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Analysis of occlusal contact combined with muscular activity evaluation in supine and upright position

조선대학교 대학원

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강 수 진

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앙와위와 정좌위에서 교합접촉 및 근활성도 분석

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강 수 진

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인간의 자세 변화는 두부위치를 결정하는 저작근 활성에 영향을 미칠 뿐 아니라 교합접촉 시 상, 하악간 관계에도 영향을 준다. 그러므로 자세 변화에 따른 두경부 위치가 치아의 교합접촉과 저작근 활성에 미치는 영향을 파악하여 생리적인 자세를 이해하는 것이 필요하다. 본 연구는 앙와위(0도)와 정좌위(90도)에서 두부의 위치에 따른 교합접촉양상과 근활성도를 기록하여 분석하였다. 연구대상은 제3대구치를 제외한 모든 영구치가 맹출되었으며, 교정 및 보철치료의 경험이 없으며, 양측성 Angle 1급의 제1대구치와 견치관계를 갖으며, 치아 교합면에의 마모가 거의 없으며, 병적 치주질환이 없고, 구강 악계에 임상적 기능이상이 없는 C 대학교 치과대학 재학생중 피검자 30명을 선정하였으며, 피검자의 평균 연령은 25.7세였다.

T-Scan System(Tekscan Co., USA)과 Bio-Pak System(Bioresearch Inc U.S.A)을 이용하여 교합접촉 검사 및 전측두근과 교근의 근전도검사를 시행하여 측정치를 기록하고 이를 비교분석하여 다음과 같은 결론을 얻었다.

1. 앙와위, 정좌위의 두부위치에서 계측한 총 교합접촉점수는 평균 25.97, 42.24개로 앙와위보다 정좌위에서 많은 접촉이 이루어졌고, 이에 대한 통계학적 유의차가 있는 것으로 나타났다. ($P<0.05$)

2. 평균 접촉력 계산은 앙와위에서 85.4, 정좌위에서 135로 정좌위에서 높게 나타났

으며, 이는 통계적으로 유의한 차이가 있는 것으로 나타났다.($P<0.05$)
3. 좌, 우측 전측두근 및 교근의 근전도는 앙와위에 비해 정좌위에서 좌, 우측 전측두근 및 교근의 근전도가 높게 나타났으나 이는 통계적으로 유의한 차이는 없었다.($P>0.05$)

자세의 변화에 따라서 접촉수와 접촉력의 변화는 매우 유의한 정상관계를 나타냈다. 그러므로 임상에서도 교합조정 시 이러한 점을 고려해야 할 것으로 사료된다.

Ⅰ. *INTRODUCTION*

Because human masticatory muscle activity affected from various factors is complex movements[1], and those factors do not equally distribute influences to the each subjects, it has been complicated to understand this mechanism in the field of the prosthodontics. However, general features can be predicted through the mean data derived from the experimental measurement. But various studies and methods to analyze the influence of the occlusal contact in the masticatory system have been performed, no consensus opinion has been reached. The bilateral distribution of the tooth contact at the maximum intercuspation is very important in normal occlusion[2]. Accomplishing the bilateral distribution of the tooth contact at the maximum intercuspation in the prosthetic treatment requires to understand the nature of the tooth contact. and it has been reported that the tooth contact has connection with the intercuspation and the muscle activity which assumably affects to the postural muscle activity[3]. Maximum intercuspation resulting from the complete intercuspal contact at certain position at the natural dentition accompanies the neuromuscular system stability[4]. Therefore, it is essential to understand the distribution of tooth contact to properly diagnose[5] and establish treatment plan[6].

Each subject has distinctive differences[7] between the number and the location at the maximum intercuspation, and even individually, also time[8] concerns likewise during the 24 hours and those relate masticatory muscle activity[3]. Nonetheless Friel et al.[9] reported maximum contact points can be achieved at the ideal intercuspation, Hekkman et al.[10] claimed the decrease of contact points through the ideal condition change. Therefore, it is important to establish clear acknowledgment of maximum tooth contact points and location in the prosthetic procedures.

Because the occlusal relation is routinely adjusted at the supine position clinically, it is questionable whether it is adequate while patient masticates at the upright position. Therefore, postural change which affects occlusal contact should be evaluated at the upright position. Not only postural changes affects to the masticatory muscle activity, but also relation between maxilla and mandible during the occlusal contact does. In this reason, it is strongly necessary to investigate the effects of the various head position related to the tooth contact and masticatory muscle activity. Schwarz[11)] demonstrated that dorsiflex(backward bending) of the head-neck complex resulted in increasing freeway space and posterior movement of the mandible. In contrast, ventroflexion(forward bending) of the head-neck produced an opposite effect. Breman et al.[11)] evaluated the effect of the head and body posture to the occlusion using Occlusogram, and McLean et al.[12)] reported the difference in the tooth contact between the supine and upright position.

In this article, the T-Scan II system (Tekscan, Inc., Boston, U.S.A.) which analyzes occlusal contact in the matters of quantitative and qualitative as well as the tooth contacts location due to the contact duration is employed, and normal adults occlusal contact was measured and evaluated with it. In using T-scan, R.J. Chapman[13)] reported about the occlusion of the implant prosthetics and William L. Maness and Robert Podoloff, S. M.[14)] demonstrated distribution of the occlusal contact in the maximum intercuspation. Wayne L. Harvey et al.[15)] evaluated the credibility of the sensor and Klaus W. Boening and Michael H. Walter[16)] analyzed the occlusal load in full denture.

Masticatory muscle which is predominant component of tissues consisting the oromandibular system controls mandibular movements, and in progress of research for occlusion, it has been focused from the dentistry. Since

Electromyogram measures active potential to analyse muscle state, it has been applied to evaluate the physiologic status of the masticatory muscle after Adrian and Brondk[17] first measured the muscle activity in 1929 with it. Moyer[18] who ultimately happened to introduce myopotential in dentistry reported masticatory muscle potential was caused by the mandibular movement. Pruazankky[19] also presented detailed method of applied myopotential after observating wave, amplitude, frequency, and interval of myopotential during mastication and Wood[20] demonstrated myopotential reaction regarding the tooth contact points. On the other hand, Ralston et al[21] reported that the internal or external factors intervene quantitative analysis using electromyogram. Comparative study between normal and abnormal occlusion for mandibular rest position and centric occlusion[22], and masticatory muscle state during mandibular movement[23,24], relation of musticatory muscle activity to patient of temporomandibular disorder[25,26] and bruxism, study on effects of clinically purposed Occlusion splint has been reported.[27,28] Therefore cooperation and antagonism between myoneural system and muscle can be understood throught the method of electromyogram[29]. However, Barbene et al.[30] pointed out that electromyogram could be affected by the measuring method, interval, electrode position and subject's head posture. Frame et al.[31] also reported electrode position caused myopotential change, but Yemm[32], Majeski and Gale[33] reported there was no signigicant differences. Yoon et al.[34] suggested that standardization of the condition, expertise of test method and sufficient education of the subjects render minimizing errors for the patients. consequently, validating conditions should be standardized to minimize factors inducing errors on measured value employing electromyogram.

In the study using T-scan system for the relationship of central occlusion and head-position, Makofsky et al.[11] reported that age makes difference. However, the study about the effect of head-position to the occlusal contact has been insufficient. The purpose of this study was to evaluate the effect of head-position to the occlusal contact and muscle activity.

Ⅱ. *MATERIALS AND METHODS*

1. Subjects

Thirteen adult patients with complete natural dentitions showing no signs of occlusal complications such as occlusal surface wear and pathologic periodontal condition were selected for the study. The subjects were primarily dental students with mean age of 25.7 and had normal function of the stomatognathic system.

2. Method

To provide an identical circumstantial condition to the all subjects, this measurement performed 1 hour after breakfast.

1) determination of head position

NHP marker(natural head posture marker) equipped to head in order to maintain the head position measures the head angle affixed to the FH plane(frankfort horizontal plane) during supine and upright position(Fig. 1).

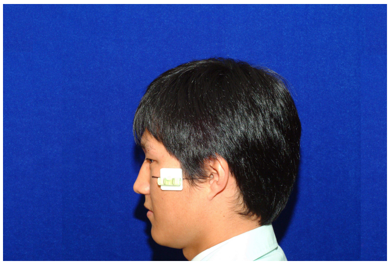

Fig. 1. Setting of the FH plane for the correct cranial position, and NHP marker positioning.

2) Measurement of the occlusal contact point and force

Using the T-scan II system(Tekscan Co., The USA), muscle activity was measured simultaneously with recording of the contact points and force in maximum intercuspation(Fig.2).

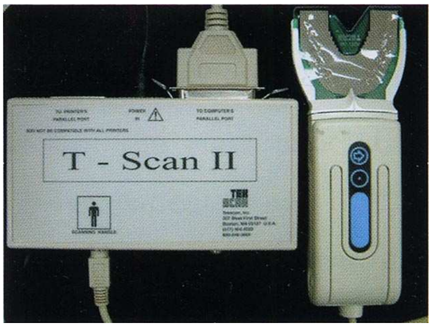

Fig. 2. T-Scan II
(Tekcsan, Inc., Boston, USA.)

T-Scan II system consists of sensor circuit, computer mother board, 9 inch color displayer, printer, power supply inserted system unit and sensor, handle and cablem specifically this study, blue standard decompression device was employed.

In order to measure the change of the occlusal contact point, subjects was fully apprehended through the test and the explanation before subjects occlude mandibular and maxillary teeth to habitual closure position at each head positions and they had been practiced until showing no slides after initial contact.

Sensor-equipped sensor support pointer located maxillary interincisors to allow repeatable pattern of contacts.[7)]

When the subjects bit the sensor in the maximum habitual intercuspation, the occlusal contact point and force were measured. This procedure was carried out 2 times in each subject and the average value was analysed(Fig. 3, 4).

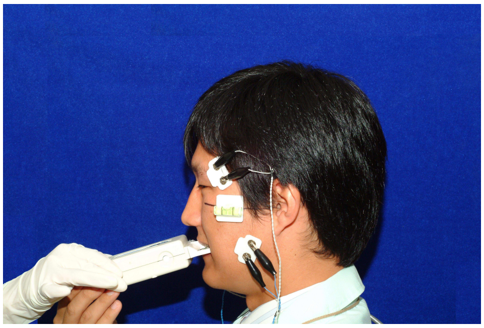

Fig. 3. Muscular activity test of the anterio-temporalis muscle and masseter muscle using Bio-Pak® and positioning the T-scan II handle in the oral cavity.

Fig. 4. Masticatory capability and muscular activity test on supine position.

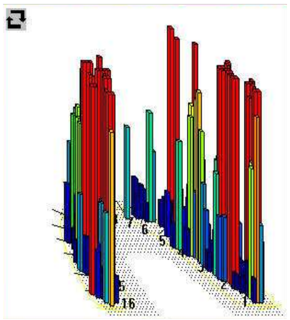

Fig. 5. Contact points & Occlusal force in the supine position

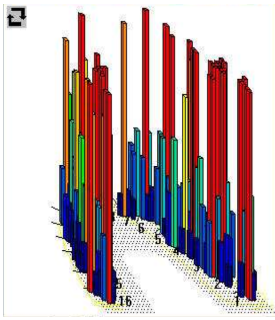

Fig. 6. Contact points & Occlusal force in the upright position

3) muscle activity measurement

In order to evaluate masticatory muscle activity, Bio-Pak system(Bioresearch Inc., U.S.A), a comprehensive mandibular function testing appliance, was employed. Calibration was 200μV and a speed of 2000ms/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. Four of the eight channels of an EMG recorder were employed to record EMG activity.

Myopotential was measured and muscle activity was recorded after reaching physiologically stable state. Applying Surface electrode (No-Gel Surface electrode, Bioresearch Inc., USA) has properties of 10mm in the diameter and 20mm in the distance.

Electrode positioner which can locate a certain position was used to minimize the errors among attaching point of the subjects. However, the electrode positioner might not fit for Korean features, because it was originally designed for the Caucasian per se. On the ground of this, electrode positioner was used as the reference for deciding the location and at the same time muscle palpation was applied for the selection the center of the muscle(Fig. 7).

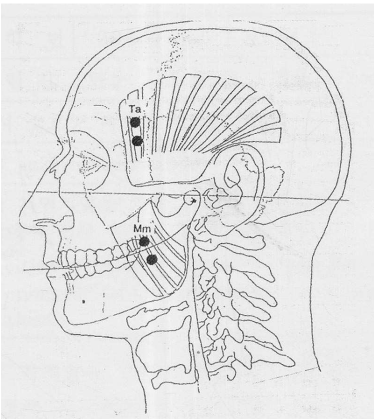

Fig. 7.
The position of the double electrode on the analysed muscles
Ta: anterior temporal muscle
Mm: masseter musle

The electrode was positioned on the surface of the anterior temporalis and masseteric muscle after palpation during the maximum intercuspation. The electrode for the anterior temporalis was attached 1.5-2.0cm posteriorly from the corner of eye and the superior part of the zygomatic arch. And also the position for the masseteric muscle was attached in the crossing of each middle of anterio-posterior length and superio-inferior length of the muscle and extra-electrode was attached in the neck region. Before locating electrode, expecting points was wiped with alcohol spongy to reduce surface impotence, and after 3~5 minutes, the muscle activity was measured. While measuring, tension was intended not to be given and the measurement was performed after several times of clenching practices.

Both masticatory muscle activity(㎶) was recorded in the peak of the maximum intercuspation at the each supine and upright position.

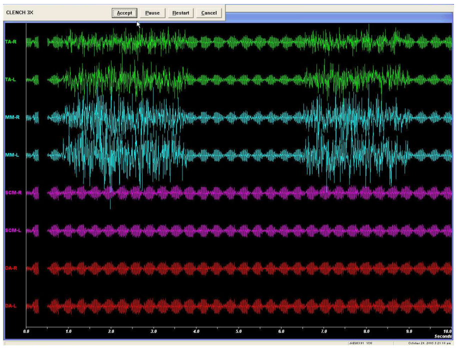

Fig. 8. Muscle active degree of Anterior Temporalis muscle & Masseter muscle in the supine position

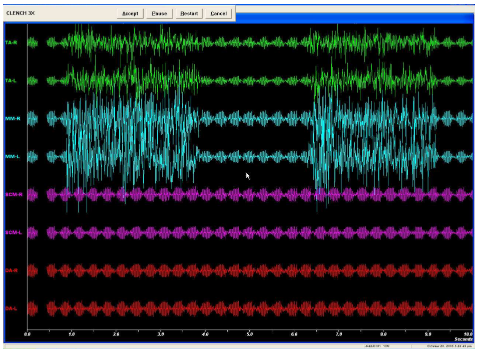

Fig. 9. Muscle active degree of Anterior Temporalis muscle & Masseter muscle in the upright position

4) Statistics method

SPSS version 10.0.7 program has been utilized for the statistics and paired t-test has been performed for significance test of measured values.

Ⅲ. *RESULTS*

The differences of the occlusal contact points and force were observed as the postures change(Table. 1, Fig. 5, 6).

Generally the postural change showed the occlusal contact point and force to be affected.

High contact point and force were observed in the upright position but muscle activity was showed normal relationship with the occlusal contact point and force.

1.The statistics of the occlusal contact point

1) While the most high frequent occlusal contact was found in 90 degree, the least frequency was found in 0 degree in the normal occlusion of the adult. The number of occlusal points of the anterior teeth was ranged from 11 to 1 in 90 degree and from 7 to 0 in 0 degree. In the premolar, 19 to 13 occlusal points were recorded in 90 degree and 13 to 1 in 0 degree. In the molar case, the number of occlusal point were 34 and 11 in 90 degree, and 14 and 4 in 0 degree.

2) Right and left distribution of the occlusal point was recorded and mean of left side was 12.27 and right was 13.70 in 0 degree, left side was 20.60 and right was 21.63 in 90 degree. Although the right side showed the higher distribution, the results didn't deliver statistically considerable differences.

3) The statistics regarding tooth contact of 30 people are presented in the table 1. The whole contact points were 42.23 in upright position and 25. 97 in supine position in 90 degree, and the results demonstrated the tendency that the contact point increased as the head position changes from the supine to the upright and also showed statistically considerable differences($P<0.05$)(Fig. 10).

	0								90							
	Left				Right				Left				Right			
Subject	I	PM	M	Total	I	PM	M	Total	I	PM	M	Total	I	PM	M	Total
1	2	3	7	12	1	3	5	9	3	7	13	23	3	5	9	17
2	2	4	7	13	1	2	5	8	2	5	9	16	2	3	7	12
3	0	1	5	6	2	1	3	6	2	2	6	10	1	1	6	8
4	0	3	7	10	0	4	9	13	0	5	8	13	2	4	9	15
5	2	2	6	10	2	3	7	12	2	5	11	18	4	6	11	21
6	1	4	6	11	3	5	7	15	2	5	8	15	4	9	12	25
7	2	4	9	15	3	6	12	21	4	7	10	21	5	8	14	27
8	2	5	9	16	2	6	10	18	4	6	11	21	3	6	10	19
9	1	1	6	8	1	3	10	14	5	8	14	27	4	7	12	23
10	2	5	6	13	3	3	8	14	3	8	10	21	6	6	13	25
11	0	2	6	8	0	4	7	11	1	3	5	9	1	5	8	14
12	1	4	9	14	3	3	6	12	3	8	10	21	4	8	12	24
13	2	5	6	13	3	5	9	17	3	6	12	21	5	6	13	24
14	0	2	4	6	1	1	6	8	2	4	7	13	3	3	8	14
15	0	2	11	13	2	4	11	17	5	8	13	26	3	8	11	22
16	1	3	7	11	2	4	7	13	2	5	8	15	3	7	12	22
17	3	4	4	11	2	5	5	12	3	5	10	18	5	4	11	20
18	1	4	6	11	4	4	9	17	2	6	9	17	4	8	17	29
19	3	4	10	17	2	8	11	21	5	6	10	21	5	7	14	26
20	2	4	7	13	2	3	5	10	5	9	16	30	3	5	11	19
21	3	4	9	16	2	3	8	13	5	9	13	27	4	5	9	18
22	1	5	8	14	2	0	6	8	5	8	16	29	4	8	12	24
23	2	4	6	12	3	4	6	13	5	5	9	19	6	8	14	28
24	3	5	8	16	2	0	7	9	3	8	15	26	2	6	12	20
25	2	3	7	12	2	5	9	16	4	8	14	26	6	9	13	28
26	2	4	7	13	2	4	10	16	3	7	11	21	5	9	13	27
27	1	3	10	14	2	6	10	18	4	8	12	24	5	9	14	28
28	2	5	7	14	2	3	6	11	5	10	15	30	4	6	9	19
29	3	3	5	11	2	7	10	19	3	4	10	17	6	6	12	24
30	1	5	9	15	2	4	14	20	3	6	14	23	4	5	18	27
AVG	1.57	3.57	7.13	12.27	2.00	3.77	7.93	13.70	3.27	6.37	10.97	20.60	3.87	6.23	11.53	21.63
STD	0.97	1.19	1.76	2.80	0.87	1.87	2.49	4.14	1.36	1.90	2.91	5.66	1.41	2.01	2.70	5.35
MAX	3	5	11	17	4	8	14	21	5	10	16	30	6	9	18	29
MIN	0	1	4	6	0	0	3	6	0	2	5	9	1	1	6	8

AVG: Average, STD: Standard deviation Max: Maximum Min: Minimum

Table 1. Numbers of occlusal contact points at centric occlusion in 0 and 90 degree

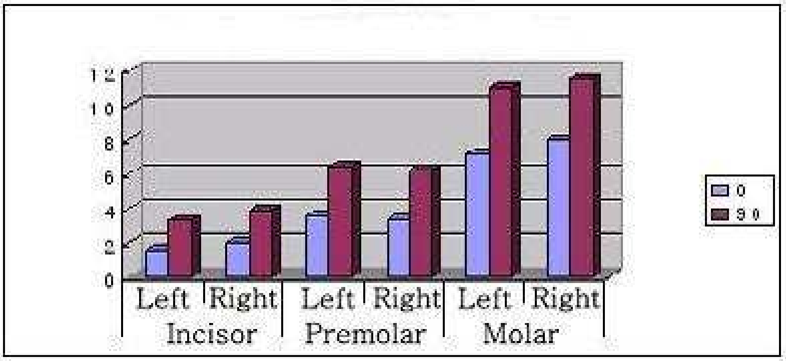

Fig. 10. Number of mean contact points at incisor, premolar, molar during each postures.

2. Tendency of contact point following the postural change.

The tooth contact point of the all subjects tended to increase in the upright position than the supine position. The number of contact point was increased and the transposition was identified. Buccal cusp tip slided to the mesially as the subject position changed from the supine to the upright position.

3. The statistics of the occlusal force score

T-Scan II system is capable to obtain the relative occlusal force. To the same subjects, occlusal force was measured by scoring the relative occlusal forces in the 0 and 90 degree. At three dimensional graph, the yellow bar graph was given 1 point, 2 points for the green and 3 points for the red color. Comparing each sum of the 0 and 90 degree, the occlusal force difference was found(Table. 2, Fig. 5, 6).

The mean occlusal force points was 73.44 in 0 degree and 116.04 in 90 degree. This result showed statistically considerable differences. ($P<0.05$)

4. The statistics of the muscle activity degree

At 0 degree, the mean masseteric muscle electromyograms were 124.87(left), 147.78(right) and the mean anterior temporalis electromyogram were 52.64(left) and 70.40(right). At 90 degree, the mean masseteric muscle electromyograms

Subject	0	90	Subject	0	90
1	54.18	102.34	16	72.24	110.94
2	54.18	79.12	17	54.18	98.04
3	32.68	49.02	18	73.1	124.7
4	75.68	86	19	124.7	148.78
5	65.36	114.38	20	62.78	135.02
6	67.08	104.06	21	75.68	119.54
7	109.22	137.6	22	55.9	134.16
8	90.3	101.48	23	75.68	149.64
9	92.02	125.56	24	63.64	121.26
10	76.54	116.1	25	74.82	150.5
11	55.9	62.78	26	78.26	122.12
12	67.08	114.38	27	98.9	132.44
13	76.54	130.72	28	69.66	119.54
14	41.28	69.66	29	78.26	118.68
15	87.72	132.44	30	99.76	170.28
AVG	73.444	116.04	MAX	124.7	170.28
STD	19.441	27.001	MIN	32.68	49.02

AVG: Average
STD: Standard deviation
Max: Maximum
Min: Minimum
Table 2. Occlusal force score in 0 and 90 degree

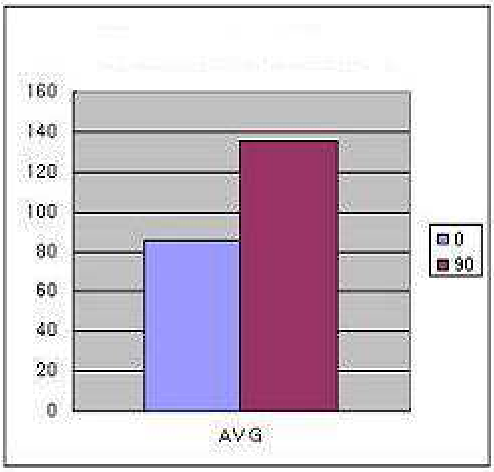

Fig. 11. Mean occlusal force score following each position

were 129.51(left), 53.86(right) and the mean anterior temporalis electromyograms were 57.56(left), 70.40(right). This results revealed that masseteric muscle had higher electromyogram in both angle. This result had statistically considerable differences(Fig. 8, 9).

Comparing both sides, left side showed higher tendency than the right side in both masticatory muscles. Masseteric muscle electromyogram were in 0 degree 124.87/147.78(left/right) and in 90 degree 52.637/70.403. Anterior temporalis electromyogram was in 0 degree 129.51/153.86 and in 90 degree 57.56/70.403. This result showed statistically considerable differences only in the anterior temporalis.

When the electromyogram was compared based on the postural changes, anterior temporalis showed 52.637/70.403 (left/Right) in 0 degree and 57.56/74.27 (left/Right) in 90 degree. Masseteric muscle showed 124.87/147.78

(left/Right) in 0 degree to 129.51/153.86 (left/Right) in 90 degree. This results had not statistically considerable differences(P>0.05) (Table. 3).

Subject	0				90			
	Ant.Temporalis m.		Masseter m.		Ant.Temporalis m.		Masseter m.	
	Left	Right	Left	Right	Left	Right	Left	Right
1	12.9	29.2	72	47.4	16	50.6	78.5	53.9
2	58.7	63.9	96.3	79.4	55.1	156	124.7	70.8
3	17.3	20.3	54.3	35.3	32.6	50.3	30.5	27.3
4	17.5	26.7	39	99	22.4	26.2	33.8	102.3
5	22.3	35.3	57.9	117	28.7	46.2	56.2	137.1
6	24.1	30.3	107.3	138.6	30.4	37.9	153.4	164.1
7	113.4	144.6	164.8	244.7	124.4	150.6	169.4	221.9
8	42.1	110.7	202.5	225.7	39.5	108.4	189.4	144.8
9	58.9	85.4	28	192.5	61.8	79.5	235.4	191.3
10	83.3	91.9	141.3	218.9	78.7	75.3	109.6	148.3
11	9.3	33.6	45.8	66	17	36.5	18.7	35.4
12	48.6	64.6	130.8	125.9	39.4	65.6	119.4	142.2
13	48.3	73.4	171.4	194.1	37.9	60.9	90.6	152.1
14	14	18.9	40.8	55.2	14.2	22.2	46.8	67
15	64.9	51.4	183	154.7	57.1	51.1	210.6	145.6
16	26.5	44.3	72.1	123.4	21.3	36.6	74.3	130.5
17	52.7	59.6	93.1	99.5	75.3	65.5	77.6	111.7
18	66.2	183.3	123.7	130.4	59.2	66.4	89.1	135.9
19	73.5	79.1	75.3	203.8	86.6	81.2	85.6	224.5
20	23.4	44.7	134	45.8	21.3	33.8	108	49.4
21	92.9	127.9	165.6	131.6	125.7	169.6	242.9	149.9
22	99.8	121.3	182.7	162.2	132.9	147.1	265.3	263.1
23	68.2	80.9	88.5	209.9	83.4	102	102.2	240
24	52.1	36.1	156.1	135.1	58.7	48.6	112.8	157.8
25	42.8	53.8	162.7	207	53.1	57	178.2	254.2
26	83.6	113.1	206.1	184.5	75.6	99.2	167.2	163.7
27	106.6	105.8	182.9	234.4	125.5	119.3	198.2	234.3
28	49.4	53.8	159.4	97.3	47.6	55.8	149.6	138.3
29	47.5	56.1	169.3	210.5	52.2	60.2	168.7	230.2
30	58.3	72.1	239.4	263.7	53.2	68.5	198.5	328.1
AVG	52.637	70.403	124.87	147.78	57.56	74.27	129.51	153.86
STD	29.039	40.054	58.206	65.601	34.516	40.158	66.677	73.08
MAX	113.4	183.3	239.4	263.7	132.9	169.6	265.3	328.1
MIN	9.3	18.9	28	35.3	14.2	22.2	18.7	27.3

AVG: Average STD: Standard deviation
Max: Maximum Min: Minimum

Table 3. Mean muscle activity degree of Ant. Temporalis muscle. & Masseter muscle. in 0 and 90 degree.

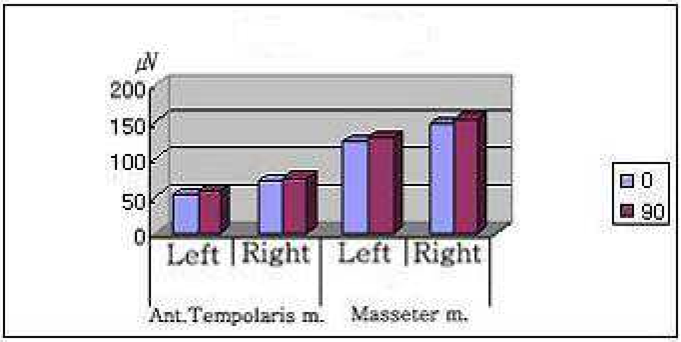

Fig. 12. Mean EMG of Ant. Temporalis musc;e. & Masseter muscle. following each position.

Ⅳ. *DISCUSSION*

At the final moment of the intercuspation, the load distributed through the temporomandibular joint, maxilla and mandible. To analyze the function of the stomatognathic system, occlusal contact should be evaluated since the physiological relationship is preserved. The ideal occlusal contact hardly achieves under the various occlusal contact, all tooth contact position in centric occlusion is used for the basic guideline. According to the definition of Beyron[2], the optimum occlusion for the stability of the stomatognathic system is that tooth occlusion does not cause hypertension or damages and at the same time makes harmony with other masticatory system. Stable centric occlusion, according to the Dawson[35], is important based on that reason, the distribution of the stress to each tooth diminishes tooth wear and protects tooth extrusion. Manns et al.[36], Bake et al.[37] and Kim et al.[38] claimed masticatory muscle activity would be presented on the optimum intercuspation. Moreover, at the maximum inercuspation, tooth contact would be accomplished bilaterally. Krough-Poulsen[5] reported that occlusal contact was resulted from afferent impulse of the periodontal ligament and other orofacial muscle activity and the state of the intercuspation position hinders the mandible stopping the rotational movement and accomplishes the even tooth contact. On these condition, Periodontal ligament activated and afferent impulse distributed broadly, eventually masticatory muscle relaxation would be achieved. On the other hand, occlusal contact activates the mechanoreceptor of the periodontal ligament and attributes to the negative feed back from the closing muscles.[37,39-42] Angelone et al.[43] reported that action potential had proportional relationship with the occlusal force in the isometric contraction of the closing muscles. And Funakoshi et al.[44] also reported the orofacial muscle activity corresponded to the postural change. In addition, Rocabado et al.[45] stated that occlulsal contact strength was affected by the postural change. Yeon et al.[46] reported that occlusal contact points were changed by the occlusal strength relating the anterior temporalis activity. Occlusal contact position proceeds anteriorly as the posture changes from the supine to the upright and the increase of the electric stimulation to the superficial temporalis also causes the anteriorly shifts.[47]

The occlusal contact point evaluation usually is performed clinically approachable. Therefore, when the patient's head position changes, the complaint comes out. Mandibular position proceeds posteriorly when the patient head moves from the upright to the supine and all these changes relates with the elongation or contraction of the surrounding muscles and ligaments.[48] Therefore, the patients posture should be carefully considered when occlusion is adjusted. Many researches about the contact point change regarding with the head postural change had been performed. Chapman[49], using T-scan, reported that the head postural change causes no effect on the tooth contact point. On the other hand, Koildis[50], using special photoplastic sheet, reported that occlusal adjustment is needed to consider the postural change. According to the Mc-Lean[14], in the research of the postural change effect using electric-tilt table, occlusal contact was increased and moved to the mesially from supine to the upright position. Additionally, they measured buccinator muscle activity and reported that postural change affected to the muscle activity to maintain mandibular position. Kim et al.[51] compared about contact point and time during habitual closing and maximum closing among the upright, semisupine and supine using T-scan and reported that habitual closing showed less contact points, which was consistent with Risse and Ericssion's reports.[7] However, Kim's research didn't show statistically considerable differences. Previously reported experiments, excepting Kim's, the contact point moved anteriorly as the mandible moved anteriorly and total contact points were increased, The present experiment also shows same results.

Sophisticated appliance should be employed to measure head postural angle. Nature Head Position marker used in the study maintains head position while patient takes lateral cephalometric radiograph so that orthondontics have adapted this appliance earlier. Cole[52)] stated usage of the general goniometer is inaccurate due to less bony landmarker and thick soft tissues in cervical area. Therefore, Molligoda et al.[53)] assumed visual estimation should be used reluctantly, even though it was not accurate clinically. Addition to the appliance for measuring head postural angle, the material for the measurement of the occlusal contact should be thin and have short setting time and high reproducibility. The appliance type for measuring the occlusal contact, occlusal force, and thickness should be considered as the factors influencing to the occlusal contact point.

The Maness[54)] and the MIT researchers developed T-Scan system that allowed tooth contact data to be analyzed qualitatively and visually. Blue decompressor can recognize from 100g to 1.1Kg[55)] and red decompressor has 4 times higher sensitivity than the blue decompressor. However, red extra sensitive sensor is designed to recognize the sensitive closing induction or few occlusal contact. In case of the more than 10 contact points, the red sensor does not fit for measuring the fully intercuspated occlusion.[7)] Eventually, in this article, blue sensor has been used. Hsu et al.1[56)] pointed out T-Scan system showed some suspicious results on analysis of the occlusion. Harvey[57)] et al. reported that decompressor should be restrictedly used at most two times and overtimes provide the results inaccurate. According Kong et al.[58)], decompressor was suitable for recording occlusal contact but showed false negative contact.

Lyons[59] reported that in the T-Scan system bar height presented contact points but not related with the forces. Although the contact points recorded less than real contact, the system was useful for evaluation contact points. T-Scan system using 0.8mm thick sensor which might be able to change the proprioceptor in the oral cavity, occlusal contact evaluation could lead the subtle changes while mandibular movement and occlusal contact. Hence, in present article, 2 times of biting were performed to reduce the error by the compression paper change inducing the maximum closing state with high reproducibility of the occlusal contact points and force.

The factors which could affect to the masticatory muscle activity, while the mandibular movements, were examined. Those factors are the mandibular postural change demonstated by Kwon et al.[60], Jimenez[61], Plesh et al.[62] and characteristic of the food reported by Kohno et al.[63], Anderson[64], Higash[65] and head postural change claimed by the Shin et al[66], Weinberg et al.[67], Root et al.[68]

In order to observe the active degree of masticatory muscle, electromyogram has been frequently used . The basic configuration is each active motor unit excitation and the amplitude is possibility of active motor unit and the log total of their excitation frequency.[69] Integral calculus analysis is used most cases for the quantitative analysis of muscle activity. In the muscles with same muscle fiber integration, integrated muscle activity has correlation with the isometric contraction, so integrated muscle activity could be landmark for the index of the muscle activity. Because this method had the correlation only within the muscles with same muscle fiber configuration, in the compound masticatory muscle, the relationship shows differently by characteristics of the fiber configurations.[30] Even though 40- 80 msec differs between the maximum electric muscle activity and the maximum mechanical masticatory force, recording maximum electric muscle activity is relatively accurate method for recording maximum mechanical masticatory forces.[70-72] When using electromyogram measuring masticatory muscle activity was questioned in credibility by the Throckmorton et al.[73] and Cecere et al.[74], Lindauer et al.[75] reported that the data would be credible especially when subjects clench and masticate. Kroon et al.[76] also supported the credibility by reporting that during the clenching the muscle activity is weakened in the muscle disorder patients. Moreover, even though electromyogram has been demonstrated as useful method, due to some variable such as individuality, different method or duration in one patient, type of electrode, location of electrode and the subjects posture, the value of electromyogram as the diagnostic tools has been underestimated. When surface electrode was used, Barbenel et al.[30] reported that the results were differed by the measurement method and time. Also Frame et al.[31] mentioned electromyogram was changed by time because of the inaccurate fixation of the electrode. Greenfield[77] mentioned changes of electromyogram was caused by the technical error. Frame et al.[31] mentioned about the problem of electrode affix, which was the major cause of the muscle activity change rather than the various muscular activity. On the other hand, Yoon et al.[34] urged that there was not a considerable differences among the examiners. Especially, if the examination was carried out in the same condition even by the different examiner, the difference could be minimized. Additionally he claimed that the chief factor for the changes was the different method by the examiner, not by the environmental factors.

From these reports, it could be speculated that there would be no difference in measuring the muscle activity, but in this article, settled electrode fixation was given to get rid of the error at every time.

Since electromyogram study for the habitual mastication was performed by

Moller and Christensen et al.[78], masticatory muscle activity research using electrode has bee carried out. However, Angelone et al.[43] demonstrated that the location of the re-affix electrode influenced to the electromyogram due to the difference of the muscle activity and skin resistance.

According to the Sims and Ruch[79], the surface electrode was influenced by the adjacent muscle and measure of the specific muscle was not easy, therefore the internal electrode should be used. Yemm[80] reported that surface electrode could present the same electrical activity measuring the internal electrode. Kawazoe[28], Ralston[81], Gibbs[82], Hagberg[83] demonstrated there was correlation between the integrated electric muscle potential and the muscle tensile strength. Latif[84] reported that, when the electrode location changes, the surface electrode more affected than the internal electrode, consequently the results presented stronger but the reaction tendency was constant.

This study was performed to evaluate the influence of the general head posture to the occlusal forces and muscle activity. Further studies regarding sophisticated lateral and anterior guidance and various head posture will be needed to get more objective criteria on these matters. Moreover, there might be exist diverse variables about the measurement of the muscle activity and occlusal contact. Therefore, standardized and reproducible method must be applied on this further studies. In summary, anterior tooth contact as well as total tooth contact were increased as the posture changed from supine to upright as well as mandible moved to the anteriorly. Additionally, posterior tooth contact also were increased. However, the difference in the same subjects was not usually considered and tapping movement was used to get the closing movement. There might be some errors because sliding of the centric occlusion wasn't identified and was less accurate than NHP marker developing for this experiment.

V. *CONCLUSIONS*

This study presents the relationship between the masticatory muscle activity and occlusal contact during mastication. Using Bio-Pak System(Bioresearch Inc USA) and T-Scan System(Tekscan Co., USA), electromyogram of the anterior temporalis and masseteric muscle and occlusal contact were measured in the 30 normal subjects. The results are consistent with the Horio[85)]'s result that masseteric muscle showed more response than temporalis during mastication.

1. Comparing both side of the masseteric and temporal muscle on centric occlusion, right side muscle showed higher activity than left. Statistically only in the anterior temporalis considerable difference showed. ($P<0.05$)

2. Mean contact force was higher in upright than supine position. Supine position had 85.4 and upright position had 135. This results showed statistically considerable difference. ($P<0.05$)

3. The electromyogram of the anterior temporalis and masseteric muscles were measured higher in the upright position than supine position. However, this result did not show statistically considerable differences. ($P<0.05$)

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