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EFFECT OF FOUR CONSERVATIVE TREATMENT METHODS ON THE MUSCULAR ACTIVITY OF MASSETER AND TEMPORALIS MUSCLES FOR SUBJECTS WITH TEMPOROMANDIBULAR JOINT DISC DISPLACEMENT WITH REDUCTION

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ABSTRACT

Objective: This study was conducted to study the effect of four different treatment methods on the muscular activity of masseter and temporalis muscles of patients with temporomandibular disc displacement with reduction. **Subjects and methods:** Total 100 patients were selected. The selected patients were 64 females and 36 males with mean age about 31 years. The selected patients were divided equally into four groups: patients in group I were treated with behavioral therapy; patients of group II had a low-level laser therapy; patients of group III received anterior repositioning splints; patients of group IV received a flat plane splints. Activities of masseter and temporalis muscles were evaluated using surface electromyography (EMG). Statistical analysis was done using one-way ANOVA test for comparison between groups. Within each group, comparison between baseline and after treatment was done using paired t-test ($p<0.05$). **Results**: All groups showed significant increase in the muscular activity after 6 months of treatment except behavioral therapy group. The flat splint showed the highest value, and the behavioral therapy group showed the lowest value. **Conclusion**: Treatment with occlusal splints significantly increased the masticatory muscles activity, and the other lines of treatment can be considered as an adjunctive therapy.

KEYWORDS: Anterior repositioning splint, Disc displacement, Flat splint, Low level laser therapy, Stabilization splint

INTRODUCTION

Temporomandibular joint disorders (TMD) and their relationship with the function of the masticatory system have been a topic of interest in dentistry for many years. The relationship between TMD, occlusion, and oral function is quite complex. Lack of knowledge has stimulated numerous concepts, theories, and treatment methods, which have led to much confusion [(1)]. Internal derangement of the temporomandibular joint (TMJ) is characterized by an abnormal disc-condyle relationship or a normal relationship associated with disc immobility[(2)]. Both conditions can result in symptoms (pain) and signs of dysfunction (muscle tenderness and joint clicking). Anterior disc displacement with reduction is

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a subgroup of internal derangement, in which the articular disc has slipped forward and mouth opening is accompanied by a clicking sound at any stage of opening. The incidence of TMD is high in pre-adolescents and adolescents [3, 4]. Over time, various modalities of therapy have been recommended to manage internal derangements of the TMJ. Among these, flat occlusal and anterior repositioning splints are the most commonly used. However, the relevant literature regarding such splints reflects equivocal long-term treatment outcomes.

The effect of occlusal splint therapy is the increase of the vertical dimension of occlusion and the possibility for spatial change in mandibular postural position[5]. The described effectiveness of splint therapy has theoretically been attributed to decreased loading of the TMJs[6] and reduction of neuromuscular reflex activity, besides the placebo effect[7]. Behavioral therapy has been proposed as a treatment modality derived from the application of behavioral science theories and methods used to change pain perception, aiming to increases pain coping skills and eliminate psychological dysfunctions in subject with chronic TMD pain[8]. Behavioral therapy includes a wide range of therapies such as biofeedback, cognitive behavioral therapy, re-education, and other relaxation techniques [9-11].

Low-level laser therapy has been used as an alternative therapy for pain relief in TMD for inducing analgesic, anti-inflammatory and bio-modulator effect of physiologic cell functions [12, 13]. Studies have shown that low-level laser therapy is efficient as a therapeutic agent for decreasing pain and increasing jaw movement amplitude [14, 15].

In light of the above, this study aimed to evaluate the effect of four different treatment modalities (Behavioral therapy, low-level laser therapy, flat splint, and anterior repositioning splint) on the electromyoghraphic (EMG) activity of masseter and temporalis muscles during maximum voluntary clench for patients with TMJ disc displacement with reduction.

PATIENTS AND METHODS

Based on data from a previous study[16] total 100 patients were selected for this study. The selected patients were 64 females and 36 males with age ranging from 19 to 44 years old with mean age about 31 years. Patients were randomly selected from the outpatient clinics of the Removable Prosthodontics Department, Faculty of Dental Medicine, (Boys, Cairo), Al-Azhar University after approval from faculty Research Ethics Committee. All patients were diagnosed before treatment clinically and radiographically using magnetic resonance imaging of TMJ bilaterally (open and closed). The inclusion criteria were patients diagnosed with unilateral disc displacement of tempromandibular joint, patients with a chief complaint of TMJ pain, noise, and limited maximum mouth opening. Subjects were diagnosed according to research diagnostic criteria for temporomandibular disorders (RDC/TMD)[17] and disgnosis was done by one trained examiner. Exclusion criteria were patients with history of previous TMJ surgery, history of head and neck radiotherapy or chemotherapy, and patients with systemic inflammatory joint disease. All subjects signed an informed consent form before participating in this study. Patients were randomly categorized into four groups, 25 subjects of each and simple randomization was used to compose the four treatment groups; Group I: Patients had received behavioral therapy. Group II: Patients had received low level laser therapy. Group III: Patients had received anterior repositioning splint. Group IV: Patients had received flat plane splints therapy.

Group I: The patients were advised to rest the TMJ as much as possible, to avoid hard food, to use thermal packs and to avoid wrong working/sleeping positions [18]. Group II: Patients were treated with LLLT two times a week during the four weeks of treatment period [19]. Equipment used was TOWER LIGHT LASER (ELETTRONICA PAGANI, Milan, Italy), Figure 1, which emits radiation obtained as from stimulation of solid state source with

wavelength of 808nm. Protocol was adjusted to a fixed power of 70 mW and doses of 105 J/cm2 in continuous emission. Each session involved laser application in five predetermined TMJ points (anterior, superior, posterior, posteroinferior points of the condylar position, and in the external auditory meatus).

FIG (1) Laser device.

For group III: Anterior repositioning splint was fabricated as descriped by okeson[20] using 2-mm thick, polyvinyl acetate sheet and self-curing acrylic resin. (Folidur N/ clear, Thermoforming Sheet, aldente Dentalprodukte GmbH, Horgenzell, Germany) which requires the mandible to assume a forward position at which pain and clicking are eliminated. Patients were instructed to wear the splint for 12 hours a day (Figure 2).

FIG (2) Anterior repositioning splint.

Group IV: A maxillary flat plane splint was constructed as descriped by okeson[20] using 2-mm thick, polyvinyl acetate sheet and self-curing acrylic resin (Folidur N/ clear, Thermoforming Sheet, aldente Dentalprodukte GmbH, Horgenzell, Germany). The splint was designed with canine and protrusive guidance as well as a flat occlusal surface for contact with the opposing teeth. Patients were instructed to wear the splint for 12 hours a day (Figure 3).

FIG (3) Flat plane splint.

Surface Electromyography:

The electrical activity of the masseter and the anterior temporalis muscles were recorded on the affected side by means of bipolar surface electrodes while subjects clenched maximally. Patients were instructed to remain seated in a chair, feet apart, shoulders relaxed and hands were resting on thighs, with the head parallel to the ground. The sites for the electrodes were cleaned with a cotton ball soaked in alcohol to diminish impedance between the skin and electrodes. Disposable circular electrodes measuring 10 mm in diameter with inter-electrode distance of 20 mm from center to center were attached to the belly of the muscle in the region with the greatest tonus after patients performed maximum clenching and electrode on the forehead served as a ground reference. Three EMG readings were taken in all groups during maximum clenching for 10 seconds, with a five-minute rest period

between readings. To avoid direct occlusal contact between the dental cusps two 10-mm thick cotton rolls positioned between the mandibular posterior teeth. EMG recording and analysis were performed according to the equipment protocol (TruTrace EMG Traveler DEYMED Diagnostic, Czech Republic). All these measurements records were considered as a baseline to be used in comparison with post-operative records (after 6 months)[21].

Statistical analysis

Data was collected, tabulated, and statistically analyzed by SPSS© Statistics for Windows version 20.0 software (IBM Corp., NY, USA). The data distribution of normality was done using Kolmogorov-Smirnov test, the test showed normal distribution of data. Data were analyzed using one-way ANOVA and post hoc Tukey tests for comparison between groups. Within each group, comparison between baseline and after treatment was done using paired t-test ($p \leq 0.05$).

RESULTS

The mean values of amplitude in microvolt (μv) of masseter muscle electromyography of different groups are shown in table 1. Paired t-test showed a significant difference between before treatment records and after treatment records (after six months) in all groups except that of group I ($p<0.05$).

One-way-ANOVA test showed non-statistical significant difference between different groups before treatment. However, the one-way-ANOVA test showed a statistical significant difference between the different groups after treatment ($p<0.05$), also pair wise comparisons using the post hoc Tukey test showed significant differences between the different groups ($p<0.05$, table 2).

The mean values of amplitude (μv) of temporalis muscle electromyography of different groups are shown in table 3. Paired t-test showed significant difference between before treatment records and after treatment records (after 6 months) in all groups except that of group I ($p<0.05$).

One-way-ANOVA test showed non statistical significant difference between different groups before treatment ($p>0.05$). However, one-way-ANOVA test showed statistical significant difference between different groups after treatment ($p<0.05$), also pair wise comparisons using post hoc Tukey test showed significant differences between different groups ($p<0.05$, table 4).

TABLE (1) Mean and SD values for amplitude (μv) of masseter electromyography with paired t-test for different time comparison ($p<0.05$).

		Group 1	Group II	Group III	Group IV
Before treatment		169 ± 30	172 ± 23	159 ± 41	166 ± 29
6 months		164 ± 12	227 ± 35	289 ± 29	334 ± 58
Paired t-test	T value	2.262	2.262	2.262	2.262
	P value	0.414	0.003	0.00004	0.00
	Significance	Non-Significant	Significant	Significant	Significant

TABLE (2) Pairwise comparisons using Tukey's Post Hoc Test for comparing masseter muscle electromyography between different groups after treatment ($p \leq 0.05$).

		Mean Difference	P value	Significance
Group I vs.	Group II	-63.001*	0.002	Significant
	Group III	-124.999*	0.000	Significant
	Group IV	-193.003*	0.000	Significant
Group II vs.	Group III	61.998*	0.002	Significant
	Group IV	130.002*	0.000	Significant
Group III vs.	Group IV	68.004*	0.001	Significant

TABLE (3) Mean and SD values for amplitude (μv) of temporalis muscle electromyography with paired t-test for different time comparison ($p<0.05$).

		Group I	Group II	Group III	Group IV
Before treatment		265 ± 57	276 ± 33	250 ± 76	244 ± 29
6 months		255 ± 36	321 ± 44	384 ± 53	498 ± 51
Paired t-test	**T value**	2.262	2.262	2.262	2.262
	P value	0.62	0.044	0.0004	0.000
	Significance	Non-Significant	Significant	Significant	Significant

TABLE (4) Pair wise comparisons using post hoc Tukey test comparing temporalis muscle electromyography between different groups after treatment ($p \leq 0.05$).

		Mean Difference	P value	Significance
Group I vs.	**Group II**	-66.000	0.006	Significant
	Group III	-129.000	0.000	Significant
	Group IV	-243.000	0.000	Significant
Group II vs.	**Group III**	-63.0000	0.009	Significant
	Group IV	-129.000	0.000	Significant
Group III vs.	**Group IV**	113.999	0.000	Significant

DISCUSSION

The current study objectively monitored the effects of four different conservative treatment methods in patients of anterior disc displacement with reduction using surface EMG. The use of surface EMG is based on extracellular recording of the motor unit action potentials by means of surface sensors, and the magnitude of energy recorded is in the microvolt range [22].

The existence of a pathophysiologic link between clenching EMG activity and chronic TMD is still being debated. Several studies have shown that in clenching tasks, greater muscle activity involves greater bite-force generated by the elevator muscles and greater TMJ and/or tooth row loads [23-26].

In the present study the mean values were ranged from 159 to 172 (μV) for masseter muscle and 244 to 270 (μV) for temporalis muscle, the previous

findings showed low overall muscles activities in unilateral TMD patients and these were in agreement with other studies [27, 28], while Santana-Mora et al. [29] reported that electrical activities at the baseline were ranged from 170.6 to 186.9 (μV) for masseter muscle, and 213.3 to 228.3 (μV) for temporalis muscle.

The results of this study were in agreement with others [22] who stated that the surface EMG signal is lower at rest and greater under isometric contraction; therefore, when a muscle is affected by some dysfunction, the signal at rest generally increases and the surface EMG activity decreases during isometric contraction. In situations of chronic muscular pain, muscular contraction ability is reduced due to the decrease in activity of the agonist muscles and the increase in activity of the antagonist muscles [30].

There were significant increases in EMG activities of masseter and temporalis muscles during maximum voluntary clenching after using flat plane and anterior repositioning splints, these increasing in EMG activities were in agreement with Altamimy et al. [31] who study the effect of using the anterior repositioning and centric splints on masticatory muscles activity and reported increasing in EMG activity of masticatory muscles. Also these were in accord with Tecco et al. [32] who found significant increase in EMG activity of masseter and temporalis muscles after using anterior repositioning splint.

There was increase in muscle activity of masseter and temporalis muscles during maximum voluntary clench after treatment with low level laser therapy; this was in accordance with a previous study by Venezian et al. [33] who reported that treatment with low level laser therapy led to tendency to increase of EMG activity. On the other hand, other studies [34, 35] reported that the EMG activities of masticatory muscles remain unchanged after treatment with occlusal splints which may be explained by variability in EMG techniques.

The results of this study revealed that there was no significant difference for the EMG activities of masseter and temporalis muscles between different groups before treatment ($p>0.05$), so the results of each group before treatment can be considered as the baseline. However there was significant difference for the EMG activities of masseter and temporalis muscles between different groups after treatment ($p<0.05$). The pairwise comparisons showed that the flat splint group showed significant increase in EMG activities of masseter and temporalis muscles more than that of behavior therapy group, anterior repositioning splint group, and low level laser therapy group ($p<0.05$). Also the anterior repositioning splint group showed significant increase in EMG activities of masseter and temporalis muscles more than that of behavior therapy group and low level laser therapy group ($p<0.05$), While the low level laser therapy group had significant increase in EMG activities of masseter and temporalis muscles more than that of behavior therapy group ($p<0.05$).

The previous results reflected the significant effect of the flat splint and anterior repositioning splint in increasing the EMG activities of masseter and temporalis muscles more than that of behavior therapy and low level laser therapy EMG values presents variability due to differences in: electrodes position, muscle anatomy, width of subcutaneous tissue between electrode and muscle, and facial morphology [36, 37]. So the differences between this study and others may be due to the difference in the methodology.

Limitation of this study is the short follow-up period which was not sufficient to completely address the controversy about different conservative treatment modalities of TMD, so further studies are needed to evaluate the long term efficacy of these treatments.

CONCLUSION

Within the limitation of the study it can be concluded that:

- Treatment of patients with anterior disc displacement with reduction using either stabilization or anterior repositioning splint significantly increased the masticatory muscle activity.

- Behavioral therapy can't be used alone for treating patients of anterior disc displacement with reduction.
- It's advisable to use low level laser therapy as an adjunctive treatment to occlusal splint to improve masticatory function in patient with anterior disc displacement with reduction

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