PRESSURE PAIN THRESHOLD AND THE RESTING EMG ACTIVITY IN PATIENTS WITH CRANIOMANDIBULAR DISORDERS BEFORE AND AFTER CONSERVATIVE THERAPY

Kyung-A Cho, D.D.S., **Myung-Yun Ko**, D.D.S., M.S.D., Ph.D.

Department of Oral Medicine, College of Dentistry, Pusan National University

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I. INTRODUCTION

Craniomandibular disorders(CMD) is increasingly being viewed as a syndrome in which a constellation of disturbances relating to the temporomandibular joints and associated musculature interacts, leading to clinical signs and symptoms[1]. Forms of CMD treatment are categorized into reversible and irreversible therapy, or conservative and radical therapy[2]. The reversible therapy includes behavior modification, physical therapy, pharmacologic therapy, and orthopedic appliances. A long-term follow-up study[3] of CMD patients reports that conservative and radical therapies show similiar success rates. Thus, conservative therapy is endorsed for initial care of nearly all CMD[4].

The most common reported symptoms of CMD are pain and tenderness upon palpation in masticatory muscles, indicating decreased pressure pain threshold(PPT)[5,6]. Algometer has recently been tested and used in attempt to standardize the palpation procedure[5 9]. Jensen et al[6], Fischer[7], Chung et a[l8], and Reeves et al[9] revealed a good reliability and a validity of algometer measurements in the masticatory muscles as a quantitative evaluation of PPT. This has led to the use of the instruments as and aid in evaluating of hypersensitive spots[9], fibrositis[10] and activity of arthritis[11], and documenting clinical effects of different treatments such as intramuscular injection[6], physical therapy[12], transcutaneous electrical nerve stimulation[13], and acupunture and occlusal splint[14].

Electromyography(EMG) is used to measure muscle activity. Glaros et al[15] used it in diagnosing of myofascial pain-dysfunction, and found that EMG activity recorded from the masseter was significantly higher in myofascial pain-dysfunction patients than in healthy controls. Gervais et al[16] suggested EMG norms for masseter and temporalis in clinical, subclinical and asymptomatic populations. Balciu-

nas[17] and Miralles et al18) evaluated the effect of many treatment modalities by using EMG.

Some workers have shown that CMD patients have high resting EMG activity[15,16]. Other investigators have found that patients have lower PPT of facial muscles than normal subjects do[6-12]. The relationship between muscle activity and pain, however, remains unrevealed. Thoug Dahlström et al[19] reported siginificant decrease in mean EMG activity from masseter and frontalis, and in clinical symptoms of mandibular dysfunction following biofeedback training, they failed to find a significant correlation between the decrease in neuromuscular activity and the clinical symptoms. Schonen[20] found that EMG level and pain threshold were weakly correlated in tension headache. As there was few literature to compare neuromuscular activity to pain thre- shold using clinical patients or normal samples, this study was attempted.

The aims of this study were 1) to evaluate the change in PPT and the resting EMG activity after conservative therapy, 2) to compare right side to left side of PPT and the resting EMG activity, and 3) to determine the level of correlation between PPT and the resting EMG activity.

II. MATERIALS AND METHODS

1. Subjects

Twenty-one women patients ranged from 20 to 30 years were participated in this study, who were referred to the Department of Oral Medicine at Pusan National University Hospital for CMD treatment. As control subjects, twenty-one female dental students from 21 to 24 years without any history and symptoms of CMD were selected randomly.

2. Methods

Apparatus

The Electronic Algometer Type I (Somedic Production, Stockholm, Sweden)[21] used in this study consists of a gun-shaped application handle with a round rubber tip and an amplifier that has a digital display panel, calibration knob, and a patient-operated switch.

The EMG recordings were performed with the model EM2 bioelectric processor(Myo-Tronics, Inc., seattle, Washington, USA)[22]. The EM2 system can interface with the model K6 diagnostic system(Myo-Tronics, Inc., seattle, Washington, USA)[23] and allow simultaneously to display and store the kinesiographic and EMG data.

Procedure

Subjects were examined individually by same operator, Each patient was assessed before and after treatment on following clinical fidings : 1) degree of pain intensity as subjective symptoms[24], 2) maximal comfortable opening(MCO) as objective finding[25], 3) PPT[10,26], and 4) bilateral resting EMG activity on the superficial masseter and anterior temporalis[15]. Degree of pain intensity was recorded on numerical analogue scale(NAS). The patients were asked to rate their pain using a numerical scale of 0 to 10. The 0 on the scale was estimated to be "no pain" and 10 to be "pain as bad as can be" [24]. Also, control subjects were assessed on PPT and the resting EMG activity bilaterally on the superficial masseter and anterior temporalis.

PPT was measured in kPa by algometer. The algometer handle was applied perpendicularly to the superficial masseter and anterior temporalis and maintained at 30 kPa/sec. In order to avoid experimental bias, the subjects could not see the digital display. As soon as the

Fig. 1. The electronic algometer applied to the masseter

Fig. 2. The electrodes positioned on masster and temporalis

pressure sensation became painful, she pushed the button on the patientoperated switch. The digital display stopped immediately for about five seconds, and the red light turned on so that the operator could record the value[21](Fig. 1).

The resting EMG activity was recorded by placing bipolar surface EMG electrodes. Silver/silver chloride disk electrodes were applied to the superficial masseter and anteior temporalis, and the patients were instructed to maintain a stable relaxed posture with eyes closed and to avoid extraneous movement during the recording peroids[22](Fig. 2).

Statistical Method

For evalution of treatment outcomes, paired t-test was used to compare patients group before treatment to patient group after treatment and unpaired t-test was used to compare patient grooup after treatment to control group. Spearman's rank test was used to describe the level of correlatioon between PPT and the resting EMG activity.

III. RESULTS

1. PPT and the resting EMG activity of patient and control group

In patient group, the PPT values after treatment increased in both muscles to statistically significant degree($p<0.01$). The posttreatment

Table 1. Mean and standard deviation of pressure pain threshold of the masseter and temporalis(kPa)

	patients		patients		control
	before treatment	t-value*	after treatment	t-value**	
R. masseter	134.05±39.60	-6.84**	191.66±32.71	-1.13NS	205.52±45.15
R. temporalis	210.71±54.79	-4.10**	249.10±54.15	0.47NS	257.24±58.23
L. masseter	131.33±29.61	-8.88**	199.52±27.37	0.28NS	196.71±36.62
L. temporalis	191.00±46.00	-4.06**	241.43±40.51	-0.45NS	247.95±51.52

** ; $p<0.01$, NS ; Not Significant

* ; comparison between patient group before treatment and patient group after treatment

** ; comparison between patient after treatment and control group

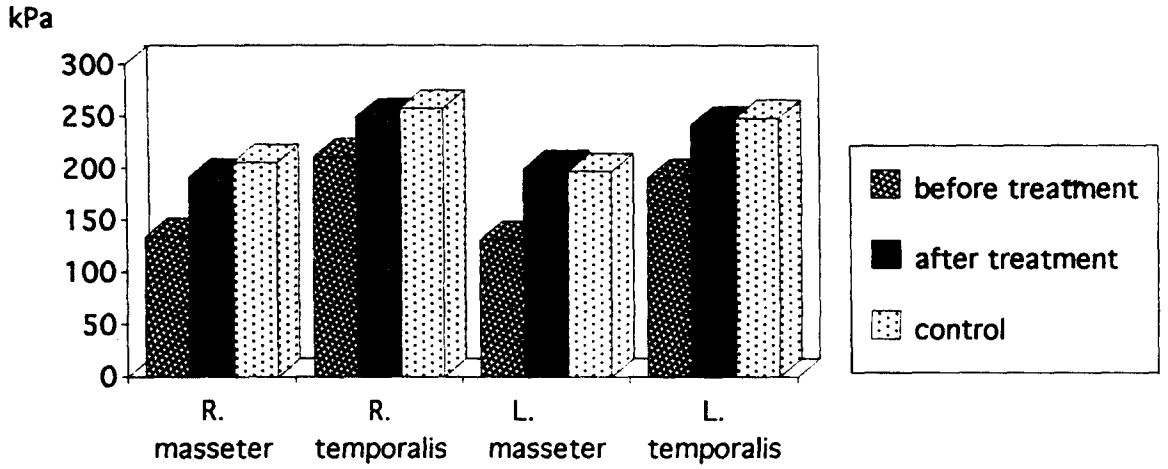

Fig. 3. Histogram showing the changes of pressure pain threshold in the masseter and temporalis after treatment

Table 2. Mean and standard deviation of the resting EMG activity of the masseter and temporalis

(μV)

	patients		patients		control
	before treatment	t-value*	after treatment	t-value**	
R. masseter	3.89±4.50	2.40*	1.55±0.28	0.07NS	1.54±0.55
R. temporalis	2.34±0.63	5.18**	1.76±0.42	-0.31NS	1.80±0.46
L. masseter	2.93±3.20	2.10*	1.50±0.70	-1.82NS	1.72±0.49
L. temporalis	2.83±2.40	2.20*	1.69±0.23	-2.35*	1.96±0.46

*; $p<0.05$, **; $p<0.01$, NS ; Not Significant

*; comparison betten patient group before treatment and patient group after treatment

**; comparison betten patient after treatment and control group

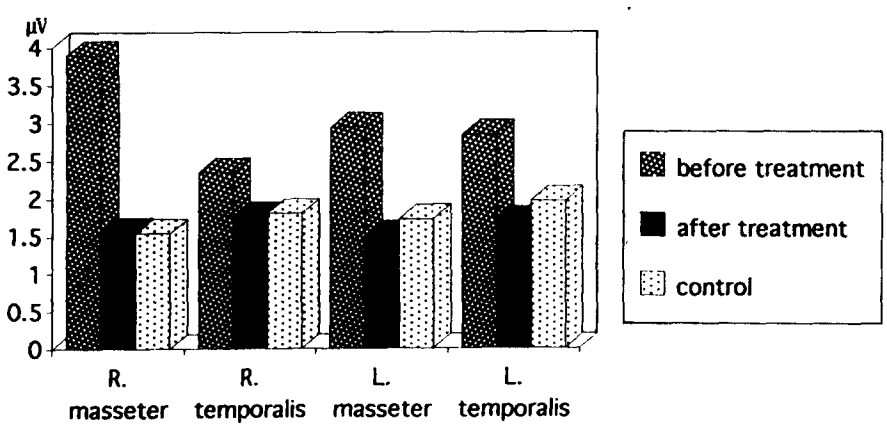

Fig. 4. Histogram showing the changes of resting EMG activity of the masseter and temporalis after treatment

Table 3. Significance comparing right to left in pressure pain threshold and the resting EMG activity(t-value)#

	patients				control	
	before treatment		after treatment			
	PPT	EMG	PPT	EMG	PPT	EMG
masseter	0.29	1.00	-1.31	1.06	1.63	-1.34
temporalis	0.09	0.36	0.31	0.46	0.25	0.09

; All Not Significant

and control group did not differ in the PPT velues of both muscles(Table 1, Fig. 3).

Siginificantly higher mean EMG level were noted in the pretreatment group as compared to the posttreatment and control group. The resting EMG activity of both muscles in the posttreatment and control group fell in normal range[25]. But the resting EMG activity of left anterior temporalis after treatment was increased as compared with that of the control group ($p<0.05$)(Table 2, Fig. 4).

2. Comparison of PPT and the resting EMG activity between right and left muscles

In all groups, no significant differences between left and right in masseter and temporalis were found in PPT and the resting EMG activity(Table 3).

Table 4. Correlation coefficient betten PPT and the resting EMG activity

	patients		control
	before treatment	after treatment	
R. masseter	-0.08	-0.19	-0.34
R. temporalis	-0.24	0.12	-0.56*
L. masseter	0.06	-0.34	-0.08
L. temporalis	-0.59**	-0.23	0.12

* ; $p<0.05$, ** ; $p<0.01$

3. Correlation between PPT and the resting EMG activity

Spearman's correlation coeffiecient was used to analyze the relation between PPT and the resting EMG activity of each muscle in all groups. There was a weak negative correlation between PPT and the resting EMG activity in the most of muscles(Table 4).

4. Objective and subjective assessment of treatment outcome

The numerical analogue scale(NSA) and maximal comfortable opening(MCO) were measured to assess the treatment effect. The mean NAS values of pretreatment group

Table 5. Mean and standard deviation of numerical analogue scale(NAS) and maximal comfortable opening(MCO) before and after treatment

	NAS	MCO(mm)
before treatment	3.67±1.59	37.14±9.10
after treatment	0.95±0.86	47.23±6.76
t-value	9.23**	-4.53**

** ; $p<0.01$

decreased significantly from 3.7 to 0.9($p<0.01$) and the mean MCO values increased significantly from 37.1mm to 47.2mm($p<0.05$) after treatment. Therefore, it indicated that the subjective and objective symptoms were improved after treatment(Table 5).

Ⅳ. DISCUSSION

Craniomandibular disorders(CMD) involve the masticatory musculature, the temporomandibualr joint and associated structure, or both[4]. The beginning of CMD usually occurs with muscular imbalance and joint disorders generally go accompany with muscular disorders. Okeson[3] suggested that muscle disorders and joint disorders could influence each other. Even in internal derangement, Isberg et al[27] demonstrated an increased muscle activity in elevartor muscles. Thus, objective evidence of muscle involvement assumes a greater importance in etiology and therapy evaluation. Algometry is a method used to measure objectively subjective myalgia, and EMG to measure muscle activity.

In this study, NAS was decreased and MCO was increased after conservative therapy in patient group. The majority of patients suffering from CMD achieved good relief of symptoms with conservative therapy[28]. A long -term follow-up study[4] of CMD patients reported that more than 50% of the patients had few or no symptom after conservative therapy. From a study[29] of 154 patients, it was concluded that most CMD patients had minimal recurrent symptoms 7 years after conservative therapy. In a recent study[30] of 110 patients, 85.5% reported that they experienced no pain or much less pain at 2.0 to 8.5 years after conservative therapy. Thus, conservative therapy should be considered preferentially.

This finding that PPT in CMD was siginificantly lower than one in controls was fully in accord with other stduy[31] that had examined PPT by algometer. The reduction of PPT in the present study was in agreement with the improvement of NAS and MCO after conservative therapy. The present results agrees with the study of List et al[14] evaluated the effect of conservative therapy, such as acupunture and occlusal splint therapy. That study showed a high correlation between muscle tenterness and the clinical dysfunction index[14]. In a study [32] of patients with tension headache, muscle tenderness was reduced siginificantly in the physical therapy group. It suggested that algometer is sensitive enough to detect changes in PPT following conservative therapy.

Most of previous investigations used other forms of the algometer and failed to be compared with the present data. The mean PPT values of normal subjects reported by Chung et al[18] were different from those of this study because a lot of factors might influence the PPT value. Especially, the application rate that the author used 30kPa/sec recommended by manufacturer[21] different from 40kPa/sec by Chung et al[8]. McCarthy et al[11] observed that PPT values differed at different application rates. Previous investigators have failed to give any information on application rate and have only taken rough estimation[14,31,32]. The appro- priate application rate should be fast enough to avoid prolonged pressure to the tissues and fatigue of the investigator. Also, it should be slow enough to allow the investigator to apply pressure with a constant rate for sufficient time so that the true PPT should not be overestimated due to reaction time of each patient[33]. Furthermore, it has been emphasized that a constant pressure rate is necessary to obtain a good reliability with the algometer[8,34].

The rest position is regarded as one of the

basic mandibular positions[35]. The resting EMG activity of masticatory muscles may be siginificant in the diagnosis of functional conditions of the mandible[35,36]. The resting EMG activity of CMD patients was increased as compared with that of normal subjects. Also, the results of this study show reduction of the resting EMG activity after conservative therapy, consistent with otehr studies16,34). Burdette et al[37] reported that after conservative therapy, the resting EMG activity decreased siginificantly in masseters of patient group compared with a normal control group. Manns et al[38] reported that a diminution of the resting EMG activity was found in CMD patients after splint theraphy. Lindström and Hellsing[39], and Wood and Tobias[40] considered that clenching position provided the most difinitive information. Balciunas et al[17] reported that a significant decrease in frequency of EMG was demonstrated in clenching position after therapy.

In the pretreatment group, there was no side-to-side difference. It suggested that patients actually demonstrated a diffuse lowering of pain threshold. In tension headache, and myofascial pain-dysfunction syndrome/fibromyalgia patients, it has been suggested that diffuse disruption of central modulating system may play a pivotal pathophysiology in CMD[10]. Thus, abnormal pain sensitivity is developed.

These date argue in favor of a weak correlation between PPT and the resting EMG activity. Both peripheral(e.g, sensitization of nociceptors) and central(e.g, altered stimulus-response function of second-order transmission neurons) mechanism may contribute to the local tenderness and pain in CMD patients[31]. Also, abnomral contraction of facial muscles has been considered as a possible cause of pain, but the resting EMG activity is increased in only a portion of patients and under certain recording conditions[41]. It is generally assumed that tenderness on palpation of various pericranial sites originates from muscles. The recorded tenderness was probably related not only to the muscles, but also to other tissues(e.g. skin, fascia, blood vessel, nerves, or other anatomical structure) compressed by Algometer. Harper and Steger[42] reported hat pain levels in headache were correlated with psychological and personality factors but not with EMG activity. Schonen[20] found that EMG levels and pain thresholds were weakly correlated. These results would suggest that there was a weak correlation between facial pain sensitivity and muscular activity. Many reports of decreased pain thresholds at the Achilles tendon in chronic tension type headache[4], in paravertebral muscles[43], and in finger[44], support the hypothesis that the diffuse disruption of central modulating system is one of the pathophysiologic hallmarks of chronic pain. The resting EMG activity is largely related to the peripheral mechanism of pain, whereas the pain sensitivity is related to the peripheral and central mechanism. The diffuse disruption of central mechanism can explain a weak correlation between PPT and the resting EMG activity.

To distinguish between abnormal and normal state in PPT and the resting EMG activity of a certain muscle, the experimental subjects should have a problem of the muscle. If the subjects have a problem of the muscle where the investigator wants, it will be possible to reveal the definite correlation between PPT and the resting EMG activity. But, the author used all the experimental subjects with pain of any temporomandibular joints or associated structures. Though the present results of a weak correlation between them need supplements in this aspect, this study has a importance as a preliminary step to use

measuring PPT of all CMD patients for diagnosis. Therefore, further studies are still needed in this aspect of using the electronic pressure algometer.

V. CONCLUSION

To evaluate the change of and correlation between pressure pain threshold(PPT) and the resting EMG activity according to conservative therapy in CMD patients, the 21 female patients were examined before and atfter conservative therapy to obtain the following clinical findings:1) degree of pain intensity on numerical analogue scale(NAS), 2) maximal comfortable opening(MCO), 3) PPT, and 4) the resting EMG activity of the masseter and anterior temporalis. The 21 female dental students without any history and symptoms of CMD were examined on PPT and the resting EMG activity of the masseter and anterior temporalis as control subjects.

The obtained results were as follows;

1. After conservative therapy, the degree of pain intensity and the maximal comfortable opening were improved.
2. The pressure pain threshold(PPT) was increased and the resting EMG activity was decreased after conservative therapy.
3. Side to side differences of pressure pain threshold(PPT) and the resting EMG activity were not found in all groups.
4. There was a slight weak negative correlation between pressure pain threshold(PPT) and the resting EMG activity in the most of muscles.

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국 문 초 록

보존적 치료에 따른 두개하악장애환자의 압력통각역치와 휴식시 근전도의 변화

부산대학교 치과대학 구강내과학 교실

조 경 아 · 고 명 연

저자는 두개하악장애환자의 보존적 치료에 따른 압력통각역치와 휴식시 근전도의 변화를 평가하기 위하여 여성 환자 21명을 대상으로 치료전후에 각각 동통의 정도를 유추척도로 나타내었고 편이개구량을 측정하였으며 교근과 전측두근의 압력통각역치와 휴식시 근전도를 조사하였다. 두개하악장애의 병력이나 증상이 없는 21명의 정상 여학생을 대조군으로 교근과 전측두근의 압력통각역치와 휴식시 근전도를 측정하여 환자군과 비교한 결과 다음과같은 결론을 얻었다.

1. 보존적 치료이후 동통과 최대편이개구량은 개선되었다.
2. 보존적 치료이후 압력통각역치는 증가하였고 휴식시 근전도는 감소하였다.
3. 압력통각역치나 휴식시 근전도의 좌우차이는 없었다.
4 압력통각역치와 휴식시 근전도사이에는 약한 음의 상관관계가 있었다.