An Electromyographic Study on the Masticatory Muscles in the Crossbite Patients before and after Orthodontic Treatment

By

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1. Introduction

In recent orthodontic practice, the introduction of multi-banded appliances has contributed heavily to the advancement of orthodontics and, thanks to them, it is possible to rectify the anomaly of jaws to a certain extent.

In final analysis, however, the ultimate object of an orthodontic treatment is directed to an improvement of morphologic and esthetic aspects, and sufficient attention is not paid to the functional change of muscles in the oral region. It is also true that, even if the morphology and esthetics have been satisfactorily improved, there is a possibility of relapse unless various gnathofacial components are brought into harmony. In the present study, therefore, the author was concerned with the examinations of muscle function in malocclusal patients; especially with reference to muscle function of the crossbite patients before, during and after orthodontic treatments to elucidate what changes would take place in these stages.

2. Materials and Method

2.1 Study subjects.

By way of study materials, a selective use was made of 11 crossbite patients (Angle' Class III anterior crossbite, dental age IIIA–IIIC), consisting of 4 boys and 7 girls treated in the Department of Orthodontics, Nihon University School of Dentistry. As controls, 2 boys and 2 girls diagnosed as in possession of normal occlusion, and their muscular growth during the corresponding period was studied for comparative purposes.

2.2 Cephalographic analyses.

Cephalograms were taken of the subjects before and after orthodontic treatments and, classified into respective dental ages, the analytical values were compared with those of Iizuka.

2.3 Electromyography and recording apparatus.

An electromyographic apparatus MM-22A (manufactured by the Japan Optical Co., and equipped with a recorder) and a linear pen writing machine also of the same manufacturer (RJG-3004) were used. Conditions were set up so that electric currents were 0.5mV: 10mm and the speed of recording sheet was 25mm/sec.

2.4 Positions of EMG inductive electrodes.

The right side muscles were selected in all the subjects, where 4 positions of front temporomandibular muscle (T_a), rear temporomandibular muscle (T_p), masseter

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Fig. 1. EMG inductive positions
 1. Front temporomandibular M. (Ta)
 2. Rear temporomandibular M. (Tp)
 3. Masseter (Mm)
 4. Mandibular biverter (Dg)

(M_m) and front of mandibular biverter muscle (D_g) were chosen. Spins for electroencephalography were used as double electrode at a distance of 1cm from each other. Indifferent electrode was 5mm in diameter.

Fig. 2. Measurement of occlusal rhythm
 A. Interval
 B. Persistence
 C. Cycle (A+B)

Table 1. Electric voltage in the crossbite patients
(Maximum mandibular movement)

	Mouth opening			Right movement			Left movement			Forward movement			Backward movement		
	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.
Ta	72.3	10.0	172.5	59.8	0.0	155.0	43.2	0.0	150.0	60.5	0.0	165.0	110.0	20.0	222.5
Tp	85.0	17.5	222.5	201.1	70.0	420.0	53.9	0.0	165.0	86.8	0.0	370.0	321.4	0.0	775.0
Mm	30.0	0.0	120.0	33.2	0.0	140.0	39.3	7.5	150.0	75.2	0.0	225.0	13.0	0.0	37.5
Dg	167.7	95.0	280.0	50.0	15.0	115.0	63.4	15.0	180.0	91.6	25.0	200.0	147.0	10.0	387.5

Table 2. Electric voltage in the controls
(Maximum mandibular movement)

	Mouth opening			Right movement			Left movement			Forward movement			Backward movement		
	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.	Mean	Minim.	Maxim.
Ta	18.8	10.0	40.0	46.3	22.5	60.0	1.9	0.0	7.5	8.8	0.0	25.0	125.0	65.0	225.0
Tp	31.3	25.0	50.0	249.5	47.5	585.0	16.3	0.0	35.0	24.4	7.5	55.0	313.1	125.0	475.0
Mm	40.6	0.0	120.0	5.0	0.0	20.0	97.5	15.0	162.5	170.6	42.5	325.0	12.5	0.0	30.0
Dg	198.8	140.0	300.0	69.4	40.0	97.5	100.6	50.0	132.5	160.6	75.0	275.0	174.4	97.5	250.0

Table 3. Electric voltage at edge-to-edge centric occlusion (Crossbite subjects) (μV)

	Edge-to-edge bite			Centric occlusal bite		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Ta	153.6	90.0-300.0		170.2	45.0-335.0	
Tp	386.4	75.0-865.0		332.0	50.0-647.6	
Mm	28.4	0.0-95.0		47.0	0.0-150.0	
Dg	121.1	10.0-227.5		51.6	0.0-200.0	

Table 4. Electric voltage at edge-to-edge centric occlusion (Controls) (μV)

	Edge-to-edge bite			Centric occlusal bite		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Ta	86.9	60.0-115.0		216.9	120.0-317.5	
Tp	41.9	10.0-75.0		336.3	60.0-735.0	
Mm	211.9	162.5-297.5		343.8	155.0-555.0	
Dg	50.0	25.0-105.0		23.8	0.0-95.0	

Table 5. Maximum electric voltage of normal subjects. (μV)

		Initial exam.	After 2 mos.	After 5 mos.
Mouth opening	Ta	40.0	20.0	25.0
	Tp	25.0	102.5	60.0
	Mm	0.0	10.0	25.0
	Dg	300.0	210.0	240.0
Right movement	Ta	47.5	47.5	55.0
	Tp	90.0	175.0	152.5
	Mm	0.0	0.0	15.0
	Dg	97.5	115.0	160.0
Left movement	Ta	7.5	0.0	0.0
	Tp	20.0	35.0	10.0
	Mm	15.0	40.0	50.0
	Dg	110.0	90.0	257.5
Forward movement	Ta	10.0	0.0	0.0
	Tp	55.0	45.0	0.0
	Mm	135.0	50.0	125.0
	Dg	185.0	110.0	230.0
Backward movement	Ta	100.0	80.0	97.5
	Tp	252.5	310.0	385.0
	Mm	0.0	20.0	12.5
	Dg	150.0	150.0	165.0
Edge-to-edge bite	Ta	60.0	42.5	130.0
	Tp	75.0	140.0	92.5
	Mm	200.0	167.5	215.0
	Dg	105.0	15.0	20.0
Centric occlusal bite	Ta	120.0	155.0	175.0
	Tp	75.0	240.0	162.5
	Mm	155.0	150.0	197.5
	Dg	0.0	0.0	0.0

T.N.

Table 6. Maximum electric voltage of crossbite patients at the end of orthodontic treatment (μV)

		Before treat.	During treat.	After treat.	After 1 mo.	After 2 mos.
Mouth opening	Ta	10.0	70.0	55.0	47.0	170.0
	Tp	17.5	110.0	45.0	100.5	60.0
	Mm	120.0	0.0	0.0	0.0	0.0
	Dg	210.0	212.5	272.5	250.0	247.0
Right movement	Ta	25.0	60.0	32.5	70.0	60.0
	Tp	210.0	397.5	147.0	200.0	162.0
	Mm	25.0	0.0	0.0	0.0	0.0
	Dg	25.0	72.5	15.0	50.0	50.0
Left movement	Ta	7.5	17.5	0.0	0.0	0.0
	Tp	5.0	30.0	0.0	0.0	0.0
	Mm	100.0	42.5	0.0	0.0	60.0
	Dg	70.0	115.0	50.0	60.0	40.0
Forward movement	Ta	0.0	20.0	10.0	0.0	0.0
	Tp	0.0	0.0	20.0	0.0	0.0
	Mm	205.0	82.5	10.0	20.0	20.0
	Dg	100.0	97.5	45.0	45.0	52.0
Backward movement	Ta	210.0	145.0	50.0	145.0	100.0
	Tp	510.0	425.0	492.5	507.5	450.0
	Mm	35.0	0.0	0.0	0.0	0.0
	Dg	257.5	75.0	70.0	90.0	125.0
Edge-to-edge bite	Ta	90.0	55.0	300.0	25.0	30.0
	Tp	430.0	427.5	665.0	10.0	5.0
	Mm	95.0	317.5	110.0	155.0	252.0
	Dg	10.0	0.0	0.0	97.0	10.0
Centric occlusal bite	Ta	45.0		282.5	400.0	360.0
	Tp	240.0		442.5	790.0	642.0
	Mm	0.0		240.0	350.0	360.0
	Dg	35.0		10.0	25.0	5.0

M.M.

2.5 EMG data.

EMG data thus collected included, 1) Mandibular rest position, 2) Maximum movement, maximum mouth opening, maximum lateral, front and back positions, 3) Edge-to-edge occlusal position, 4) Centric occlusal position, and 5) Manner of masticatory movement (Fig. 2).

3. Findings

Comparative data between the normal and crossbite patients, and findings of pre- and postoperative orthodontic care as related to muscle functions are given in Tables 1 to 6, and in Figs. 3 to 6.

4. Discussion

4.1 Pre-orthodontic treatment.

In EMG findings, at the maximum mandibular movement T_a and T_p in the

Fig. 3. Right occlusal movement of Ta (MM)

Fig. 4. Right occlusal movement of Tp (MM)

Fig. 5. Right occlusal rhythm of Mm (MM)

Fig. 6. Right occlusal rhythm of normal subjects (MM)

crossbite group were found to have become activated. But, as compared with the control group, muscles associated with various movements failed to reveal clear behaviors or patterns. Generally speaking, masseter gave a tendency of high electric voltage.

In the mouth opening movement, mandibular biverter muscle (D_g) which acts as an elevator registered an increased electric voltage together with T_a , T_p and M_m . This fact may be thought to prevent the dislocation of jaw joint or to act against it.

At the edge-to-edge occlusal position, T_a , Y_p and D_g revealed high electric voltages, whereas M_m gave a pronouncedly low voltage. Interestingly enough, the same tendency was observed at the centric occlusal position.

4.2 *Comparison of pre- and postoperative findings.*

After the completion of an orthodontic treatment, a high voltage was measured in the masseter at an occlusion of the molar region. The reduction of voltage at the edge-to-edge occlusion position of T_a and T_p may be explained by the fact that, through the improved occlusion of maxillary and mandibular anteriors, the crossbite patients did not have to move their mandibles backward but could occlude with their mandibles in the forward position, as is true of normal occlusal subjects.

An increased electric voltage of T_a , T_p and M_m at the centric occlusal position is due to the achievement of a stable relationship between the maxillo-mandibular occlusion as well as their antagonistic relationship, thus gaining in the occlusal force which in turn led to an activated muscular function.

The rhythm or cycle of masticatory movement in the crossbite subjects under study was found to be far from uniform and full of irregularities. During the stages of mid- and postorthodontic treatment, on the other hand, these irregularities came to disappear and gradually assumed a more or less rhythmical movement. This fact is to be thought owing to a stabilized occlusal relationship brought about by a simplified occlusal function through an improved occlusion.

That the masseter which was quite inactive before an orthodontic treatment came to be activated in a relatively short period of time through an improved morphologic change, is attributed not to an innate lack of functional ability of itself, but to the fact that it had been forced in an abnormal position where the masseter could not fully activate because of some kind of morphologic anomaly imposed on it.

5. Conclusions

As a result of the above electromyographic study, the author arrived at the following conclusions concerning the muscular function in the crossbite patients before and after orthodontic treatments:

1. At the maximum mandibular movement, although there was confirmed the activity of temporomandibular muscles in crossbite patients even pre-operatively, the definite behaviors or pattern could not be revealed.

Postoperatively, however, certain patterns could be recognized with their movement and they approximated to those of normal subjects.

2. Occlusions at the edge-to-edge and centric occlusal position were muscularly inactive pre-operatively. But after an orthodontic care, they were much improved and were found to be close to those of normal subjects. Although an electric voltage in the mandibular biverter muscle registered a slight increase or decrease either pre- or postoperatively, it never became inactive in all the cases.

3. As for the back of temporomandibular muscle, what was inactive pre-operatively became activated. What was already activated came to be far more activated by an orthodontic treatment.

4. The rhythm of masticatory movement on the part of crossbite patients

came to be similar to that of normal subjects upon completion of an orthodontic treatment.

5. There was no chronological change in the muscular function on the part of normal subjects.