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ORIGINAL ARTICLE

Correlation of splint therapy outcome with the electromyography of masticatory muscles in temporomandibular disorder with myofascial pain

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Abstract

Objectives. The aim of this study was to assess the effect of occlusal splint therapy on the electromyographic amplitude records (μV) of masticatory muscles in temporomandibular disorder (TMD) with myofascial pain and to detect a possible existence of a relationship between this effect and the treatment outcome. ***Materials and methods.*** Forty patients (23 females and 17 males) having TMD with myofascial pain were included in this study. They were randomly divided into two equal groups (20 of each). The first group (A) was treated by occlusal splints for 6 months while the second group (B) acted as a control. A clinical assessment and surface electromyography (EMG) for the masticatory muscles were performed at the beginning of the study, then 6 months later. The collected data were statistically analyzed using paired *t*-test. The differences were considered significant at $p < 0.05$. ***Results.*** The results showed that 85% of group A either completely recovered (35%) or clinically improved (50%) while only 20% of group B had a spontaneous improvement. In group A, the means of the electromyographic amplitude records (μV) of the monitored muscles have decreased after 6 months. However, the decrease was statistically insignificant ($p > 0.05$) in the patients (15%) who had no clinical changes. In group B, the means of the muscles' records (μV) in the left side slightly increased while those of the right side slightly decreased. These changes were statistically insignificant ($p > 0.05$). ***Conclusions.*** Occlusal splint could eliminate or improve the signs and symptoms of TMD patients with myofascial pain. It reduces the electromyographic amplitude records (μV) of the masticatory muscles. The splint therapy outcome has a correlation with the electromyographic amplitude changes of the masticatory muscles.

Key Words: *TMD disorder with myofascial pain, splint, electromyography*

Introduction

Temporomandibular disorder (TMD) patients with myofascial pain are suffering mainly from a chronic non-teeth-related orofacial pain. This myofascial pain is defined by the American Academy of Orofascial Pain (AAOP) as a sub-group under the musculoskeletal disorders [1,2]. Its main etiology has not been found yet. However, various factors including occlusal disturbances, parafunctional activities, psychological stress and general health are involved in the etiology of such functional disorder [3–6]. Several authors [7,8] have stated that a hypertonicity of the masticatory muscles is considered the primary cause of this disorder.

The main signs and symptoms of TMD with myofascial pain are masticatory muscles pain, temporomandibular joint (TMJ) pain, restricted mandibular movements and joint noises. Furthermore, myofascial trigger points are usually present within the taut band of the masticatory muscles. These points are painful on compression and give rise to a characteristic referred pain [2,9]. Diagnosis of the TMD with myofascial pain is based mainly on the case history and clinical examination. It has been mentioned in literature that Helkimo [3] is considered the first one who developed an index for clinical assessment of the severity of the TMJ disorders. In the last years the results of some studies [10,11] have shown that electromyographic exploration of the masticatory

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muscles and recording the skin surface temperature over the masseter muscles are helpful tools in the diagnosis of TMD with myofascial pain.

Concerning the management of TMD with myofascial pain, various modalities [12–23] of treatment have been tried including physiotherapy, pharmacotherapy (analgesics and muscle relaxants), muscle exercise, thermotherapy, electrotherapy, ultrasound therapy, laser therapy, relaxation therapy, biofeedback, trigger point injections, acupuncture, hypnosis. etc. However, soft and hard occlusal splints are still widely used for the treatment of TMD patients with myofascial pain as they are non-invasive, reversible and have a high success rates [24–29].

Despite the extensive use of occlusal splints in the treatment of TMD with myofascial pain, their mechanisms of action remain controversial. In the literature, various hypotheses have been proposed including alteration of the electromyographic activity of the masticatory muscles, modification of the harmful oral behaviour of the patient and changes in the patient's occlusion. However, the actual mechanism of action remains unsettled. So, the first aim of this study was to assess the clinical outcome of occlusal splint therapy in patients having TMD with myofascial pain and to evaluate the effect of this treatment modality on the electromyographic amplitude records (μV) of masticatory muscles. The second target was to detect a possible existence of a relationship between the effect of occlusal splint therapy on the masticatory muscles and the treatment outcome.

Materials and methods

Forty patients (23 females and 17 males) from those attending the Department of Oral and Maxillofacial, Faculty of Oral & Dental Medicine, Cairo University complaining of TMD with myofascial pain were included in this study. They were diagnosed as having TMD with myofascial pain by the presence of a non-teeth-related chronic orofacial pain with localized areas of tenderness in the masticatory muscles. The ages of the patients ranged from 22–46 years, with a mean age of 32 years.

A proper case history and clinical examination were carried out for every patient. The signs and symptoms were recorded according to the clinical dysfunction index of Helkimo [30]. The criteria of Helkimo's index are masticatory muscles tenderness, range of mandibular motion, TMJ function impairment, TMJ pain and pain during mandibular movements. The patient assigned a score of 0, 1 or 5 points in each item. The dysfunction index (Di) of the patient is determined by summation of all points of the five items where Di 0 (0 points) means free of dysfunction symptoms and Di I (1–4 points) means mild dysfunction while Di II (5–9 points) and Di III (10–25 points) mean moderate and severe dysfunction, respectively. Panoramic radiographs were made for every patient to evaluate the osseous components of the temporomandibular joint.

The exclusion criteria were: any systemic neurological or muscular diseases that may influence the EMG records; and presence of pathological changes involving the components of the temporomandibular joint. The patients were randomly divided into two equal groups (20 of each). The randomization was performed using a computer-generated random number list. The first group (A) was treated by occlusal splints while the second group (B) acted as a control and received no actual treatment. The patients of group B were informed about the nature of their disorders and they accepted to wait and see the results of splint therapy in the other group (A).

Prior to the trial, every patient was informed about the procedures of splint therapy, the aim of the study and the possible complications. A signed informed consent was obtained from all patients. The two patients who had photographs used in the methodology of this study have signed an additional permission to allow their photographs to be published in both printed and electronic versions of the Journal.

Splint design

A flat-plane splint was fabricated on articulated dental casts. The vertical pin of the articulator was adjusted to create a 2–3 mm space between the molars. Clear acrylic resin was mixed to the desired consistency and applied to the upper arch. The models were brought into occlusion on the articulator. The acrylic was heat and pressure processed and removed from the model. The excess acrylic was removed and the occlusal surface was finished so that it was flat. When placed in the patient's mouth, the splint was relieved to take pressure of teeth. In five cases the inside of the splint was relined with cold-cure acrylic to add retention. The occlusion was adjusted to provide a bilaterally stable biting platform (Figure 1). Several adjustment visits were required as the patients accommodate the splints. The patients were instructed to wear the splints during the whole night and as much as possible during the daytime for 6 months.

Electromyography of the masticatory muscles

Electromyographic exploration of the anterior temporalis and masseter muscles bilaterally was carried out for both groups at the beginning of the study, then 6 months later. For that purpose, we have used an electromyograph of four channels (Nihon Kohden Neuropack, Japan) The patient was seated comfortably in an orthostatic position and informed about the test to offer maximal co-operation. The skin covering the evaluated muscles was disinfected with gauze soaked in ethyl alcohol. Then surface electrodes were applied onto the skin covering the

Figure 1. Photographs showing a hard-clear acrylic resin occlusal splint inserted into the patient's mouth and covering all maxillary teeth.

monitored muscles following the proposal of Macalusa and De Laat [31] (Figures 2A–C). The wires were connected and the apparatus was tested to check the electrodes state and the connections. The apparatus was calibrated according to Ardizone et al. [8]. The EMG records of the masticatory muscles were obtained during a maximal voluntary clenching. The patient started from a rest state and maintained the contraction for 3 s. The electromyographic amplitude records (μV) of the evaluated muscles, in both groups, were collected and statistically analysed.

Statistical analysis

The collected data were presented as mean ± standard deviation (SD). The statistical analysis was performed using paired *t*-test. The differences were considered significant at $p < 0.05$.

Results

In general, all patients have tolerated the appliance uneventfully. Five patients did not totally comply with the post-operative instructions. However, they responded well after clarifying the importance of these instructions. No evidence of occlusion disturbances has been observed after using the occlusal splint throughout the follow-up period.

The results have shown that 85% ($n = 17$) of the patients who received splint therapy either completely recovered (35%, $n = 7$) or improved (50%, $n = 10$) while only 15% ($n = 3$) of the patients had no changes in their clinical dysfunction indices. In the control group, 20% ($n = 4$) of the patients showed a spontaneous improvement in their clinical dysfunction indices while 80% ($n = 16$) had no changes (Table I). This indicates that the patients who have been treated with occlusal splints had a better clinical outcome than those of the control group.

The amplitude records of the masticatory muscles during the maximal voluntary clenching (3 s) ranged between 80–270 μV. In the splint therapy group (A), the means of the electromyographic amplitude records (μV) of right masseter, left masseter, right temporalis and left temporalis muscles were 133 ± 30, 203 ± 36, 229 ± 57 and 169 ± 20, before the treatment and became 111 ± 38, 187 ± 33, 186 ± 25 and 152 ± 27, respectively, after using the occlusal splints for 6 months (Table II). This indicates a decrease of the means of the electromyographic amplitude records of the masticatory muscles after the treatment. In general, the decrease was statistically significant ($p < 0.05$). However, the decrease was statistically insignificant ($p > 0.05$) in the patients (15%, $n = 3$) who had no changes in their clinical dysfunction indices (Table III).

The means of the electromyographic amplitude records (μV) of right masseter, left masseter, right temporalis and left temporalis muscles in the control group (B) were 163 ± 45, 249 ± 56, 228 ± 55 and 223 ± 38 at the beginning of the study and changed to

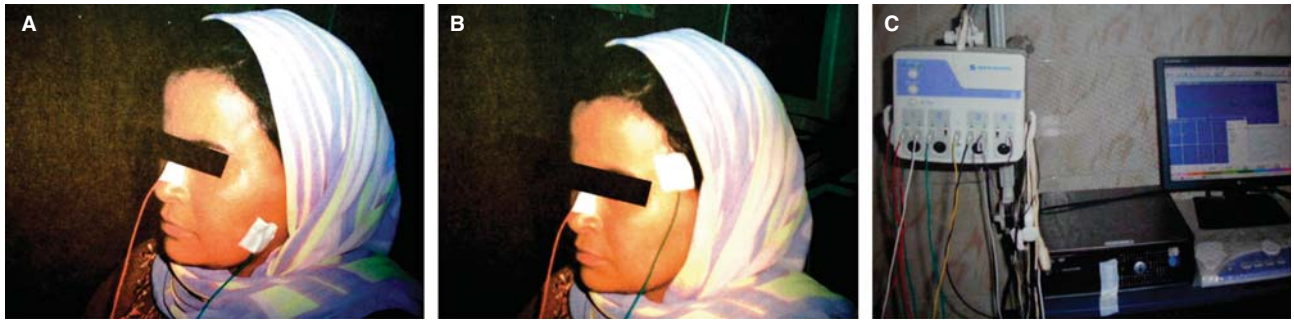

Figure 2. Photographs showing: (A) surface electrodes for EMG of masseter muscle; (B) surface electrodes for EMG of anterior temporalis muscle; (C) the EMG apparatus (photograph published with the permission of the patient).

Table I. Distribution of the clinical dysfunction indices at the beginning of the study then 6 months later in both groups.

	Group A (n = 20)		Group B (n = 20)	
Dysfunction index	Before	After 6 m	Before	After 6 m
Di 0	0	7	0	0
Di l	1	9	0	0
Di ll	6	1	6	10
Di lll	13	3	14	10

160 ± 42, 253 ± 60, 227 ± 50 and 225 ± 36, respectively, at 6 months later (Table II). The changes that have occurred in the control group (B) were statistically insignificant ($p > 0.05$).

Discussion

Myofascial pain is considered one of the most common chronic problems that encounter Oral Surgeons in their clinical practice. A variety of therapies has been described in the literature for its management. Despite the wide use of occlusal splints in the treatment of TMD with myofascial pain, their mechanisms of action remain controversial. So, the first goal of the current study was to assess the clinical outcome of the occlusal splint therapy in patients having TMD with myofascial pain, using Helkimo's clinical dysfunction index and the effect of this treatment modality on the electromyographic amplitude records (μV) of masticatory muscles. The second goal was to detect a possible existence of a relationship between the effect of occlusal splint therapy on the masticatory muscles and the treatment outcome. We have used in our study Helkimo's index to express the severity of signs and symptoms accompanying TMD with myofascial pain because it is considered one of the reliable indices that have been used for this purpose [30].

The results of the present study have shown that, in group A, 17 patients (85%) of 20 either completely recovered or showed an improvement while only four patients (20%) of group B had a spontaneous improvement in their clinical dysfunction indices. This means that occlusal splint is an effective treatment modality for patients having TMD with myofascial pain as it could eliminate or improve the signs and symptoms of such a condition. These findings coincide with the results of Littner et al. [1], Nilner et al. [24] and Naikmasur et al. [26].

One of the most important hypotheses that have been proposed to explain the mechanism of action of occlusal splint is an alteration of the electromyographic activity of the masticatory muscles. In the current study, the results have showed a statistically significant decrease in the electromyographic amplitude records of the masticatory muscles after using the occlusal splints for 6 months. These findings are consistent with the results of Scopel et al. [32] and others [33,34]. In our study, the three patients (15%) of the splint therapy group who showed no change in their clinical dysfunction indices had a statistically insignificant decrease ($p > 0.05$) in the electromyographic amplitude records of the masticatory muscles. This could be explained on the basis that the use of occlusal splints for 6 months maybe is not quite enough to produce such an effect.

Concerning the relationship between the electromyographic activity of the masticatory muscles and the splint therapy outcome, our results revealed that the patients who showed a successful (recovered or improved) treatment outcome had a statistically significant decrease in the electromyographic amplitude records of the masticatory muscles. This means that the splint therapy outcome is correlated with the alteration of the electromyographic activity of the masticatory muscles. These findings are inconsistent with the results of Suvinen et al. [35] and Dahlstrom & Haraldson [36]. This disagreement may be due to differences in the methodology of the studies as they have used the occlusal splint therapy for a short period of time.

Depending on the results of the current study we have concluded that occlusal splint could eliminate or improve the signs and symptoms of TMD with myofascial pain and reduce the electromyographic amplitude records (μV) of the masticatory muscles. Also, the results have shown that the splint therapy outcome has a correlation with the electromyographic amplitude changes of the masticatory muscles.

Table II. Showing the means ± SD of the electromyographic amplitude records (μV) for masticatory muscles in both groups (A and B).

	Group A (n = 20)			Group B (n = 20)		
Masticatory muscles	Before	After 6 m	p	Before	After 6 m	p
Right masseter	133 ± 30	111 ± 38	S	163 ± 45	160 ± 42	N
Left masseter	203 ± 36	187 ± 33	S	249 ± 56	253 ± 60	N
Right temporalis	229 ± 57	186 ± 25	S	228 ± 55	227 ± 50	N
Left temporalis	169 ± 20	152 ± 27	S	223 ± 38	225 ± 36	N

S: significant difference; N: insignificant difference.

Table III. Demonstrating the means ± SD of the electromyographic amplitude records (μV) in successful (completely recovered or improved) and resistant cases of the splint therapy group (A).

	Successful cases (n = 17)			Resistant cases (n = 3)		
Masticatorymuscles	Before	After 6 m	p	Before	After 6 m	p
Right masseter	136 ± 25	118 ± 29	S	155 ± 23	149 ± 15	N
Left masseter	190 ± 28	178 ± 22	S	202 ± 34	195 ± 12	N
Right temporalis	235 ± 43	202 ± 24	S	195 ± 27	186 ± 18	N
Left temporalis	185 ± 20	158 ± 27	S	175 ± 30	167 ± 20	N

S: significant difference; N: insignificant difference.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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