

OPTIMUM MANDIBULAR POSITION GUIDE BY USE OF EMG ACTIVITY AND INTRA-ORAL TRACER

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Jaw relations and the recording methods have been controversial aspects of dentistry. The purpose of this study was to quantify the relative muscle activity of the masseter and temporal muscles in relation to different intermaxillary relations recorded by intra-oral tracer during maximal clenching and to decide the optimal mandibular position. Ten volunteers with healthy TMJ were studied. Intra-oral tracer was assembled and bite block was fabricated in the articulator. Intra-oral tracer was placed in the mouth, and four mandibular positions were recorded. EMG activity was recorded on a BIO-PAK system (Bio-Research Associates, Inc. USA.) in masseter and temporal muscle and compared in each mandibular positions. The results were as follows:

1. In comparison with maximum intercuspation, the chewing position was the most similar followed by tapping position, myocentric position and posterior border position. However the differences were not statistically significant.
2. In comparison of bilateral symmetry of masseter muscle, tapping position was the most symmetrical followed by chewing position and maximum intercuspation. Myocentric position and posterior border position were not symmetrical. ($P < .05$)
3. In comparison of bilateral symmetry of anterior temporal muscle, chewing position was the most symmetrical followed by posterior border position, maximum intercuspation, myocentric position and tapping position. However the differences were not statistically significant.
4. In comparison of proportionality of anterior temporal muscle to masseter muscle activity on left side, posterior border position was the greatest followed by myocentric position, tapping position, chewing position and maximum intercuspation. And the proportionality of posterior border position was greater than that of maximum intercuspation. ($P < .05$)
5. In comparison of proportionality of anterior temporal muscle to masseter muscle activity on right side, myocentric position was the greatest followed by posterior border position, tapping position, maximum intercuspation and chewing position. However the differences were not statistically significant.

Key Words

Mandibular positions, EMG, Intra-oral tracer

Maxillomandibular relations and the methods for recording them have been some of the most controversial aspects in dentistry. In mouth rehabilitation, the dentist should establish jaw relations in such a way that provide comfortable function, physiologic compatibility and reproducibility.¹ The recording of centric relation is influenced by numerous factors, one of which is the neuromuscular system. This system has a strong adaptive capacity to permit function and protection of the stomatognathic system. Deflective occlusal contacts will induce conditioning of neuromuscular system, which will be constantly reinforced with each closures through proprioceptive feedback. This conditioning may induce changes at the level of any components of the masticatory unit.

Clinicians have used many methods and devices in attempt to precisely locate and record the reference point of the mandible. No single method has been universally accepted although several techniques have achieved varying degrees of popularity. These include holding the tip of tongue back in the soft palate; telling the patient to swallow while closing; having the patient pull the lower back or stick the upper jaw out; having the patient relax the mandible and let the dentist manipulate it upward and posteriorly; and telling the patient to relax and close naturally. More precise but less popular methods are using needle point tracing devices, clutches and a pantographic recording, an acrylic resin jig or leaf gauge to exert an upward and posterior guidance during closure.²

Among various methods of guiding jaw relation (i.e., wax records and terminal hinge position), an electronic device that has been introduced is the Myo-Monitor (Myo-tronics research, Inc. USA.). "Myo-Monitor is an instrument designed to exact occlusal registration by means of autonomic, involuntary, electronic control of the mandibular

closure. Myo-Monitor registers simultaneously the vertical and horizontal position of occlusion most compatible with individual musculature of the patient."³

Various reports have addressed different jaw positions and the therapeutic position. Jimenz⁴, Williamson et al.⁵, Strohaber⁶, Kantor et al.⁷, Long⁸ and others have provided qualitative data or quantitative data that described the condylar positions in altered jaw positions. In addition, much has been written regarding electromyography and jaw positions. Little has been reported on maximum static clench and electromyography in masticatory muscles with respect to different therapeutic positions.

In dentistry, EMG recordings of human masticatory muscles have been used as a means to evaluate and treat craniomandibular disorders.⁹ Based on the current knowledge of muscle physiology, establishing a therapeutic position for optimum occlusion should result in bilateral physiologic activation patterns of masticatory muscles recordings. It has been found that the anterior temporalis muscle activity in low level clench at retruded contact and ICP is higher than the masseter muscle activity, but by contrast the latter increase during protrusive clenching.¹⁰ As stated above, it is clear that EMG analysis at varied jaw positions is confined in a time domain in which mean amplitude is the main index to represent the level of EMG activity. However EMG activity of masseter muscle is a stochastic quasi-stationary signal that contains a few time or frequency domain features.¹¹

McCarroll et al.¹² investigated the reaction to lateral positioning of the mandible. They concluded that the temporalis muscle activity is especially sensitive to immediate changes in lateral positioning and that the masseter activity remains unchanged when conditions of stable bilateral occlusal contacts are present.

Regarding the jaw registration positions, Jimenez showed that in the retruded contact position the anterior and posterior temporalis muscle activity increased and the masseter muscle activity decreased relative to the activity in the intercuspal position.⁴ He concluded that RCP requires more positioning muscle activity (temporalis muscle) and limits biting muscle activity (masseter muscle).

With respect to the vertical dimension, Carlsson et al.¹³ investigated the effect of increased vertical dimension on the activity of the temporalis muscles. Raising the vertical dimension brought about a reduction of the postural activity. They stated that "a moderate increase in the vertical dimension of occlusion does not seem to be a hazardous procedure provided occlusal stability is established."

Since the time of its proposal by Gysi in 1910, the needle point tracing has been accepted as an accurate method of locating the centric maxillo-mandibular relation at a given degree of jaw separation.¹⁴ Many investigators thought that the intercuspal position of natural teeth should coincide with the most retruded position or the apex of the arrow point tracing. They considered a lack of coincidence between these two positions to be non physiologic. And other investigators considered centric relation to be anterior to the apex of the tracing. It was their belief that the apex of the tracing represented a retruded or strained position. They recommended a more anterior position which they called a true or functional relation. Many more such references in the literatures provided additional concepts concerning the positions of the condyles in the glenoid fossa when the mandible was positioned at the apex of the needle point tracing.

Kleinrok¹⁵ introduced a recording device termed a "Kleinrok Functiograph" and documented condular- and tooth- guided mandibular move-

ments on the same plate. It facilitated the detection of occlusal disturbances and improved the accuracy of diagnosis and adjustment of occlusion.

Gothic arch tracing is a useful method for the jaw relation taking, because mandible is guided by condyle and masticatory muscles without the tooth interference and the tripodism composed by two condyles and a stylus is very stable for the bilateral jaw closing muscle activity and different jaw relations can be recorded in a plate at the same horizontal plane. The clinician can compare and confirm each mandibular positions.

The efficacy of therapeutic positions has been debated for years, but no physiologic data have been provided to substantiate any improvement. We used EMG analysis of jaw closing muscles to document relative changes with different jaw positions.

The objective of this study is to quantify the relative muscle activity of the masseter and temporalis muscles in relation to different intermaxillary relations recorded by intra-oral tracer during maximal clenching and to decide the mandibular position that is stable and harmonious with the neuromuscular system.

MATERIAL AND METHODS

SUBJECTS

Ten healthy volunteers who met following criteria were studied: Angle class I molar relations with complete permanent dentitions, no palpable masticatory muscle, no sign and symptom in TMJ, no limitation of mandibular movement, no significant differences between CR position guided by Dawson's bimanual manipulation and the maximum intercuspalation. The volunteers consisted of 7 male and 3 female with an average age of 26.7yr and a range from 24 to 31yr.

ASSEMBLY OF INTRA-ORAL TRACER

After impression taking and face bow transfer, upper and lower models were mounted to a semi-adjustable articulator (Hanau modular). The recording stylus was fixed to a lower model and tilted anteriorly¹⁷ against the occlusal plane. Then the recording plate was connected with stylus temporarily mediated by transfer plate. The recording plate was transferred to a upper model and held with putty impression material (Fig. 1). The recording stylus was raised to the level that upper and lower teeth did not interfere anterior and lateral movement (Fig. 2). In the level, incisal pin was tightened and acrylic resin was poured between upper and lower teeth for the maximum intercuspal position bite block fabrication. As this method, maximum intercuspal position was compared with the other mandibular positions in the same vertical dimension.

RECORD OF 4 MANDIBULAR POSITIONS

Subjects were seated in a comfortable, upright position with the head unsupported and the Frankfort horizontal plane parallel to the floor. Before the record, stimulating low frequency electrodes of the Myo-Monitor (Myo-tronics Research, Inc. USA.) were placed 45~60minutes, anteriorly to the left and right tragi for the proprioceptive deprogramming of masticatory muscles. Intra-oral tracer was fixed to the upper and lower teeth (Fig. 3), and four mandibular registrations were recorded: a posterior border position (PB), a chewing position (CP), a tapping position (TP), a myocentric position (MP) and a maximum intercuspal position (MI).

RECORD OF POSTERIOR BORDER POSITION

2~3 times of anterior-posterior movements, left and right lateral movements were done with the stylus touch to recording plate. The apex drawn in the plate was accepted (Fig. 4-1).

RECORD OF CHEWING POSITION

After left and right lateral movements, mandibular movement was done medially like chewing food with the stylus touch to recording plate. The point that median line and lateral line met was accepted (Fig. 4-2).

RECORD OF TAPPING POSITION

In a rest position, stylus and recording plate untouched, each subjects asked to close jaw lightly 2~3 times. The point by the touch of stylus and recording plate was recorded (Fig. 4-3).

RECORD OF MYOCENTRIC POSITION

Myo-Monitor (Myo-tronics Research, Inc. USA.) was placed anteriorly to the left and right tragi and subject maintained a rest position (Fig. 5). As the Myo-Monitor amplitude advanced to the clinical threshold, mandible begun to rise involuntarily through the freeway space. The point with stylus and recording plate touched was accepted (Fig. 4-4).

RECORD OF MAXIMUM INTERCUSPAL POSITION

Premade bite block guided the mandible to maximum intercuspal position and it was possible to compare the mandibular positions at the same vertical dimension.

RECORD OF ELECTROMYOGRAPHIC ACTIVITY

EMG activity was recorded on an eight-channel instrument, BIO-PAK system (Bio-Research Associates, Inc. USA.). Calibration was 200 μ V and a speed of 200ms/division depending on the recordings. The instrument was directly interfaced with a computer which presented the data graphically and recorded them on magnetic a media. The stored data could be utilized in subsequent quantitative and qualitative clinical analysis (Fig. 6). Disposable bipolar surface disc

electrodes with Ag/AgCl (Myo-Tronics research, Inc. USA.) were used to record EMG. Each pair had an inter-electrode distance 20mm (center-center), paralld to the main direction of the bilateral anterior temporal and masseter muscles by anatomic landmarks. The ground electrode was placed on front of the neck (Fig. 7). The skin placing the electrodes was cleaned with alcohol to reduce the impedance factor and recordings were performed 5~6 minutes later, allowing the conductive paste to adequate moisten the skin surface. The electrodes were filled with electric jelly and fixed with adhesive strips. Each subjects were asked to clench maximally into each of five mandibular positions. Three 1.4~2.7 seconds clenches seperated by 2~3 seconds were made with each positions. 2 minutes rest period was allowed between the different mandible positions to eleminate muscle fatigue.

RESULTS

The EMG activities of left, right masseter and anterior temporal muscle in 5 jaw relations are illustrated in Table I. 10 subjects were asked to clench maximally three times and the mean of 3 record-

ings is depicted.

The difference means in masseter and temporalis EMG activities between MI position and CP, PB, MP, TP positions are illustrated in Table II. The analysis of variance was operated and at the $p < .05$ level of significance, Tukey HSD comparisons test was done. In the left masseter muscle, EMG activity difference between MI and CP position was the lowest and PB position was the greatest, but the significant differences between four mandibular positions were not found. In the left temporalis anterior muscle, EMG activity difference between MI and TP position was the lowest and PB position was the greatest, but the significant differences between four mandibular positions were not found. In the right masseter muscle, EMG activity difference between MI and CP position was the lowest and MP position was the greatest, but the significant differences between four mandibular positions were not found. In the right temporalis anterior muscle, EMG activity difference between MI and CP position was the lowest and PB position was the greatest, but the significant differences between four mandibular positions were not found.

The difference means and standard deviations

Table I . EMG activity during maximum clench in five mandibular positions for 10 subjects (Unit: μV)

	1		2		3		4		5		6		7		8		9		10	
	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt
MI temporalis	38.3	38.5	49.8	49.0	57.1	55.5	36.3	34.8	20.3	27.5	28.7	26.4	26.9	29.2	42.0	37.1	40.2	51.3	42.7	47.0
masseter	53.1	52.3	62.6	56.8	64.4	40.7	40.1	40.6	61.3	50.8	36.9	38.7	55.2	62.7	55.1	51.4	69.8	54.1	67.9	75.3
CP temporalis	39.0	36.9	47.9	48.4	54.7	52.7	37.1	34.7	19.2	25.1	30.8	28.3	30.1	33.4	39.4	34.3	41.4	44.8	48.5	50.1
masseter	51.9	48.6	59.3	60.2	65.7	45.9	39.4	41.0	62.7	48.2	38.2	37.0	58.8	63.7	48.4	47.7	63.5	58.3	70.1	73.4
PB temporalis	44.1	40.7	55.3	59.3	67.3	51.7	36.1	33.9	41.2	32.6	29.7	32.9	45.2	39.9	52.1	58.3	43.6	50.8	55.6	59.8
masseter	50.7	57.1	57.2	63.4	56.5	53.5	35.8	34.3	43.5	55.8	35.2	37.1	42.3	58.0	53.8	60.5	53.3	60.7	60.8	59.7
MP temporalis	40.2	42.3	57.2	55.4	58.2	60.1	33.1	32.0	31.4	33.3	31.5	31.7	37.4	44.1	49.3	40.6	44.1	45.3	50.1	52.6
masseter	50.3	47.9	70.5	68.7	66.1	55.3	43.2	41.1	45.0	41.2	41.9	38.0	59.7	48.7	50.4	48.1	59.7	48.6	63.3	68.7
TP temporalis	42.2	50.5	37.2	33.1	49.3	49.4	29.9	31.8	22.5	27.2	30.0	31.9	36.0	37.6	36.6	35.9	36.0	47.6	61.3	59.8
masseter	55.4	64.7	41.8	49.3	44.2	48.6	43.9	40.3	33.5	39.3	43.4	39.6	41.5	47.0	67.7	77.8	75.4	55.6	70.1	69.3

Table II. The difference in masseter and temporalis EMG activity between MI position and CP, PB, MP, TP positions (Unit: μV)

	C P	P B	M P	T P
Lt. masseter MI	0.84	7.73	1.63	4.95
Lt. temporalis MI	0.58	8.79	5.02	0.13
Rt. masseter MI	0.006	1.67	1.71	0.99
Rt. temporalis MI	0.49	6.63	5.25	1.12

Table III. The difference in masseter and temporalis EMG activity between left and right sides (Unit: μV)

	Lt. masseter - Rt. masseter	Lt. temporalis - Rt. temporalis
MI	4.30 ± 9.9778	1.13 ± 5.0228
CP	3.40 ± 7.9220	0.06 ± 3.4394
PB	5.10 ± 6.0809 *	1.03 ± 7.3436
MP	4.38 ± 5.2336 *	1.36 ± 2.3618
TP	0.34 ± 9.0439	2.38 ± 4.6932

mean standard deviation. * indicates significant difference (P<.05)

Table IV. The ratio of temporalis to masseter EMG activity (Unit: μV)

	Lt. masseter - Rt. masseter	Lt. temporalis - Rt. temporalis
MI	0.689 ± 0.1825	0.774 ± 0.2540
CP	0.711 ± 0.1835	0.753 ± 0.1778
PB	0.960 ± 0.1118 *	0.857 ± 0.1476
MP	0.785 ± 0.09583	0.883 ± 0.1061
TP	0.757 ± 0.1876	0.804 ± 0.1760

mean standard deviation. * indicates significant difference (P<.05)

in masseter and temporalis EMG activities between left and right sides are illustrated in Table III. The T-test was done in each mandibular positions, at the p<.05 level of significance. In the masseter muscles, the EMG activity difference between left and right sides was the lowest at TP position. And

the difference was greater at PB and MP positions.

In the temporalis anterior muscles, the difference of left and right sides was the lowest at CP position and the greatest at TP position but the significant differences between five mandibular positions were not found.

The means and standard deviations of temporalis/masseter ratio of each sides are illustrated in Table IV. The analysis of variance was operated at the $p < .05$ level of significance, and Tukey HSD comparisons test was done. In the left temporalis/ masseter ratio, MI position was the lowest and the PB position was significantly greater than the MI position. In the right temporalis/ masseter ratio, CP position was the lowest and the MP position was the greatest, but the significant differences between five mandibular positions were not found.

DISCUSSION

The ideal jaw relation to achieve a reference and treatment position has varied considerably among different clinicians. Centric relation is a common reference and therapeutic position but much debate exist as to what it is and how it is achieved. In the past, the criterion for evaluating an occlusal position has been the repetitiveness with which the position could be registered. But similar to posture assessment, these measures relied on the cooperation of the patient and the disposition of the observer when assessing the final registration; thus a wide variability existed.¹⁶ Many researchers have observed that the change in direction of applied effort or in mandibular position influenced the response on EMG of temporalis and masseter muscles to a different extent.¹⁷

With the introduction of EMG analysis for mandibular assessment and treatment, it has become possible to establish objective criteria for jaw positioning during therapeutic intervention.⁹ As many investigators have shown a linear relation or direct correlation between EMG activity and bite force, increased EMG activity recorded during maxial clenching could indicate an improved functional capability of the mandibular musculature.¹⁸

In addition to the ability of maximal muscle activ-

ity, the balance of synergistic musculature is important for efficient muscle action. To determine a measure of balance a ratio of masseter/temporalis EMG activity was determined. In patient with TM dysfunction, lower ratios have been reported.¹⁹ The mechanism for decreased masseter EMG activity with TM dysfunction was thought to originate in reflex inhibition. One possible source of variable sensory input could be the mechanoreceptors of the periodontal ligament. For example, it is reported that as the mandible was retruded or pain developed, inhibition of masticatory musculature could be occurred.^{4,19} But none of the subjects complained of any pain during the testing, nociceptive inhibition could be ruled out. Thus the cause of difference in masseter/temporalis ratio at each mandibular positions remains unknown.

Visser. A. et al.²⁰ stated that the mean masseter EMG amplitude was not influenced by the immediate changes in the vertical and protrusive intermaxillary relation. This is in agreement with the findings by Christensen, Kawazoe et al. and Jimenez.²¹ However, in contrast, Wood and Tobias found an overall increase of maximum EMG activity of the masseter muscle after insertion of a stabilization splint.²² This may be explained by differences in the occlusal design of the stabilization splints used and by methodological differences in recording of the clenching efforts.

In this study, intra-oral tracer was used to record the mandibular positions and EMG activity was evaluated in raised vertical dimension. It was inevitable to avoid the tooth interference during the mandibular movement. Holmgren, Sheikholeslam¹³, Visser. A. et al.²³ stated that postural activity of temporal muscle was decreased and small fluctuation of masseter muscle activity was induced similar change in temporal muscle activity after insertion of stabilization splint in both patients and healthy individuals.

In the maximum intercuspation and chewing position the proportionality of anterior temporal

muscle to masseter muscle activity was lower than other positions in this investigation and this result is similar to that of Naeije.²⁴ Shi. et al.²⁵ stated proportionality of anterior temporal muscle to masseter muscle activity in intercuspal position was lower than in retruded contact position and greater than in protruded position. At lateral positions, the proportionality on working side increased, but the difference at left side position was not significant, and the proportionality on the non working side decreased.

In this investigation, myocentric position is more anterior than maximum intercuspation in horizontal plane and proportionality of anterior temporal muscle to masseter muscle activity was greater than that of maximum intercuspation. This opposite result is due to the difference of anterior position, protruded position is edge to edge bite of anterior teeth in Shi's study and myocentric position is only 1~2mm anterior position from maximum intercuspation.²⁵ Naeije, et al.²⁴ stated at low clenching levels the anterior temporal muscle activity tended to dominate, at high levels the masseter muscle activity was stronger in intercuspal position.

Anatomical observations suggest that the temporal muscle arising from the temporal fossa has three bundles of fibers. The anterior fibers are vertical, the fibers in the middle part are increasingly oblique, and the most posterior fibers run horizontally.²⁶ Anatomical findings show that the masseter muscle can be divided into two separate functional parts. The fibers of the superficial layer run forward from the mandibular angle to the zygomatic arch and the fibers of the deep layer are vertical.²⁷ On the basis of the findings of myoelectrical amplitude investigation of jaw closing muscles during clenching at varied jaw positions, the anterior temporal muscle may elevate the mandible upward and backward, and the masseter muscle may lift the mandible upward and forward.

When the mandible is at posterior border position, though anterior teeth break away from contact, the activity of anterior temporal is stronger. This result may be due to the contraction of the posterior temporal section of the muscle bringing the mandible from maximum intercuspation to posterior border position. This increases the activity of anterior fibers through an antagonistic effect.

Naeije. et al.²⁴ stated that the asymmetry in muscle activity also depended on the clenching levels, while at each levels the asymmetry in the masseter muscle was greater than the asymmetry in the temporalis muscle.

The strong dependency of the asymmetry on the clenching effort is in agreement with the findings by Pruim²⁸ regarding asymmetries in bilateral static bite forces and suggests that results of maximal clenching studies cannot simply be extrapolated to lower more functional clenching levels. However, so far no quantitative study has been performed on these symmetries in different mandibular positions. This study has shown that the symmetries in tapping position, maximum intercuspation and chewing position greater than the other mandibular positions.

Watanabe⁹ evaluated the mandibular positions obtained by gothic arch tracing was loaded into a personal computer and stated gothic arch apex and tapping position varied depending on body position. In the supine position, the gothic arch apex and the tapping position were close to the mandibular position determined by bilateral manipulation. Joseph et al.³⁰ noted the significant changes in the variability of the apex position of the needle point tracings during one day and over a day period. And the changes in the mediolateral direction were greater than in an anteroposterior direction.

Since the sample size was not large enough and samples were healthy in temporomandibular joint, the difference between 5 mandibular posi-

tions was not great and significant difference was not found exactly. It seems that within a biologically acceptable range and there is no significant alteration in muscular activity.

More studies about the relation of mandibular position and EMG activity are needed. And the positions of disc-condylar complex in glenoid fossa must be evaluated to determine the therapeutic position.

CONCLUSIONS

From the analysis of the results, the following conclusions were obtained:

1. In the comparison with maximum intercuspation, the chewing position was the most similar followed by tapping position, myocentric position and posterior border position. However the differences were not statistically significant.
2. In the comparison of bilateral symmetry of masseter muscle, tapping position was the most symmetrical followed by chewing position and maximum intercuspation. Myocentric position and posterior border position were not symmetrical. ($P < .05$)
3. In the comparison of bilateral symmetry of anterior temporal muscle, chewing position was the most symmetrical followed by posterior border position, maximum intercuspation, myocentric position and tapping position. However the differences were not statistically significant.
4. In the comparison of proportionality of anterior temporal muscle to masseter muscle activity on left side, posterior border position was the greatest followed by myocentric position, tapping position, chewing position and maximum intercuspation. And the proportionality of posterior border position was greater than that of maximum intercuspation. ($P < .05$)
5. In the comparison of proportionality of anterior temporal muscle to masseter muscle activ-

ity on right side, myocentric position was the greatest followed by posterior border position, tapping position, maximum intercuspation and chewing position. However the differences were not statistically significant.

Maximum intercuspation, chewing position, tapping position, myocentric position and posterior border position were compared with each other. Five mandibular positions were recorded by intra-oral tracer in one horizontal plane and quantified with electromyography. Though significant difference was not found exactly, in each tests the most acceptable result was obtained at the chewing position.

If possible, the result of any therapeutic intervention should be to improve function. In normal volunteers, the chewing position proved to be the most functional of therapeutic positions in the views of balance and activation of jaw musculature.

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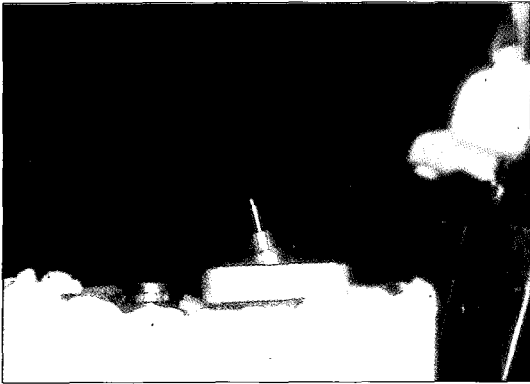


Fig. 1. Assembled upper and lower intra-oral tracer.

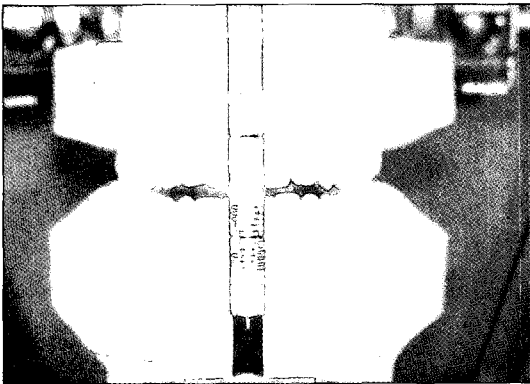
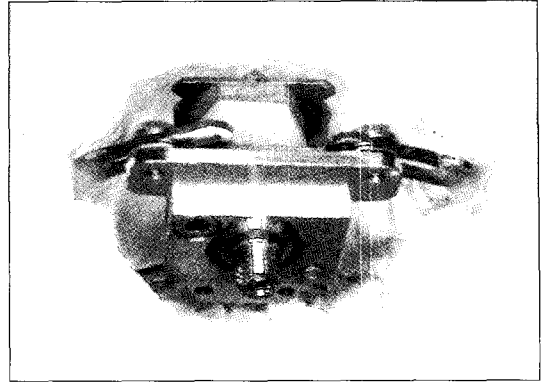


Fig. 2. Adjustment of recording stylus in the articulator.

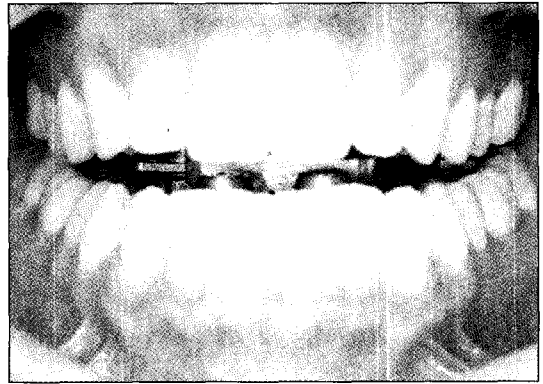


Fig. 3. Placement of intra-oral tracer in the subject's mouth.

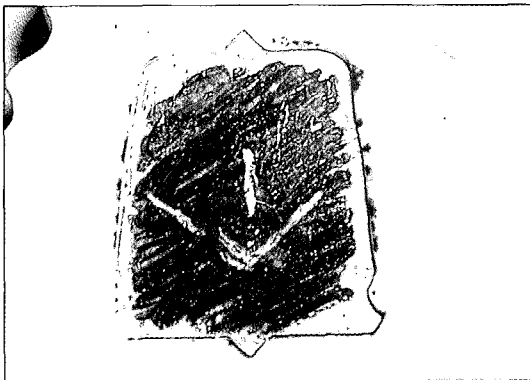


Fig. 4. Record of four mandibular positions on a recording plate.

4-1 posterior border position.

4-2 chewing position.

4-3 tapping position.

4-4 myocentric position.

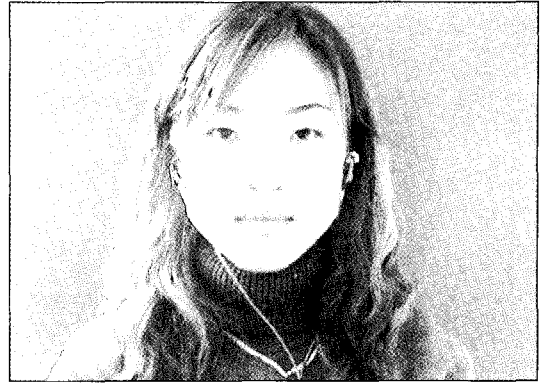
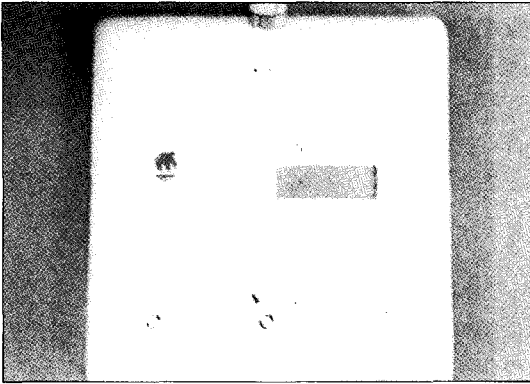
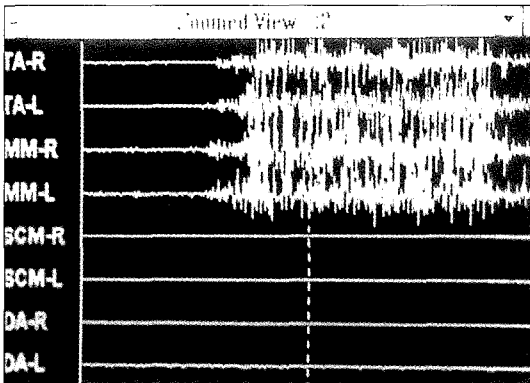


Fig. 5. Placement of Myo-monitor to the subjects.



TA-R	48.5	350
TA-L	57.0	352
MM-R	84.3	295
MM-L	58.3	312
SCM-R	5.1	1024
SCM-L	5.0	1024
DA-R	4.4	1024
DA-L	0.7	1024

Fig. 6. Record of Maximum bite force by Bio-pak.



Fig. 7. Placement of Bio-pak electrodes.