Bite plates and stabilization splints in mandibular dysfunction

A clinical and electromyographic comparison

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Dahlström L, Haraldson T. Bite plates and stabilization splints in mandibular dysfunction. A clinical and electromyographic comparison. Acta Odontol Scand 1985;43:109–114. Oslo. ISSN 0001–6357.

Twenty patients with mandibular dysfunction, all women, aged 17–41 years, were randomized for treatment with either a bite plate with a frontal plateau or a full-coverage stabilization splint. The occlusal appliances were used at night for 6 weeks to compare clinical and electromyographic effects (EMGs). Integrated EMGs were recorded bilaterally from the anterior and posterior parts of the temporal muscle and the masseter muscle in the rest position and during gentle and maximal biting before and after treatment without the appliances in situ. Initially recorded EMG activity in the temporal muscle was correlated to signs of dysfunction in the rest position. Compared with previously investigated healthy subjects, the patients had lower EMG activity in the anterior part of the temporal muscle and in the masseter muscle during maximal biting. Use of occlusal appliances at night for 6 weeks did not change the EMG activity in the rest position or during maximal biting. The clinical signs improved, significantly in the splint group. The subjective symptoms improved in both groups, significantly more in the splint group. □ *Masseter muscle; muscle function; temporal muscle; temporomandibular joint syndrome*

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Different types of occlusal appliances are common in occlusal therapy of patients with mandibular dysfunction. The positive clinical effect of such treatment is well documented (1), but comparisons between different kinds of occlusal appliances are rare. Posselt & Wolff (2) concluded, from a retrospective study, that the hard acrylic bite guard gives a slightly better result than the modified Hawley plate. Greene & Laskin (3) reported similar results and also stressed the psychological effects of splint therapy in patients with mandibular dysfunction. In a clinical comparison of the two types of appliances, no differences in treatment effect were found (4). The occlusal appliances may have several effects on the masticatory system, like elimination of occlusal interferences (5), elongation of the elevator jaw muscles (6), and change of the condyle–fossa relationship (7).

Electromyographic (EMG) studies of patients with mandibular dysfunction have shown an increased total EMG activity at night (8) and an increased postural activity and low maximal strength (9).

Several electromyographic investigations of the effects of occlusal appliances in mandibular dysfunction indicate a decreased activity in the masticatory muscles with the appliances in situ. Fuchs (10) investigated the muscular activity during sleep in healthy subjects and in patients with mandibular dysfunction treated with bite plates and concluded that 'use of bite plates reduces masticatory muscular activity to the level corresponding to normal subjects'. A decreased nocturnal EMG level during treatment with full arch maxillary occlusal splints was also noted in half of a group of patients with myofascial pain (11). It has been shown that the vertical thickness of a splint is of importance for its electromyographic and clinical effects (12, 13). The degree to which the splints suppress the nocturnal activity in the masticatory muscles may depend on the severity of the initial symptoms (14).

Thus, the electromyographic and clinical

effects of therapy with an occlusal appliance seem to depend on several factors, including its design. In a previous comparative study in healthy subjects (15) the activity in the rest position decreased more after nocturnal use of a splint than after use of a bite plate. The purpose of this study was to compare the clinical and subjective effects of therapy with bite plates and stabilization splints in mandibular dysfunction and to compare any electromyographic effects on the temporal and masseter muscles after use of the different appliances.

Materials and methods

Subjects

The subjects were selected from among female referrals to the Department of Stomatognathic Physiology, University of Gothenburg, during a 3-month period. Patients with mandibular dysfunction (1) without any known joint pathosis and with a fairly complete natural dentition with molars in each quadrant were considered. The subjects selected consisted of 20 women with a mean age of 26.3 years (range, 17–41) and with mainly muscular disturbances.

Occlusal appliances

The patients were randomized for treatment with either a bite plate (modified Hawley plate, relaxation plate; Fig. 1) or a stabilization splint (full coverage splint; Fig. 2). One patient in the bite plate group refused to participate in the second EMG recording. The groups thus comprised 9 patients in the bite plate group and 10 in the splint group. The appliances were constructed from heat-cured acrylic resin for the upper jaw and carefully adjusted in the mouth (16).

Electromyographic equipment

The EMG recordings were made with a DISA electromyograph and an EMT 43B integrator. The activity in the anterior and posterior parts of the temporal muscles and in the masseter muscles were recorded bilaterally with bipolar hook electrodes in stan-

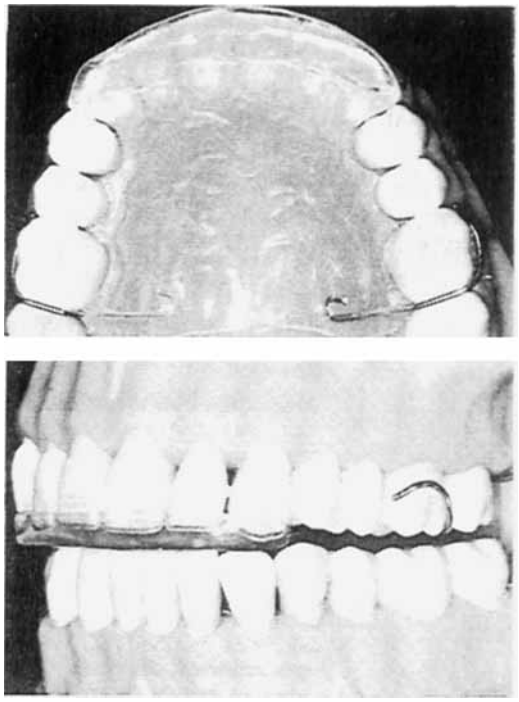

Fig. 1. The bite plate, occlusal and lateral view.

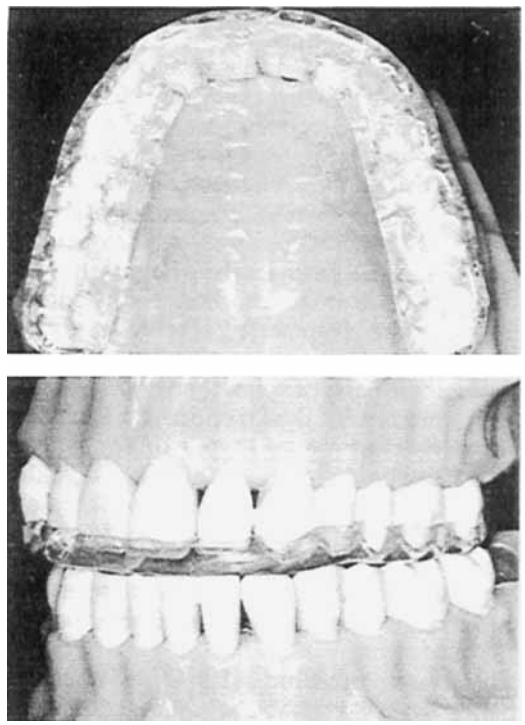

Fig. 2. The stabilization splint, occlusal and lateral view.

dardized positions. The equipment and test procedure are described elsewhere (15).

Procedure

At the first visit, all patients underwent a standardized clinical examination of the masticatory system, including palpation of the muscles of mastication and temporomandibular joints (TMJ) and assessment of mandibular mobility, TMJ function, and pain on mandibular movements (17). The dysfunction index of Helkimo (18) was calculated.

Two observers alternated at the examinations. The patients rated their discomfort on a scale from one to five, one signifying no or minimal discomfort, and two slight, three moderate, four severe, and five very severe discomfort. Alginate impressions of the jaws and an index in the retruded position was made for each patient.

At the next visit, 1 week later, initial EMG recordings were made and the bite plates or splints delivered for use at night.

After 1 week's use of the appliances, the patients were seen again for a second EMG recording, and any necessary adjustments to the bite plates or splints were made. After 6 weeks' use of the appliances at night, a third and final EMG recording was made, together with the final clinical and subjective evaluation of discomfort.

Electromyographic analyses

The bite plates or splints were not worn during the recordings. The following analyses were made on the integrated electromyograms:

1. Typical activity in 10 sec with the mandible in the rest position. The mean of four 10-sec recordings, two in the beginning and two at the end of the EMG session, was calculated.
2. Typical activity in 10 sec during gentle biting in the intercuspal position.
3. Maximal activity in 10 sec during maximal biting in the intercuspal position.

Statistical methods

Non-parametric methods, the paired Wilcoxon test, and Spearman rank correlations were used (19).

Results

Clinical findings

There were no statistically significant differences between the bite plate and splint groups in D_i scores or in subjective evaluation of symptoms at the initial examination. At the final examination, after 6 weeks' use of occlusal appliances at night, five patients in the plate group had lower D_i scores, two had higher, and two were unchanged. The median decreased from 5 to 1 (mean, 5.2 to 3). The difference was not statistically significant. The subjective symptom score decreased significantly ($p \leq 0.05$) from a median of 4 to 2 (mean, 4 to 2.8).

In the splint group, seven patients had lower D_i scores, none had higher, and three were unchanged at the final examination. The median decreased from 5.5 to 5 (mean, 6 to 3.2), and this difference was statistically significant ($p \leq 0.05$). The patients' subjective symptom scores decreased significantly ($p \leq 0.05$) from a median of 3.5 to 2 (mean, 3.5 to 1.7). At the final examination, the patients' subjective symptom scores were significantly lower in the splint than in the bite plate group ($p \leq 0.05$).

Electromyographic findings

At the initial registration there were no statistically significant differences in integrated EMG activity between the left and right sides for any pair of the tested sites at any of the functional levels tested, with one exception—the masseter muscle during maximal biting ($p \leq 0.05$).

The integrated EMG activities from the left and right sides were pooled, and the mean activity at the three registrations for the three tested sites and three tested functional levels for the patients in the bite plate and splint groups, respectively, are shown in Table 1.

The correlation coefficients between the three tested sites at the initial registration are given in Table 2.

Table 1. Integrated electromyographic activity, in μV^2s, mean (and SEM) of the left and right sides, for the 9 patients in the bite plate and 10 patients in the splint group, respectively, in the anterior (AT) and posterior (PT) parts of the temporal muscle and in the masseter muscle (M) in the rest position and during gentle and maximal biting at the three registrations

		Rest position		Gentle biting		Maximal biting	
		Plate	Splint	Plate	Splint	Plate	Splint
Reg. 1	AT	53 (20)	146 (41)	3039 (1406)	6987 (2693)	89,714 (9363)	159,114 (50,009)
	PT	1063 (488)	975 (241)	2333 (1024)	6532 (2052)	38,802 (10,324)	100,391 (21,077)
	M	37 (5)	39 (6)	626 (233)	1246 (475)	30,339 (5848)	47,539 (16,439)
Reg. 2	AT	162 (98)	128 (50)	3794 (1671)	9661 (4118)	87,764 (13,679)	234,609 (129,577)
	PT	501 (178)	1507 (797)	3322 (1604)	7842 (2838)	37,630 (9758)	129,538 (45,764)
	M	66 (32)	36 (3)	2755 (1267)	1491 (715)	45,443 (17,517)	72,472 (37,958)
Reg. 3	AT	99 (50)	132 (57)	3091 (1027)	4155 (1543)	97,266 (19,641)	192,188 (95,177)
	PT	432 (128)	658 (118)	1552 (270)	2815 (1115)	48,717 (12,407)	96,680 (47,110)
	M	44 (14)	46 (11)	255 (88)	879 (389)	25,615 (5552)	67,090 (36,562)

At the initial registration the activity was significantly higher in the splint than in the bite plate group in the rest position in the anterior part of the temporal muscle ($p \leq 0.05$), during gentle biting in the posterior part of the temporal muscle ($p \leq 0.05$), and during maximal biting in the posterior part of the temporal muscle ($p \leq 0.05$). These differences between the groups had decreased at the second and third registrations and were then not statistically significant. At the final registration the activity in the masseter muscle during gentle biting was significantly higher in the splint than in the plate group ($p \leq 0.05$).

The magnitude of activity in the rest position was greatest in the posterior part of the temporal muscle and smallest in the masseter muscle.

During gentle and maximal biting the activity was highest in the anterior part of the temporal muscle and lowest in the masseter muscle. Use of bite plates or splints had not affected the magnitude of the activity at the final registration.

After use of the bite plate the integrated EMG activity was significantly lower in the posterior part of the temporal muscle in the rest position at the second registration ($p \leq 0.05$). The activity in the masseter muscle during gentle biting was significantly lower at the final registration than at the second ($p \leq 0.05$).

After use of the splint the activity in the

Table 2. Rank correlation coefficients, according to Spearman, between integrated electromyographic activity, mean of left and right sides, in the anterior (AT) and posterior (PT) parts of the temporal muscle and in the masseter muscle (M) in the rest position and during gentle and maximal biting at the initial recording for the patients

	Rest position	Gentle biting	Maximal biting
AT-PT	0.08	0.26	0.69**
AT-M	0.13	0.48*	0.55*
PT-M	−0.06	0.29	0.09

* $p \leq 0.05$.
** $p \leq 0.01$.

posterior part of the temporal muscle during gentle biting was significantly lower at the final registration than at the initial and second registration (both $p \leq 0.05$).

Discussion

Both types of appliances tested seemed to be able to reduce the signs and symptoms of mandibular dysfunction, which is in accordance with earlier findings (2–4). It should be kept in mind, however, that different observers have been involved. This may influence the reliability of the clinical examinations to an unknown extent (20). Compared with the previously described 25 healthy subjects (15), the patients did not have significantly higher activity in the rest position in any muscle at the initial recording. Lous et al. (21) found greater postural activity in single muscles, but not as a general trait in the muscles of mastication. In the patients in this study, however, there was a positive correlation between D_i scores and activity in the anterior part ($r_s = 0.45$, $p \leq 0.05$) and the posterior part ($r_s = 0.45$, $p \leq 0.06$) of the temporal muscle in the rest position at the initial registration. The activities at the tested sites also seemed to be less well correlated in the patients, especially in the rest position, than in the healthy subjects. Of the six significant positive correlations between the tested sites in the healthy subjects, only three were found in the patient group (Table 2). During maximal biting the patients had significantly less activity than the healthy subjects in the anterior part of the temporal muscle ($p \leq 0.001$) and in the masseter muscle ($p \leq 0.05$). At lower bite force in patients with mandibular dysfunction than in controls has been reported (22, 23), and weak masticatory muscles in patients with muscle pain and tenderness have also been described (9).

Thus, the patients with mandibular dysfunction differed electromyographically from healthy subjects, in line with the results of earlier investigations. With occlusal appliances in situ, a decrease in activity has been shown several times (10, 11), and the design of the applicance may alter the muscular activity (12, 13, 24, 25).

After conventional therapy, including occlusal splints, a normalized EMG activity after regression of symptoms of mandibular dysfunction has been reported (26).

In this study, no statistically significant changes in EMG activity could be observed in the rest position or during maximal biting after 6 weeks' use of the appliances at night, although the signs and symptoms decreased in severity. The observation time in this study was considerably shorter, however, and the patients were not completely free from signs and symptoms at the final registration.

After use of splints at night for 1 week, the previously described healthy subjects (15) had significantly lower activity in the anterior and the posterior parts (both $p \leq 0.05$) of the temporal muscle in the rest position than the patients had after wearing a splint at night for 6 weeks. After use of the bite plate, the healthy subjects had significantly higher mean activity in the anterior part of the temporal muscle ($p \leq 0.01$) during maximal biting than the patients had after wearing a bite plate.

The explanation of the clinical treatment effects or the difference between them is thus not to be found in the EMG data as recorded in this study during the daytime with the occlusal appliances removed. It may be taken as an indication that the outcome of treatment of mandibular dysfunction is associated with many different factors and difficult to analyse by means of single determinants (27).

In summary, patients with mandibular dysfunction differed electromyographically from healthy subjects, and it was more difficult to influence the activity in their masticatory muscles with short-term use of bite plates and splints.

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Received for publication 10 September 1984