

Temporal and masseter muscle activity in children and adults with normal occlusion

An electromyographic investigation

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Temporal and masseter muscle activity was investigated in male subjects with normal occlusion, 11 years ($n = 23$) and 25 years ($n = 21$) of age. Integrated EMG recordings were analysed quantitatively during maximal biting in intercuspal position and during chewing of peanuts. The results of the investigation revealed the following:

1. Masseter muscle activity was greater in the older than in the younger age group.
2. Temporal muscle activity was the same in both age groups.
3. Masseter muscle activity was increased in relation to temporal muscle activity in the older subjects. In the younger subjects the same activity was found in the two muscles.
4. For the temporal muscle the chewing activity was positively correlated to maximal biting activity in both age groups. For the masseter muscle a clear correlation between chewing and biting activity was found in the younger age group only.

The difference in EMG activity found between children and adults may be attributed to age changes and/or an exercising effect of the masseter muscle occurring during maturation.

Key-words: Integrated EMG; maximal biting; chewing

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Electromyographic (EMG) investigations of the temporal and masseter muscles have been the focus of attention of research workers for several years. In the field of orthodontics investigators have, among other things, tried to correlate EMG activity with occlusal relationships (1, 4, 13, 14, 16, 17, 21), craniofacial morphology (1, 4, 8, 18) and different treatment procedures (5, 6, 14, 15, 21). Investigations in which masticatory mus-

cle activity is related to age are sparse and incomplete. Furthermore, the variety of recording techniques and types of electrodes used in the EMG studies makes it difficult to compare the various findings reported. The purpose of the present investigation was, therefore, to analyse quantitatively the EMG activity in the temporal and masseter muscles with a standardized electrode technique and to compare recordings in homogenous groups of children and adults.

MATERIAL AND METHODS

23 boys aged 10–13 years (Mean = 11 years) and 21 young men aged 23–33 years (Mean = 25 years) were selected for the investigation. All subjects had normal occlusion without clinical evidence of dysfunction of the stomatognathic system. None of the subjects had been subjected to orthodontic treatment. The 11 year old boys were selected from the children receiving regular dental care at the Department of Pedodontics, School of Dentistry, University of Lund. The 21 young men were dental students attending the courses in orthodontics at the University.

A quantitative analysis of electromyographic (EMG) activity from the temporal and masseter muscles was performed by using bipolar hook electrodes (2). The electrodes were placed bilaterally on the temporal and masseter muscles according to Fig. 1. Direct and integrated recordings were obtained from all muscles studied with the aid of a Mingograph 800 (Elema – Schönander, Stockholm). The integrating technique has been described previously (20). An amplification of 500 or 1000 μ V/cm was used for the recordings. Paper speed was 50 mm/sec.

The following registrations and measurements were made on the integrated EMG recordings:

Maximal biting in intercuspal position

The patients were instructed to close their jaws in centric occlusion as forcibly as possible. The maximal integrated activity during a biting cycle (the mean value of five consecutive cycles) was used for evaluation. For both the temporal and masseter muscles the mean value of right and left side registrations was used.

Chewing five peanuts

The only instruction given to the subjects was to eat the peanuts. The maximal inte-

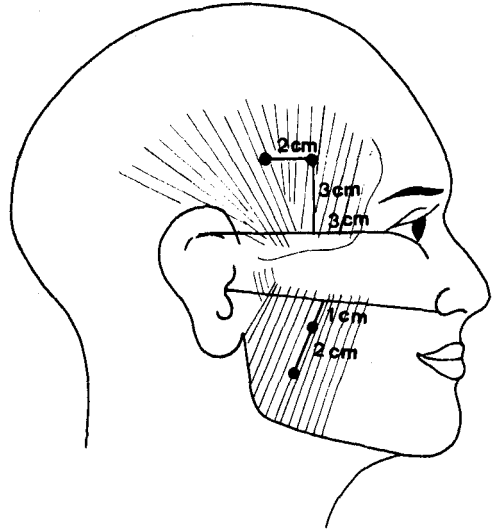


Fig. 1. Diagram demonstrating electrode placement on the temporal and the masseter muscles.

grated activity during a chewing cycle (the mean value of ten consecutive cycles) was used for evaluation. For the temporal muscle the mean value of right and left side measurements was used. For the masseter muscle the mean value of right and left side measurements was used in cases with a bilateral chewing pattern. In cases with an unilateral chewing pattern the EMG activity was recorded from the chewing side only.

All measurements on the electromyograms were made to the nearest mm.

The relationship between temporal and masseter muscle activity during maximal biting and chewing was evaluated in each subject by calculating the integrated EMG ratio temporal/masseter muscle activity. A ratio 1/1 indicated an equal activity in the temporal and masseter muscle. A ratio larger than 1/1 indicated a greater temporal than masseter muscle activity and a ratio less than 1/1 indicated a greater masseter than temporal muscle activity.

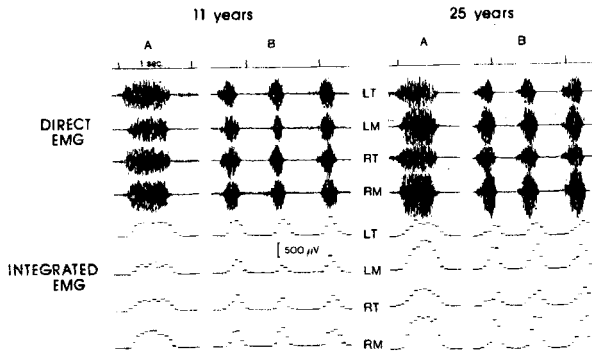


Fig. 2. Electromyograms during maximal biting in intercuspal position (A) and during chewing of peanuts (B) in two cases 11 years and 25 years of age.

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

Statistical methods

The arithmetic mean (Mean) and the standard deviation (S.D.) were calculated for temporal and masseter muscle activity. Differences in EMG measurements between the two muscles and between the two age groups were tested by Student's *t*-test. The interdependence between maximal biting and chewing activity was analysed with the Pearson coefficient of correlation (*r*).

The levels of significance used were $p < 0.001$, $p < 0.01$ and $p < 0.05$. $p \geq 0.05$ was regarded as not significant (N.S.).

RESULTS

Electromyograms from two subjects 11 years and 25 years of age are shown in Fig. 2.

Temporal muscle activity

During maximal biting in intercuspal position the EMG activity from the temporal muscle was on the average the same in the 11 year and 25 year old subjects. Although the EMG activity during chewing of peanuts was less than during maximal biting, the same amount of activity was found in both age groups (Table 1). Maximal biting activity was significantly

correlated to chewing activity. In the 11 year old group the correlation coefficient (*r*) was 0.63 ($p < 0.001$), and in the 25 year old group 0.60 ($p < 0.01$).

Masseter muscle activity

Both during maximal biting and chewing the EMG activity from the masseter muscle was significantly ($p < 0.001$) greater for the older than the younger age group (Table 1). A high correlation ($r = 0.85$, $p < 0.001$) was found between the biting and chewing activity in the 11 year old group. In the 25 year old group, on the other hand, the correlation between biting and chewing activity was not significant ($r = 0.28$).

Comparison between temporal and masseter muscle activity

In the adults the EMG activity from the masseter muscle was on the average significantly greater ($p < 0.001$) than from the temporal muscle. This was true both during maximal biting and chewing. As regards the children, no difference in EMG activity in the temporal and masseter muscles was found, neither during maximal biting nor chewing.

When comparing temporal and masseter muscle activity by calculating the EMG ratio temporal/masseter muscle

Table 1. *Maximal integrated EMG activity (in μV) from temporal and masseter muscles during maximal biting in intercuspal position and during chewing of peanuts in male subjects 11 years ($n = 23$) and 25 years ($n = 21$) of age*

		11 years		25 years		P
		Mean	S.D.	Mean	S.D.	
Temporal	Maximal biting	646	118	694	198	N.S.
	Chewing	414	101	474	183	N.S.
Masseter	Maximal biting	631	253	945	315	<0.001
	Chewing	460	176	774	295	<0.001

significant differences ($p < 0.01$) between the two age groups were found for both maximal biting (Fig. 3) and chewing (Fig. 4). During maximal biting the average ratio was 1.1/1 for the younger age group and 0.8/1 for the older age group. During chewing the corresponding values were 1.0/1 and 0.6/1, respectively.

DISCUSSION

The integrated EMG represents a composite picture of the number of active motor fibres and the frequency of their excitation. The results of this investigation revealed an increase in integrated EMG activity of the masseter muscle with age, both during maximal biting and chewing. The temporalis EMG, on the other hand, seemed unaffected by age. Similar findings have been reported in other EMG studies performed in man (14), monkeys (9) and pigs (7). Ahlgren (1) and Ingervall & Thilander (8), on the other hand, found when examining 9–14 year old children, that the EMG activity was reduced in relation to maturation. This occurrence may be explained by an inhibition of muscle activity during the transition from the primary to the permanent dentition. The age differences in the

material of Ahlgren (1) and Ingervall & Thilander (8) were, however, small in relation to individual differences and no significant relationship was found between age and EMG.

Advancing age (24) and physical training of a muscle (10, 11) has been shown to increase the average duration of the action potentials and the mean amplitude (24). It has also been demonstrated that the diameter of the muscle fibre increases with age (23) and that the amplitude of the action potentials is dependent on the fibre diameter (22). This agrees with the results of Ahlgren et al. (3) who in bruxism cases found that a hypertrophy of the masseter muscle fibres was accompanied by an increased EMG activity. Thus, the difference in EMG activity found between the present children and adults may be explained by both age changes and motor learning (12) and/or an exercising effect of especially the masseter muscle occurring during normal jaw functions. This agrees with the hypothesis that the masseter is a force muscle and the temporalis a position muscle. A training effect of the masseter muscle has also been reported to occur during orthodontic treatment when using bite jumping devices such as the activator (5, 14) or the Herbst appliance (21).

Whether or not the number of teeth in

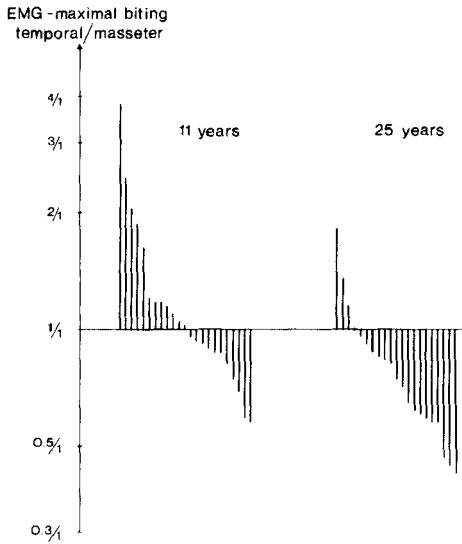


Fig. 3. EMG ratio (logarithmic scale) temporal/masseter muscle activity during maximal biting in intercuspal position in male subjects 11 years ($n = 23$) and 25 years ($n = 21$) of age.

occlusion has any effect on masticatory muscle activity has been widely discussed (1, 8, 19). In this investigation all adult subjects had a full complement of permanent teeth while several of the children were in the mixed dentition. Therefore, the different dental status found in the present material could possibly also affect the masticatory muscles and contribute to explain the greater EMG activity ascertained in the adults. This supposition would agree with Scott's (25) finding that the muscles of mastication develop in association with the development of the dentition. Since it has been shown that the EMG activity of the masticatory muscles is related to craniofacial morphology (1, 4, 8, 18, 20), it cannot be excluded that craniofacial changes occurring during growth will also affect muscle function.

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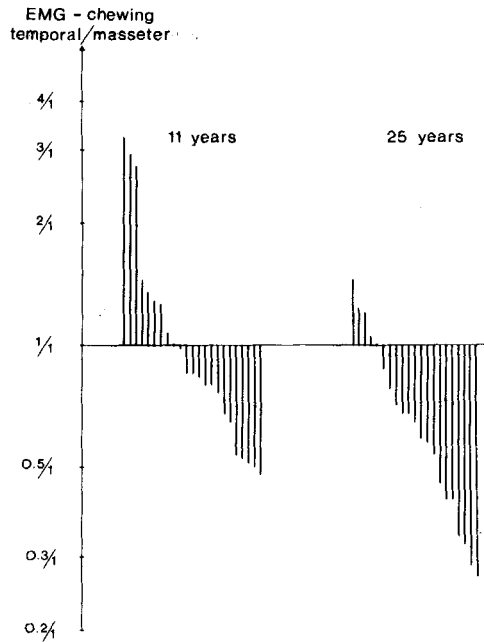


Fig. 4. EMG ratio (logarithmic scale) temporal/masseter muscle activity during chewing of peanuts in male subjects 11 years ($n = 23$) and 25 years ($n = 21$) of age.

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