard splint	Cohort study	10	EMG activity of masticatory muscles
6	Pettengill et al	1998	Soft splint & Hard splint	RCT	18	EMG activity of masticatory muscles

Table 2. OUTCOMES OF VARIOUS STUDIES (only one type of splint).

S.No	Study	Intervention	EMG activity before splint therapy(mean)	EMG activity after splint therapy(mean)
1	Carlsson et al (1979)	Occlusal splint in mandible	1.1±1.46	0.5±0.1
2	Nasser et al (2012)	Lucia jig	7.67±1.61	8.11±1.85
3	Lickteig (2013)	Michigan splint	6.25±3.97	3.51±1.52
4	Matsumoto (2014)	Stabilisation splint with cuspid guidance in maxilla	6.6±2.6	4.9±2.1

of studies included were Clinical studies, case control studies and randomized control trials. The studies which were excluded was case reports/case series, in vitro studies, review articles.

Results

Out of the 66 articles obtained from electronic search 47 were excluded on examination of title and abstract and 15 were excluded on the basis of core data. Two articles were hand picked and a total of 6 articles were reviewed as depicted in the flow chart below.

The included studies were analysed in two different aspects one was based only on the EMG activity of the masticatory muscles and the other aspect includes comparison of EMG activity of masticatory muscles with hard and soft splints.

Risk Of Bias In Included Studies:

The assessments for the four main methodological quality items are shown in table. The study was assessed to have a "High risk" of bias if it did not record a "Yes" in three or more of the four main categories, "Moderate" if two out of four categories did not record a "Yes" and "Low" if randomisation assessor binder and completeness of follow-up were considered adequate.

Four studies were identified discussing EMG activity before and after splint therapy (Table2) and two studies reported the difference in EMG activity with Soft and Hard splints (Table 3).

The data were extracted from the above mentioned studies and metaanalysis was done to evaluate the influence of occlusal splints on muscle activity and another metaanalysis for the difference in the effect of hard and soft splints.

The effect size was the difference between EMG activity before and after splint therapy. Meta analysis showed overall effect size z=0.95(p=0.34) at 95%CI. The weighted mean difference at 95% CI with 100% weight is -0.27. The diamond illustrates the overall result of the meta analysis. The Middle of the diamond sits on

Table 3. Outcomes Of Various Studies (with soft and hard splints).

S.NO	Study	Intervention	EMG activity after soft splint therapy(mean)	EMG activity after hard splint therapy (mean)
1	Okeson et al (1987)	Soft splint& Hard splint	6.7±1.38	5.7±1.25
2	Pettengill et al (1998)	Soft splint& Hard splint	3.9±10.7	0.7±1.2

Table 4. Risk Of Bias.

Author and year	Randomisation	Allocation concealed	Assessor blinding	Dropouts described	Risk of Bias
Carlsson et al (1979)	No	No	No	No	High
Nassar et al (2012)	Yes	No	No	No	High
Lickteig et al (2013)	Yes	No	No	Yes	Moderate
Matsumoto et al (2014)	Yes	No	No	No	High
Okeson (1987)	Yes	No	No	No	High
Pettengill et al (1998)	Yes	Yes	Yes	Yes	Low

Table 5. Cebm Level Of Evidence Of Included Studies.

S.NO	Study	Study Design	Cebm Level Of Evidence
1	Carlsson et al (1979)	Invivo	Level 4
2	Nassar et al (2012)	Invivo	Level 4
3	Lickteig et al (2013)	Invivo	Level 4
4	Matsumoto et al (2014)	Invivo	Level 4
5	Okeson (1987)	Invivo	Level 4
6	Pettengill et al (1998)	Invivo	Level 1 b

Figure 1. Forest Plot-EMG values pre and post splint therapy.

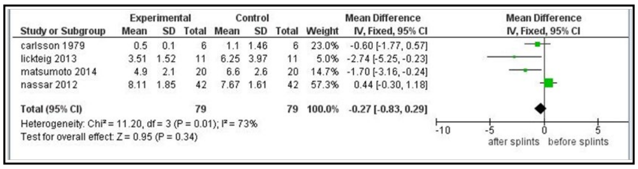


Figure 2. Forest Plot-EMG values of Hard splints and Soft splints.

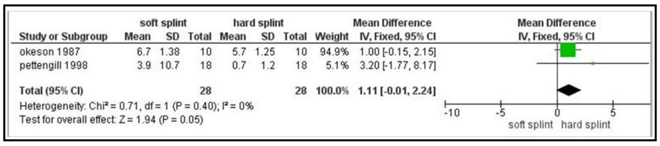
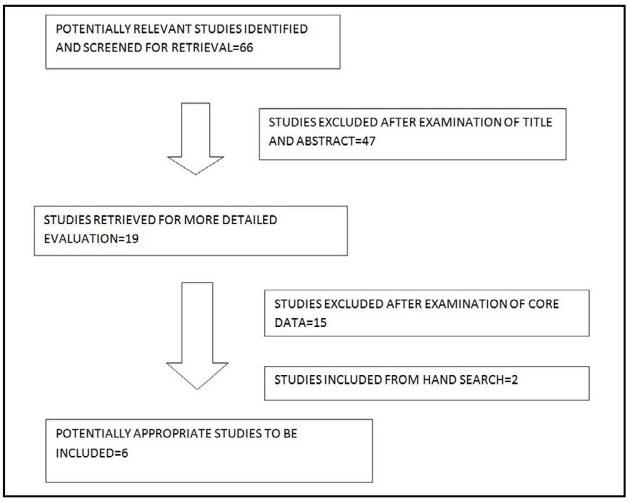


Chart 1. Search Flow Chart.



the overall effect value of -0.27(-0.83,0.29) and it crosses the line of no difference towards the left. This indicates favour towards intervention using occlusal splints. The size of the box for the study by Nassar et al being bigger had a greater weight on the overall effect.

The effect size was the difference between EMG activity of the masticatory muscles with hard splints and soft splints. Meta analysis showed overall effect size z=1.94(p=0.05) at 95% CI. The weighted mean difference at 95%CI with 100% weight is 1.11(-0.01,2.24). The middle of the diamond crossed the line of no difference towards the side favouring hard splints. The study by Okeson has a greater weight on the overall effect.

Discussion

In patients with myofacial pain or temporomandibular joint pain, occlusal splint therapy has been used as first line treatment [9-11]. Various splint materials have been used in treating TMD and their associated therapeutic changes at the muscular level have been assessed using electromyography [12, 13]. Although studies are available in the direction of EMG activity, there is a lack of systematic evidence or cohesive literature [14, 15].

Effect Of Usage Of Splints

In this present systematic review six studies compared EMG values elicited on usage of various splints. Among the 6 studies included, four studies had baseline comparison of EMG values and two studies had compared the EMG values obtained from hard and soft splint therapy.

On comparing muscle activity before and after splint therapy, the forest plot indicated reduced muscle activity in all studies except one where the splint was worn only for duration of 30 minutes, butthere seems to be no statistical significance (p=0.34). This indicates that the duration of wearing a splint is acrucial factor in determining the effectiveness of splint therapy (fig.1).

A meta analysis was performed comparing hard and soft splint and theresults obtained indicated a statistical border line value which is insignificant (p=0.05). The analysis indicated a reduction inmuscle activity favouring hard splint therapy (fig.2).

Effect Of Increase In Vertical Dimension

Studies performed by Carlsson et al and Manns et al discuss the effect of increasing vertical dimension on the masticatory system [16, 17]. Manns et al, in his study, compared the effect of occlusal splints fabricated at different values of vertical dimension (1mm, 4mm & 8mm) and found that occlusal splints with greater vertical dimension (4&8 mm) had more profound effect on reducing the muscle activity compared to1-2mm splint [16].

In Carlsson et al‘s study, the vertical dimension was increased by 4mm and a considerable reduction of 0.6μV in the EMG activity after the insertion of splint was observed [17]. This indicated that an increase in vertical dimension using occlusal splints had a favourable effect on the masticatory system.

Effect Of Duration Of Use

Nassar et al in his study used Lucia jig as a splintfor a period of 30 minutes intraorally to asses any change in action potential of muscles. There was a difference in action potential of the muscles but it was considered negligible. Even though the EMG recording of left masseter muscle and left temporalis muscle was reduced, the right masseter muscle and temporalis muscle showed a considerable increase. The use of splints for a short duration and uneven distribution of splint contacts could have attributed to the discrepancy in the recordings [18, 19].

Differences In Masticatory Muscle Activity

Difference in reduction of muscle activity was observed between the masseter and temporalis muscle with splint therapy [17]. The activity of the temporalis muscle was found to be more when compared to masseter muscle. The posterior part of fan shaped temporalis musclewas havinga greater EMG activity compared to the middle, anterior parts of temporalis muscle or the masseter muscle either during the use of splints or without it [18, 20].

Anterior temporalis muscle displayed constant activity during rest position suggesting the sensitivity of the muscle to changes in the jaw and occlusal positions [21, 22]. Temporalis muscle is responsible for maintaining the stability of the mandible and their activity is dependent on jaw position. In C F Amorim et al's study, the EMG of masseter muscle indicated a decrease in activity where as the temporalis muscle showed increase in EMG activity with the splint therapy [23].

Effect Of Splint Design

Most of the studies showed considerable reduction in the muscle activity at rest position after occlusal splint therapy. The studies by Carlsson et al with mandibular occlusal splint [17], Lickteig with Michigansplint therapy [20], Matsumotoet al with stabilisation splints [21] and CF Amorim et al with stabilisation splint [22] showed reduction in muscle activity despite the difference in splint design.

Variations Of Effects Observed In Associated Craniomandibular Disorders And Parafunctional Habits

In Craniomandibular disorder patients with Temporomandibular joint pain, there was a considerable fall in the EMG values and the patients showed reduction in pain without any pain medications [24-26]. In Bruxism patients with splint therapy, the number of events and duration as well as the intensity of bruxism was considerably low [27-29].

Effect Of Splint Material

Okeson, in his study comparing effect of hard and soft splints observed that therapy with hard splints showed better results in bringing about a decrease in muscle activity and hence providing symptomatic relief as compared to that obtained with soft splints [30]. Similar result was obtained in a study by Pettengil et al, where both groups displayed reduction in muscle activity. However, values elicited with soft splint did not hold much significance as compared to that obtained with hard splint [30].

Conclusion

Based on the evidence provided by the literature, occlusal splints were effective in producing changes in muscle activity regardless of the type or duration of wear. In patients with TMJ pain, occlusal splints were effective in reducing the muscle activity and associated pain. Masseter showed significant reduction in activity as compared to that of Temporalis muscle. The occlusal splints with thickness >1 mm showed marked reduction in the activity of the masticatory muscles than those with thickness ≤1 mm. Hard splints were effective in providing therapeutic relief by bringing down the muscle activitythan soft splints. However, there is inadequate evidence on the effect of different types of splint and their respective changes in muscle activity in similar conditions. Further studies should be performed to throw light on the aspect of splint design, associated condylar position and their respective changes in the muscle activity.

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