

# Reliability of Skin Temperature over the Trigger Points of Temporalis and Masseter Muscles in Normal Individuals

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## I. INTRODUCTION

Several epidemiologic studies have shown that craniomandibular dysfunction (CMD) is a common condition in the population.<sup>1,2)</sup> Pain is the most commonly reported symptom in clinical materials<sup>3,4,5)</sup>, and the most frequent clinical finding is tenderness in the masticatory muscles.<sup>1,5)</sup> Finger palpation is the most frequently used clinical method of measuring

tenderness in the soft tissue. It is, however, difficult to quantify this method.

Pathological conditions in joints and muscles are often associated with circulatory disturbances and/or inflammatory reactions located in the synovial membrane of the joint, the tendons, and the connective tissue in muscles and bone.<sup>6)</sup> When these processes are close to the surface of the body, they influence the skin temperature, which can be measured by thermography<sup>7,8)</sup>. Measurements of skin surface temperature may be useful in the assessment of disease activity and progress and in evaluation of treatment results, which otherwise is largely based on subjective observations.<sup>9)</sup> An objective instrument to record skin surface temperature could be useful in evaluation of temporomandibular joint disorders, as has been proposed previously.<sup>7,10,11)</sup> However, before the technique can be introduced for practical use in the clinic, its reliability must be studied.

The purpose of this study is to investigate inter and intra-individual temperature variations, variations in temperature differences between the right and left side, and the repro-

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ducibility of temperature measurements on the skin surface over the trigger points of anterior temporal and superficial masseter muscles in normal individuals.

## II. MATERIALS AND METHODS

### Subjects

Fifteen volunteers among dental students of Dankook University who were all free of tenderness to palpation of the masticatory system and had a normal mandibular mobility were included in this study. The mean age was 25 years, ranging from 29-65 years.

### Apparatus

The thermometer (YSI Precision 4000, Yellow Springs Instrument Co. Ohio, USA) used in this study is a dual-channel, dual display electronic instrument intended for patient temperature monitoring in surgery and critical care. It is designed to be used with a YSI reuseable probe. Each channel operates independently, allowing for simultaneous measurement of temperature at two sites. Temperature display range is 0 to 50°C. Accuracy is  $\pm 0.10^\circ\text{C}$  in the range between 32 and 42°C and  $\pm 0.20^\circ\text{C}$  throughout the measurement range. Resolution is 0.02°C.

### Recording procedure

The measurement points recommended by previous researchers<sup>12,13)</sup> were modified and used for the present study<sup>14)</sup>. Following are the muscles (Fig.1) and the methods used in this study to find the location of skin temperature measurement constantly:

1. Anterior temporal muscle: The subject is asked to clench and relax to help identify the muscle. The fibers above the infratemporal fossa and immediately above the zygomatic process are palpated.
2. Anterior masseter muscle: The subject is asked to clench while the masseter is observed for the location. Fibers of the anterior border are palpated immediately below the zygomatic arch.
3. Inferior masseter muscle: The area 1 cm superior and anterior to the angle of the mandible is palpated.

Following a discussion of the application of these criteria in clinical situations, at least ten subjects were examined by all examiner. Their measurements were compared on each subject, and differences were discussed. Questions regarding the locations of probes were resolved prior to the reliability study.

Inter-examiner and intra-rater reliability was tested by the use of multiple examinations of patients on the same and on different days. For determination of inter-examiner reliability, 15 subjects were examined in one day by two examiners, each blind to the other examiner's measurements.

For testing of intra-examiner reliability, all subjects were examined twice by one examiner blind to his first measurement. Seven days separated the first and second examinations by examiner A in order to minimize both memory of the first measurements. All examinations were done prior to management to minimize variability of the patient's status. Patients were asked whether they had had any change in status since the last exam and prior to this reliability study.

## Statistical analysis

The correlation coefficient was used to measure consistency and paired t-test was used to compare the differences of measurements between both sides of muscles.

### III. RESULTS

The average skin temperature (Table 1,2,3) was significantly higher over the temporalis anterior than over the masseter muscles ( $p < .0001$ ). The inter-individual variation of the temperature was greater for the masseter inferior (3.26 °C) than for the other muscles.

The correlation of skin temperature (Table 4,5) for muscles between the first and second

examiner and between the first and second measurements of one examiner were significantly positive but were lower between the first and second measurements of one examiner ( $r = .739, .646$ ).

The mean temperature differences between the right and left side were .06°C for the masseter inferior, .09°C for the masseter anterior and .29°C for the temporalis anterior. There was no statistically significant difference between the right and left side of masseter muscles, but there was significant difference between the right and left side of temporalis anterior even though very small difference (.29°C)(Table 6).

**Table 1.** Means temperatures for each group in each visit

		1st Exam(A)		2nd Exam(B)	Total averages
		Examiner 1	Examiner 2	Examiner 1	
Mi	R	32.447 ±.731	32.411 ±.883	32.951 ±.778	32.632 ±.803
	L	32.557 ±.793	32.555 ±.892	32.869 ±.696	
Ma	R	32.649 ±.616	32.615 ±.578	33.160 ±.621	32.765 ±.638
	L	32.637 ±.681	32.637 ±.704	32.891 ±.520	
Ta	R	33.093 ±.851	33.031 ±.894	33.300 ±.758	32.998 ±.720
	L	32.816 ±.633	32.691 ±.607	33.057 ±.427	

Mi=Masseter inferior, Ma=Masseter anterior, Ta=Temporalis anterior, R=Right, L=Left

**Table 2.** Total averages, standard deviations of skin temperature(in °C)over the muscles.

Group		Average	SD	Range
Mi	n=90	32.632	.803	31.140-34.400
Ms	n=90	32.765	.638	31.180-34.420
Ta	n=90	32.998	.720	31.500-34.540

Mi=Masseter inferior, Ma=Masseter anterior, Ta=Temporalis anterior, SD=Standard deviation

**Table 3.** Results of paired t-tests for the location of measurement in muscles

	Mean Diff	DF	P-value
Mi:Ma	-.133	89	.0194
Mi:Ta	-.366	89	<.0001
Ma:Ta	-.233	89	<.0001

Mi=Masseter inferior, Ma=Masseter anterior, Ta=Temporalis anterior, DF=Degree of freedom

**Table 4.** Results of correlation test for each group classified according to examiner and side

	Correlation	P-vlaue
E1AR:E1BR	.739	<.0001
E1AR:E2AR	.920	<.0001
E1AL:E1BL	.646	<.0001
E1AL:E2AL	.931	<.0001

E1=Examiner 1, E2=Examiner 2, A=First examination, B=Sencond examination, R=Right, L=Left

**Table 5.** Results of correlation test for each muscle classified according to examiner and visit.

	Correlation	P-vlaue
E1AMi:E1BMi	.654	<.0001
E1AMi:E2AMi	.884	<.0001
E1AMa:E1BMa	.522	.0026
E1AMa:E2AMa	.958	<.0001
E1ATa:E1BTa	.857	<.0001
E1ATa:E2ATa	.949	<.0001

E1=Examiner 1, E2=Examiner 2, A=First examination, B=Sencond examination, Mi=Masseter inferior, Ma=Masseter anterior, Ta=Temporalis anterior

**Table 6.** Results of paired t-tests for right and left muscle groups

	Mean Diff	DF	P-value	No of subject over 1°C of difference
RMi:LMi	-.058	44	.4567	2
RMa:LMa	.086	44	.1668	3
RTa:LTa	.287	44	.0007	3

Mi=Masseter inferior, Ma=Masseter anterior, Ta=Temporalis anterior, R=Right, L=Left

#### IV. DISCUSSION

Electronic infrared thermography is a non invasive method of determining skin temperature by converting thermal energy into electronic signals, which are displayed on a video monitor. Because thermography demonstrates physiology,<sup>15)</sup> it may be helpful in documenting the presence of muscle spasm, myositis, and myofascial trigger points. These muscle problems are commonly seen in patients with TMDs<sup>16)</sup>.

Specific site with an increased or decreased skin temperature generally could not be discriminated detailly in monitors. It is suggested that new skin temperature measurement system which are able to locate small area like a trigger point. This study, therefore, used the electronic thermometer having a dual-channel and dual display to measure experimental and control sites simultaneously.

The normal skin temperature over the masseter and temporal muscles showed considerable inter- and intra-individual reliability, although the inter-individual correlation ( $r=.920$  to  $.931$ ) was higher than intra-individual correlation ( $r=.646$  to  $.739$ ). It can be thought that intra-individual correlation would be generally higher than inter-individual correlation. Possible reasons for this contrary result are, for example, variation in room temperature and biological differences of subject between first and second measurements.

The application site and the pressure of the thermometer against the skin also influence the temperature<sup>17)</sup>. An application to the temporalis anterior will locate the thermometer close to the superficial tneporal artery and will result in a higher temperature ( $33.00^{\circ}\text{C}$ ) than an application over the masseter muscles ( $32.6$

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3°C and 32.77°C). The difference between the right and left side of temporalis anterior in this study might be explained by such suggestion. Likewise, a hard pressure of the temperature probe against skin will cause temperature differences compared with a light pressure<sup>18)</sup>. To exclude this possibility, in this study, an adhesive plaster for medical use was used to immobilize the probe with a constant pressure.

Some investigators hypothesized that the higher surface temperature was due to inflammation with hyperemia in the tender area of the muscle.<sup>19)</sup> In 1983, a group in Sweden measured the surface temperature over 35 normal TMJs and 29 normal masseters<sup>20)</sup>. The variability within subjects from right to left was 0.3°C to 0.4°C. In this study, the mean differences between right and left muscles are 0.06°C for masseter inferior, 0.09°C for masseter anterior and 0.29°C for temporalis anterior.

A range between subjects was wide—for the TMJ, 32.1°C to 35.5°C, and for the masseter, 30.9°C to 35.7°C. This study showed that the ranges between subjects for the masseter inferior and anterior and the temporalis anterior was 31.14°C to 34.40°C, 31.18°C to 34.42°C and 31.50°C to 34.54°C. Compared with Sweden's results, the range of masseter muscle in this study was smaller than that in their study.

In this study, the numbers of subjects which the temperature difference between right and left sides was more than 1°C were 2 of 45 for the masseter inferior, 3 of 45 for the masseter anterior and the temporalis anterior respectively. These results confirmed that temperature differences between right and left sides were less than 10°C in 90% of cases<sup>21)</sup>. This result supports that a difference should be 1°C or more to be judged clinically significant<sup>22)</sup>.

Nemcovsky et al.<sup>23)</sup> reported that the skin temperature reduction in the myofascial pain group during the treatment phase was a mean of 0.4°C which was statistically significant and an initial difference of 0.8°C in skin temperature between the myofascial pain and control groups prior to treatment was measured.

The small differences between both sides in this study, therefore, indicate that skin temperature measurements have an acceptable reproducibility and that the differences in skin temperature between the right and left muscles also have an acceptable constancy with time and that skin temperature measurements can be an objective accessory instruments in diagnosis and follow-up of myofascial pain. However, the significant difference between right and left sides for the temporalis anterior in this study requires further studies to investigate the intraindividual variation for each trigger point in all muscles.

## V. CONCLUSIONS

The results of this study indicate that skin surface temperature measurements have an acceptable reproducibility and that the differences in skin temperature between the right and left masseter and temporalis also have an acceptable constancy with time to be used in future clinical studies.

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## 정상인의 측두근 및 교근내 발통점의 피부온도측정에 대한 신뢰도에 관한 연구

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두개하악장애는 가장 흔히 발병하는 질병중의 하나이다. 이때 저작계에 흔히 호소하는 주소가 근육의 통증이다. 통증의 정도를 측정하는 방법으로 측진이 가장 널리 사용되고 있으나 정량화하기 어렵다는 단점이 있다. 따라서 통증 측정기 등과 같은 다양한 시도가 진행되고 있다. 근육이나 관절의 병적 소견은 해당조직의 혈액순환장애나 염증반응과 종종 관련이 있다. 이러한 상태는 신체의 표면과 밀접한 관계가 있어 피부온도에 영향을 미치며, 따라서 thermography로 측정할 수 있다. 피부온도의 측정은 질병의 활성 상태를 평가하는 데 유익하며, 또한 치료결과를 평가하는 데에도 역시 효과적이다. 객관적 피부온도 측정장치가 있다면 턱관절이나 저작근의 이상상태를 평가하는 데 매우 도움이 될 것이다. 따라서 본연구의 목적은 경제적이면 양측성으로 특정 부위의 피부온도를 측정할 수 있는 기기를 사용하여 검사자내 및 검사자간 신뢰도를 측정하고 좌우 온도차이를 확인함으로써 향후 질환 및 치료경과에 대한 임상적 평가시 객관적 측정방법의 하나가 될 수 있는 지를 알고자 하는 데 있다.

구강내 염증이나 이상이 없으며 두개하악장애가 없는 치과대학생 15명을 대상으로 조사하였다. 평균연령은 24.9세, 범위는 24-30세이었다. 사용한 기기는 미국산 YSI Precision 4000이다. 18-20℃의 일정한 실내온도에서 두 검사자가 각각의 검사를 알지 못하는 상태에서 별도로 정해진 부위에 검사를 시행하고, 약 1주일후 이전 검사에 대한 기억이 없어진 상태에서 두 검사자중 한 검사자가 다시 동일한 검사를 시행하였다.

측정치들을 이용하여 상관관계를 계산하고 이에 대한 유의성을 검정하였다.

1. 검사자내 상관관계(r)는  
좌 .798( $p < .0001$ ), 우 .757( $p < .0001$ )이었다.
2. 두검사자간 상관관계(r)는  
좌 .958( $p < .0001$ ), 우 .951( $p < .0001$ )이었다.
3. 좌우 측정치간의 차이는 유의한 차이가 없었다.
4. 근육부위별 측정에서는 inferior masseter muscle의 검사자간에서만 유의한 상관관계가 없었을 뿐 anterior masseter muscle, anterior temporalis 모두 검사자내 및 간에 모두 유의한 상관관계를 나타내었다.

이상의 결과로 보아 정상인에 있어 근육내 발통점의 피부온도는 검사자간에는 특정부위에 따라 다소 차이가 있을 수 있으나 일반적으로 높은 재현성을 보여줌으로서 향후 교근 및 측두근의 임상연구 평가에 피부온도조사는 도움이 되리라 사료된다.