An Electromyographic Study on Masticatory Muscles —Comparison and Examination of Crossbite Patients Preoperatively, Postoperatively and in Post Retention—

by

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1. Introduction

Although there has been a fair amount of literature published on the application of electromyography on crossbite patients, both in their preoperative and postoperative stages, the research efforts during their retention and post retention conditions are yet scanty. Along this line of thinking, this author concerned himself with a comparison of crossbite patients after several years of retention in whom the muscles in these patients had been morphologically improved with reference to the behavior of the masticatory muscles.

2. Materials and Methods

2.1 Materials

Of the crossbite patients (Angle Class 111 anterior crossbite) consulted in the Department of Orthodontics, Nihon University Dental Hospital, Tokyo, a total sample of 10 males and 2 females with chief masticatory function on the right were selected. They were subjected to preoperative examinations (10 yrs. 9 mos. on the average), postoperative examinations (13 yrs. 2 mos. on the average after dynamic treatment) and post retention stages after the passage of 29 mos. after the removal of their retainers, their average age being 16 yrs. 5 mos.

For controls, 2 males and 3 females corresponding to Hellman dental ages after orthodontic treatment (12 yrs. 5 mos. on the average) and another group of 7 males and 5 females (19 yrs. 8 mos.) who corresponded to those in post retention stages were selected. Both the experimental and control subjects were subjected to electromyography; however in the latter, they had no experience with orthodontic treatment and their main masticatory force was exerted on the right. Ages, sexes and Hellman dental ages of these two groups are given in Table 1.

2.2 Methods

In all the subjects, experimental and control, only the right side was employed and three different muscles, the anterior portion of the M. temporomandibularis (Ta), the posterior portion of the M. temporomandibularis (Tp) and the shallow portion of the masseter (Mm), were selectively used (Fig. 1).

Bipolar clinical E.C.G. spins were used as electrodes at a distance of 1 cm between the electrodes. The occlusal and jaw movements which the patients and

Table 1 Sex, Hellman dental age and physical age of the subjects

Case No.	Sex		Hellman dental age (Hellman)					Age (Y.M.)				Retention mos.		
	Control		Pre-operative	Postop-erative	Post retention	Control		Pre-operative	Post operative	Post retention	Control		Appliance used	
	A	B				A	B					A		B
1	M	M	IIIB	IVA	IVA	IIIC	IVA	10.0	13.1	15.4	11.2	18.1	②③④	13
2	M	F	IIIC	IVA	IVC	IIIC	IVC	10.4	12.5	15.9	11.8	19.3	② ④	27
3	M	F	IIIC	IVA	IVC	IVA	IVC	13.5	16.0	18.7	11.2	18.1	②③④⑥	20
4	M	M	IIIB	IVA	IVA	IVA	IVA	9.3	12.9	14.8	13.1	17.3	② ④	12
5	M	F	IIIB	IVA	IVA	IVA	IVA	10.4	13.0	15.9	14.2	19.2	②③④⑥	24
6	M	F	IIIC	IVA	IVC		IVC	13.4	15.8	18.6		20.5	②③④⑥	20
7	M	M	IIIC	IVA	IVA		IVC	10.2	12.9	15.9		19.4	②③④	21
8	M	M	IIIB	IVA	IVC		VA	10.5	11.0	17.4		21.2	① ⑤	66
9	M	F	IIIB	IVA	IVC		VA	10.2	10.9	18.0		22.3	①③④	74
10	F	F	IIIC	IVA	IVA		IVC	11.2	13.1	16.7		21.4	②③④	26
11	M	F	IIIB	IVA	IVA		IVA	10.4	13.4	15.7		20.2	②③④⑥	19
12	F	F	IIIB	IVA	IVC		IVC	12.3	14.2	18.0		21.9	② ⑤	31

Note: ① F.K.O ② Edgewise ③ Chin cap ④ Hawley type retainer ⑤ F.K.O retainer ⑥ Chin cap retainer

Ta : Anterior portion of M. temporomandibularis
 Tp : Posterior portion of M. temporomandibularis
 Mm : Masseter

Fig. 1 Induction positions of electromyography

controls were instructed to perform are as follows.

- A. Bite
 - i. Maximum bite (at centric occlusion)
 - ii. Incisal bite
- B. Masticatory movement

The subjects were instructed to chew a commercial chewing-gum in the form of a sheet, and the masticatory movements were examined on both the right and left sides.

The electromyographs that were obtained were measured at their maximum amplitudes and ratios between the Tp/Ta values and the Mm/Ta values were calculated on the basis of Ta as a standard.

For masticatory movement, the patients in whom their mastication had become stabilized were subjected to 20 continuous strokes for measurement and the resulting data was used as indicative of mean values. The various sets of values, expressed in percentages, were computed for the mean values and standard deviations for detecting statistical differences between the preoperative and postoperative stages as well as between the post-operative and post-retention stages. Moreover, the detection of statistical differences was performed between the postoperative patients and the A control group and between the post-retention subjects and the B control group.

3. Results

The results relative to the maximum and incisal bites are given in Table 2 and Fig. 2, while those of masticatory movement are shown in Table 3 and Fig. 3.

Table 2 comparison of maximum amplitudes in each group (Tp/Ta, M/Ta)

		Preoperative		Postoperative		Post retention		Controls A		Controls B	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Maximum bite	Tp/Ta	104.2	39.1	*161.3	68.2	*122.5	30.1	137.6	26.0	92.5	24.5
	Mm/Ta	79.1	28.2	98.5	41.3	131.5	48.3	79.0	55.1	*106.0	30.1
Right mastication	Tp/Ta	105.2	44.3	121.5	36.1	88.8	47.3	114.3	53.7	82.5	51.3
	Mm/Ta	77.1	41.5	81.1	24.2	*109.3	39.6	84.8	41.2	129.3	58.4
Left mastication	Tp/Ta	129.1	33.4	*143.2	28.1	110.3	31.4	127.2	47.1	119.0	98.2
	Mm/Ta	92.2	44.1	85.6	25.0	*71.2	26.4	62.1	35.3	85.2	58.2
Incisal mastication	Tp/Ta	241.3	137.2	**79.4	53.3	101.2	55.1	61.8	17.3	203.1	76.1
	Mm/Ta	26.1	30.2	*102.5	62.4	**355.5	129.1	58.7	16.0	*567.6	213.5

Unit: % *: $P < 0.05$ **: $P < 0.01$

Fig. 2 Comparison of the maximum amplitudes

Fig. 3 Comparison of the maximum amplitudes

4. Summary and Discussion

4.1 The maximum bite

Although there was a measured decrease in the Tp/Ta value preoperatively, in the postoperative stage both the Tp/Ta and the Mm/Ta values showed a tendency to increase, the tendency in the former being particularly noteworthy. The main reason for this may lie in the fact that the mandible was retracted posteriorly. Also, in the post-retention stage, as already pointed out by Moss, they came to have more or less the same values approximating those of normal occlusal subjects.

In a comparison of the preoperative, postoperative and the A control groups, the general feature was $Tp/Ta > Mm/Ta$ and this finding may be related to the fact that, in infants especially, the Tp is far more active than the Mm in the maximum bite.

4.2 The incisal bite

Compared with the preoperative group, the Tp/Ta value was found to be much larger than the Mm/Ta but this fact can be easily explained when sufficient consideration is taken into account from a morphological point of view. In the postoperative group both the Tp/Ta and the Mm/Ta values were observed to have more or less the same relationship to those of the A controls. The reason for

this may be due to the fact that the Tp is a muscle concerned with the posterior movement of the jaw and also to the premature age of the Mm involved. As regards to the post-retention group, on the other hand, the tendency was that the Mm/Ta value was larger than that of the Tp/Ta regardless of the same movement pattern and thus constituted a main movement source of the Mm and the data obtained was close to that of the B controls.

4.3 Masticatory movement

In right masticatory movement the tendency was for $Tp/Ta > Mm/Ta$ in pre-, post-operative and post-retention in the A controls but, the post-retention group and the B controls showed the reverse order to the above revealing the same tendency as in maximum bite.

For this reason, it may be reasonably inferred that some different muscular activity in masticatory movement is involved between the ages corresponding to pre-, post-operative and the A controls to that of the post-retention group and the B controls.

When the Tp/Ta and Mm/Ta values were examined on an individual basis, on the other hand, there were no pronounced differences observed in the maximum bite common to pre-, post-operative and the A controls resulting in more or less similar data. The conclusion drawn from this fact is that in a limited movement such as maximum bite and masticatory movement with a soft type of comestible, such as chewing gum, certain changes are bound to be introduced into the electromyograms.

Stated another way it would be to say that although a definite difference is discernable between normal occlusal and malocclusal subjects at occlusion in the molar region any noteworthy masticatory movement will not always occur in a normal occlusal situation.

5. Conclusions

The present study, in which electromyograms were taken of crossbite and normal occlusal subjects and then comparatively examined brought the following conclusions to light.

1. In maximum bite and free masticatory movement using chewing gum on the right side, the function of the masticatory muscles were found to be more active in the postoperative group as compared with the preoperative group. Here the posterior portion of the M. temporomandibularis constituted a major pattern in the masticatory mechanism. In the post-retention group, on the other hand, the major masticatory pattern was found in the masseter and the pattern resembled that of the B controls (adult normal occlusal subjects).

2. In the incisal bite the masticatory pattern in the preoperative group was in a state of overbite attributable to the activity of the posterior portion of the M. temporomandibularis.

In the postoperative group, however, the posterior portion of the M. temporomandibularis and the masseter revealed more or less equal muscular activity.

3. As for masticatory movement, there were no definite differences observed between the muscular activities of the pre-, post-operative and post-retention groups

and the normal occlusal controls corresponding to them. On the other hand, in such a limited movement as maximum bite and free masticatory movement the differences in muscular activity were clearly corroborated.