# Masticatory function after activator treatment

## An analysis of masticatory efficiency, occlusal contact conditions and EMG activity

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Masticatory function was investigated in nine patients with relapse and ten patients without relapse of overjet after activator treatment, Masticatory efficiency, evaluated by a chewing test, was related to the number of intermaxillary tooth contacts and the electromyographic (EMG) activity from the temporal and masseter muscles during chewing. The results of the investigation indicated that a reduced masticatory efficiency was connected with fewer intermaxillary tooth contacts and less EMG activity from the temporal and masseter muscles. In patients with relapse of overjet, masticatory efficiency and muscle activity was reduced in comparison with patients without relapse. The relationship between the number of tooth contacts and masticatory efficiency was poor in the relapse patients. Unstable occlusal conditions and atypical tongue function may be an explanation.

*Key-words:* Electromyography, intermaxillary tooth contacts, orthodontics

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Masticatory function has been investigated by judging the masticatory efficiency from a sieve analysis of chewed food (8, 9, 11, 12, 17, 28). Masticatory efficiency has also been evaluated by measuring the occlusal contact area (9, 16, 19, 25, 27) or the number of tooth contacts (26).

For normal development of the facial skeleton chewing is an important stimulus as has been found in some animal experiments (7, 21). In several clinical investigations a relationship has been established between malocclusions and reduced masticatory efficiency (6, 14, 18, 20, 25, 26). Investigations of the function of the temporal and masseter muscles during chewing, showed less electromyographic (EMG) activity in subjects with postnormal occlusion than in subjects with normal occlusion (1, 4).

Investigations dealing with masticatory

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function after orthodontic treatment have received little attention (15). No investigation has been published concerning the relationship between masticatory function and relapse after orthodontic treatment.

The aim of the present investigation was to examine masticatory function in patients with and without relapse of overjet after activator treatment and to discuss differences in masticatory efficiency in relation to occlusal contact conditions and activity in the masticatory muscles.

The investigation attempted to answer the following:

1. Is there any connection between masticatory efficiency, occlusal contact condition and muscle activity?
2. Do patients with relapse chew food as effectively as patients without relapse?
3. Do patients with relapse have different occlusal contact conditions than patients without relapse?
4. Are there any differences in masticatory muscle activity in patients with and without relapse?

## MATERIAL AND METHODS

From a follow-up material of 112 patients treated with activators 10–20 years previously (23) 19 patients were selected with respect to relapse or stability of overjet after the completion of activator treatment. The relapse group consisted of 9 patients (1 male and 8 females) where the overjet had increased during the period after treatment-follow-up examination. The stable group consisted of 10 patients (3 males and 7 females). These patients had unchanged or reduced overjet during the period after treatment-follow-up examination. The average change in overjet for the two groups during the period before treatment, after treatment and at follow-up examination was:

Relapse group 7.9. – 4.8. – 6.4 mm
Stable group 8.3. – 4.7. – 4.0 mm

Before treatment all patients had a Class II or Class I malocclusion with proclination of the maxillary incisors. The ratio of Class I and II malocclusion was the same in the two groups studied. The tooth status at the time of the follow-up examination was about the same in the two groups. The average number of missing teeth, mainly third molars, were 4.3 for the relapse group and 3.3 for the stable group.

The average age of the patients in the two groups before treatment, after treatment and at follow-up examination was:

Relapse group 11.0 – 13.7 – 28.9 years
Stable group 11.1 – 13.2 – 28.7 years

### *Masticatory efficiency*

Masticatory function measured by a masticatory efficiency test (10) was evaluated on all patients at the time of follow-up examination. The test equipment consisted of a system of sieves which fractionated the masticated test food (a silicon material for dental impressions, Optosil® Bayer). The efficiency test was carried out by having the patients chew five separate test portions of standardized optosil tablets for twenty masticatory strokes. Each of the samples of chewed material was dried and fractionated. By a mathematical formula (10) a masticatory efficiency values (R) was calculated for each test portion.

R = 100 all test material had passed through the sieves, i.e. the test material was very well pulverized.

R = 0 no test material had passed any of the sieves, i.e. the test material was poorly pulverized.

A masticatory efficiency index ($R_i$) was calculated as the mean of four out of five R-values. The most divergent value was excluded.

*Occlusal contact conditions*

Occlusal contact conditions were evaluated by counting intermaxillary tooth contacts on dental casts from the follow-up examination. Antagonist contacts were registered in the anterior and posterior dental arch segments. The anterior segment comprised incisors and canines. The posterior segment comprised premolars and molars, including third molars (Fig. 1). The maxilla was taken as a base for counting the contacts. Two antagonist contacts were possible for each maxillary tooth.

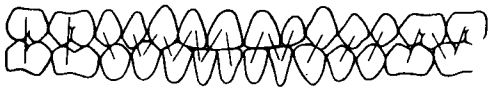

Fig. 1. Diagram demonstrating the method used in counting antagonist contacts. In this case 10 contacts were registered in the anterior and 9 in the posterior dental arch segments.

*Activity of the masticatory muscles*

A quantitative evaluation of electromyographic (EMG) activity from the temporal and masseter muscles was made at the time of follow-up examination. Bipolar hook electrodes were used as described by Ahlgren (3). The interelectrode distance was 20 mm. The electrodes were placed on the temporal muscle according to Ahlgren (3) and on the masseter muscle as described by Gustafsson & Ahlgren (13). The electrode placement on temporal and masseter muscles (Fig. 2) was performed bilaterally.

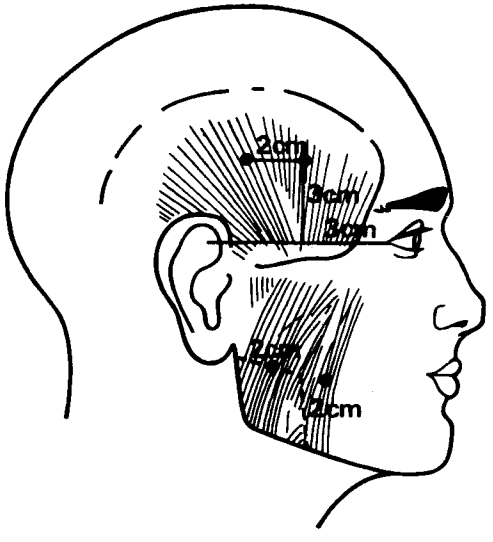


Fig. 2. Diagram demonstrating electrode placement on temporal and masseter muscles.

The EMG recordings were made with a Mingograph 800 (Elema-Schönander, Stockholm) equipped with five direct channels and four integrating channels. Paper speed was 50 mm/sec. The integrators were constructed to integrate the EMG potentials during a fixed time period of 0.05 sec. – so-called epoque integration. The integral was calculated by measuring the height of the integrated signal from the baseline. The absolute value of the integrated activity was obtained by multiplying the height of the epoque by a calibration factor.

The integrated EMG activity was recorded during the chewing of five peanuts. Calibration 500 $\mu$V/cm.

The mean values of ten consecutive chewing cycles from each patient were used for evaluation. A chewing cycle was defined as the opening and closing phase of one masticatory movement of the mandible. For the masseter muscle, measurements were made from both the working (chewing) and balancing (not chewing) side. For the temporal muscle, the mean value of the right and left side measurement was used. The following integrated EMG recordings were analysed:

a) Total activity during a chewing cycle, obtained by a summation of the included epoque values.
b) Maximal peak activity, obtained by measuring the greatest epoque value of the ten chewing cycles.

## RESULTS

*Masticatory efficiency* (Table 1)

The patients in the relapse group pulverized the test material less effectively than the patients in the stable group. The difference between the groups was highly significant ($P < 0.001$).

Table 1. *Masticatory efficiency index $R_i$, measured by the ability to pulverize a silicon test food material. Patients with relapse of overjet (n = 9) and stable overjet (n = 10) after activator treatment*

| Relapse | | Stable | | |
|---|---|---|---|---|
| $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | p |
| 24.2 | 14.7 | 44.4 | 15.7 | < 0.001 |

*Occlusal contact conditions* (Table 2)

The number of antagonist contacts in the anterior dental arch segment was to an almost significant degree ($p < 0.05$) fewer for the relapse group than for the stable group. For the posterior dental arch segment, on the other hand, no significant differences were found between the groups.

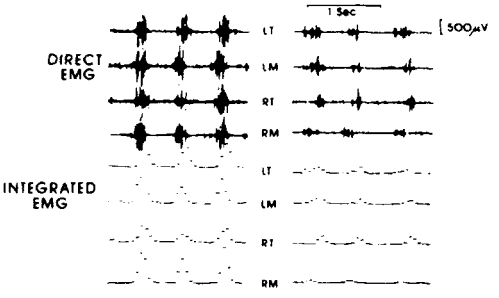


Fig. 3. Electromyograms during mastication.

Case 1 (to the left) with stable overjet. The masticatory efficiency index ($R_i$) was 52 and the number of antagonist contacts 5 in the anterior dental arch segment and 14 in the posterior dental arch segments.

Case 2 (to the right) with relapse of overjet. The masticatory efficiency index ($R_i$) was 16 and the number of antagonist contacts 1 in the anterior dental arch segment and 9 in the posterior dental arch segments.

LT = Left temporal muscle
LM = Left masseter muscle
RT = Right temporal muscle
RM = Right masseter muscle

*Electromyografic muscle activity* (Table 3)

The quantitative evaluation of the integrated EMG activity from the temporal and masseter muscles during chewing was, on the average, less in the relapse group than in the stable group for both muscles. A statistically almost significant difference ($P < 0.05$) was found for the temporal muscle and for the masseter muscle on the working side.

*Correlation analysis* (Table 4)

For all patients in the relapse and stable group masticatory efficiency was correlated to the number of antagonist contacts in the posterior dental arch segment ($r = 0.51$, $p < 0.05$). The correlation was larger for the stable group ($r = 0.63$) than for the relapse group ($r = 0.28$). Masticatory efficiency for all patients in both groups was also correlated to EMG activity to the temporal ($r = 0.41$) and working side masseter muscles ($r = 0.41$).

An almost significant correlation was found between antagonist contacts in the posterior dental arch segment and EMG activity from the temporal ($r = 0.50$, $p < 0.05$) and working side masseter muscles ($v = 0.57$, $p < 0.05$).

*Case presentation*

Electromyograms from two patients with a Class II, Division 1 malocclusion are presented (Fig. 3). Treatment was performed with activators as the sole orthodontic appliance. Case 1 exhibited a stable long-term treatment result of overjet correction while Case 2 relapsed.

Table 2. *Number of antagonist contacts in the anterior and posterior dental arch segments. Patients with relapse of overjet (n = 9) and stable overjet (n = 10) after activator treatment*

| Antagonist contacts | Relapse | | Stable | | |
|---|---|---|---|---|---|
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | p |
| Anterior segment | 2.1 | 3.1 | 5.7 | 3.6 | < 0.05 |
| Posterior segment | 10.4 | 1.5 | 11.3 | 2.9 | N.S.* |
| Anterior + posterior segment | 12.6 | 3.2 | 17.0 | 4.2 | < 0.05 |

* N.S.; not statistically significant.

Table 3. *Integrated EMG activity from temporal and masseter muscles. Maximal and total epoque values in μV during a chewing cycle. Patients with relapse of overjet (n = 9) and stable overjet (n = 10) after activator treatment*

| Muscle | Maximal | | | | | Total | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Relapse | | Stable | | | Relapse | | Stable | | |
| | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | p | $\bar{X}$ | S.D. | $\bar{X}$ | S.D. | p |
| Temporal | 436 | 287 | 612 | 284 | < 0.05 | 616 | 381 | 1131 | 549 | < 0.05 |
| Masseter working side | 428 | 162 | 665 | 301 | < 0.05 | 558 | 252 | 1190 | 782 | < 0.05 |
| Masseter balancing side | 189 | 132 | 400 | 324 | N.S.* | 229 | 193 | 498 | 576 | N.S.* |

* N.S. not statistically significant.

Table 4. *Correlation coefficients (r) between different variables in 19 patients treated with activators*

| Variable | | EMG-activity (total epoque values) | | | Antagonist contacts | |
|---|---|---|---|---|---|---|
| | | Temporal | Masseter working side | Masseter balancing side | Posterior | Anterior |
| Masticatory efficiency | | 0.41 | 0.41 | 0.15 | 0.51* | − 0.11 |
| Antagonist contacts | posterior | 0.50* | 0.57* | 0.20 | | 0.01 |
| | anterior | 0.19 | 0.13 | 0.06 | | |

* indicates a significance beyond the five per cent level of confidence.

## DISCUSSION

When investigating all 19 patients a moderate correlation ($r = 0.51$) was found between masticatory efficiency and the number of antagonist contacts in the posterior dental arch segment. This was in agreement with several other investigations where a direct relationship was found between masticatory efficiency and the occlusal contact area (16, 19, 25) or the number of tooth contacts (26) in the posterior dental arch segment.

The number of antagonist contacts in the anterior dental arch segment differed markedly between the stable and relapse groups, because relapse of overjet was accompanied with an open bite in many cases. However, anterior teeth are not likely to influence masticatory efficiency significantly. This was also reflected by the low and negative correlation ($r = -0.11$) between masticatory efficiency and the number of antagonist contacts in the anterior dental arch segment.

The number of antagonist contacts in the posterior dental arch segment was about the same in the patients with stable overjet and relapse of overjet after activator treatment. However, masticatory efficiency was found to be significantly greater ($p < 0.001$) in the patients from the stable group compared to those from the relapse group. A moderate correlation ($r = 0.63$) between masticatory efficiency and number of antagonist contacts in the posterior dental arch segment was found for the stable group. For the relapse group, on the other hand, the correlation was poor ($r = 0.28$). These findings indicate that other factors than the number of occlusal contacts in the posterior dental arch segment influenced masticatory efficiency in the patients investigated. A cusp-to-cusp occlusion in the posterior dental arch segment was found more frequently in the relapse patients than in the non-relapse patients. Such an occlusal relationship may be thought to impair masticatory performance (18). In an earlier study Pancherz (24) found that the patients with relapse of overjet had a greater EMG activity from the mentalis muscle and exhibited a much higher frequency of tongue thrust and open bite than the patients without relapse. Open bite and tongue thrust may influence the patients' ability to position and maintain the food on the occlusal food table and thus influence masticatory efficiency (6, 16).

When evaluating the balance of EMG activity from the temporal and masseter muscles Pancherz (23) found imbalance between the right and left temporal muscles during strong biting in intercuspal position in patients from the relapse group but not in patients from the stable group. Imbalance in muscle activity may be a result of cuspal interferences (2). However, when investigating the present patients clinically (23) no differences were found between the groups for functional occlusal disturbances. Asymmetric sliding movements from retruded contact position to intercuspal position were found in three patients from each group. Muscle imbalance may also be due to an unstable occlusion as a result of the tongue thrust (22) found in the patients (24) and may thus explain the reduced EMG activity during chewing found in the relapse group when compared to the stable group.

When correlating EMG activity to masticatory efficiency a moderate correlation was found for the temporal ($r = 0.41$) and working side masseter muscles ($r = 0.41$). This was not in agreement with other investigators (12, 25) who found no relationship between biting force and masticatory efficiency.

The number of tooth contacts in the posterior dental arch segment was almost significantly ($p < 0.05$) correlated to EMG activity. The correlation coefficient was 0.5 for the temporal muscle and 0.57 for the masseter muscle on the working side. No differences were found between the relaps and stable group. These results agreed with Ahlgren (5) but not with Shiere and Manl (25) who found no relationship betwee

maximum biting force and food platform area.

In earlier investigations it was found that the chewing pattern influenced both the muscle force and the chewing efficiency. Lateral chewing strokes were accompanied by more muscle activity (1) and were more effective (12, 29) than vertical chewing strokes. In this investigation, however, all subjects in both groups chewed with lateral strokes, when the patients were examined clinically during the chewing test.

From the results of this investigation it may be concluded that an impaired masticatory ability was connected with fewer intermaxillary tooth contacts and diminished activity of the masticatory muscles. In the relapse patients, however, the relationship between the number of tooth contacts and masticatory efficiency was poor. Unstable occlusal conditions and an atypical tongue function are presumable factors of importance affecting masticatory efficiency in these patients.

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