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An Ultrasonographic Evaluation of Masseter Muscle Thickness in Patients Having Parafunctional Habit

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Purpose: The purpose of this study was to investigate the masseter muscle thickness before and after treatment using ultrasound sonography in patients with parafunctional habits.

Materials and Methods: From September 2019 to March 2020, a total of 27 patients who visited the Department of Oral and Maxillofacial Surgery at Ewha Womans University Seoul Hospital were collected. The thickness of both masseter muscles was measured using a tablet ultrasound scanner. Statistical analysis was performed by using the IBM SPSS version 26.0 statistical package (IBM Corp) with significance level at 0.05.

Result: According to the statistical results, the thickness of the masseter muscle was thicker on the right side than on the left, with no correlation with sex or age. The severity and duration of pain did not have a significant correlation with the thickness of the masseter muscle. Botulinum A toxin injection in the masseter muscle was the most effective way to reduce pain and reduce the thickness of the masseter muscle. Splint treatment also showed some effects in reducing the thickness of the masseter muscle.

Conclusion: Based on the findings, it can be claimed that ultrasonography is simple, inexpensive and easily repeatable method to get real-time diagnosis and treatment results for masseter muscles.

Key Words: Masseter muscle; Bruxism; Ultrasonography

Introduction

The etiology of temporomandibular disorder (TMD) has been related to trauma, malocclusion, and parafunctional habits[1]. Temporomandibular joint (TMJ) pain, masticatory muscles hyperactivity or pain of the masticatory muscles, complex derangements between mandible condyle and disc, as well as changes and limitations of mandible movement have been reported as main symptoms of TMD. Ad-

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ditionally, tinnitus, other ear pains and headaches were also included in the symptoms[2].

An overdose of caffeine, alcohol, smoking, and medications, such as selective serotonin reuptake inhibitors, have been suggested as external etiological factors responsible for parafunctional habit[3,4]. Bruxism may occur during sleep as a form of teeth grinding (sleep bruxism) or as a clenching teeth while awake (awake bruxism) due to the contraction of the masseter, temporalis and other masticatory muscles[5-8]. It can lead to masticatory muscle hypertrophy and hyperactivity, dental attrition, fractures or mobility of dental restorations and tooth structures, hypersensitive or painful teeth and periodontal diseases[7,9].

The goal of the treatment of the parafunctional habit is to reduce muscles pain, hypertrophy and hyperactivity and the remedies include medication, surgical or non-surgical therapies, depending on the patient's specific conditions and presence of parafunctional habits[10].

The stabilization splint (SS) is often used for parafunctional habit, especially for the treatment of sleep bruxism. In the literature, there have been many studies showing decrease in the activity and hypertrophy of the masseter muscle (MM) resulted from the use of a SS[11,12].

Botulinum toxin A injection (BTX-A) is another type of treatment which is the injection of a neurotoxin protein into hypertrophied and/or painful MM. It can decrease hyperactivity and thicknesses of the MM and can also relieve pain and reduce muscle activity[13].

The MM is one of the masticatory muscles which has superficial and deep layers. The MM plays a crucial role in efficient chewing of the food as well as in facial appearance[6,14]. Thickening of the MM depends on various factors such as facial morphology, bite force, occlusal factors, and TMD related abnormal activities[8,15].

In the previous studies, MM thickness has been measured by using various imaging techniques including ultrasonography (US), computed tomography (CT) or magnetic resonance imaging (MRI) for the diagnosis and treatment. CT can visualize the bone, soft tissue and other body structures but has limitations in the imaging of the muscles[16]. MRI clearly shows the morphology of the muscle, but the obtaining images takes much longer time than that of CTs and is generally costly for the patients[17]. US is a convenient and simple method for diagnosis, measurement and detection of changes in the muscle[18]. The application of ultrasound was first introduced by Jacques and Pierre Currie in 1880, and the use of US in dentistry was reported by Baum et al, in 1963[19]. In dental practice, US has been used for imaging maxillofacial fractures, various types of soft tissue masses, muscles, TMJ, tonsils, and salivary glands[20].

The purpose of this study was to measure MM thickness before treatment and determine the decreases in these thickness after treatment by first visit and follow-up measurements using US in patients with parafunctional habit.

Materials and Methods

1. Patients Review

This study was approved by Institutional Review Board of Ewha Womans University Seoul Hospital (1-2019-0088), and the requirement for patient consent was waived because of the retrospective nature of the study. Records of patients who underwent ultrasonographic examination of TMJ at Ewha Womans University Seoul Hospital from September 2019 to March 2020 were reviewed. The patients with a history of mandible fracture or trauma, previous TMD treatment, orthodontic treatment or orthognathic surgery were excluded from the subject group. A total of 27 patients were finally selected for this study, with 13 male and 14 female patients and the mean age of 42.2±16.5 years.

The basic information of patients such as dura-

tion of the MM pain and numeric pain rating scale (NPRS) scores of patients, were collected. The MM thicknesses of all the 27 patients were examined and measured at first visit and the subjects were divided into three groups depending on their treatments based on symptoms, pain durations, pain levels, and the type of parafunctional habits. The three groups were splint treatment group, BTX-A injection group, and other treatment group (including medication, physical therapy, self-therapy, and others). The 14 patients were excluded due to absence of information on treatment or insufficient follow-up measurement. The MM thickness of the final subjects was examined and measured in 13 patients at 6-month follow-up (Table 1).

Table 1. Group divisions of patients at first visit and 6-month follow-up

Group	Value
First visit (n=27)	
Group 1	16 (59)
Group 2	5 (19)
Group 3	6 (22)
6-month follow-up (n=13)	
Group 1	6 (46)
Group 2	5 (38)
Group 3	2 (16)

Group 1: stabilization splint treatment, Group 2: Botulinum toxin A injection, Group 3: other treatments.
Values are presented as number (%).

2. Ultrasonographic Examination

Each patient was seated in the upright position with natural head posture. Real time US screening was performed bilaterally at both relaxed and clenched intercuspal position, using a tablet-based ultrasound scanner (MINISONO; Alpinion Medical Systems Co., Ltd., Seoul, Korea) with L3-12H linear probe.

The transducer with lubricating gel was located in the middle point of the line from the lower point of the ear lobule to the labial commissure and inferior border of the mandibular body (Fig. 1).

MM thickness was determined at the thickest point, in parallel with the freezed image during US screening in the vertical position (Fig. 2). INFINITT PACS DICOM Viewer program (INFINITT Healthcare Co., Ltd., Seoul, Korea) was used to measure at 0.1 mm accuracy.

3. Statistical Analysis

Statistical analyses of the data were performed us-

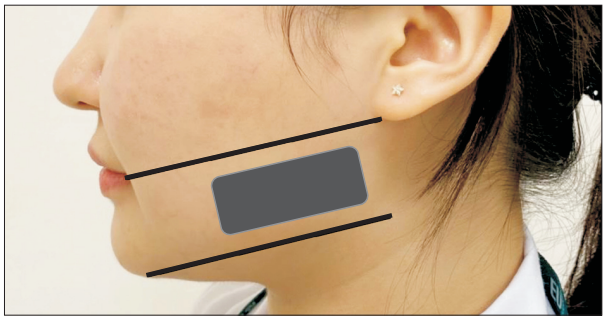

Fig. 1. Transducer location on patient masseter muscle.

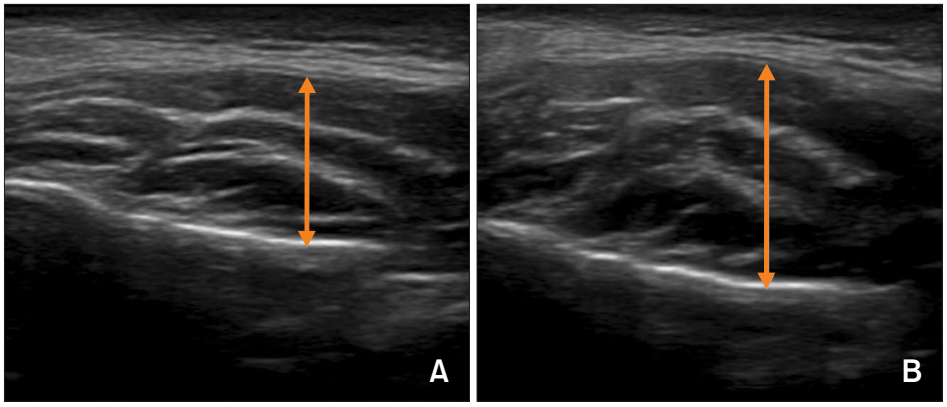

Fig. 2. Masseter muscle on ultrasonography. (A) Masseter muscle in relaxed position. (B) Masseter muscle in clenched position.

ing the IBM SPSS version 26.0 statistical package (IBM Corp., Armonk, NY, USA). Descriptive statistical analysis was used for means of MM in relaxed and clenched positions on both sides, which was then reassessed for correlation between MM thickness and duration of the pain. Paired sample t-test showed the difference of MM thickness between the right and left side. The correlation between the pain level and MM thickness was analyzed by using Spearman's correlation. Differences in the MM thickness and decreases in the pain level were determined with six-months interval by using the Wilcoxon Signed-Rank test. Decreases in MM thickness in six months and comparisons among the three treatment groups were analyzed by using one-way analysis of variance (ANOVA) test.

Result

1. Results of First Visit Measurements and Statistical Analysis

For the females, the mean MM thickness was 10.5±1.75 mm on the right side in a relaxed position (RR_0) and 12.39±2.42 mm on the right side in a clenched position (RC_0). In the male group, mean thickness was 11.18±2.70 mm on RR_0 and 13.71±3.38 mm in RC_0. On the left side, the mean MM thickness was 10.35±1.79 mm in a relaxed position (LR_0), 12.5±2.09 mm in a clenched position (LC_0) for females, and 10.65±2.92 (LR_0) and 13.28±3.07 mm (LC_0) respectively for males (Table 2).

Paired sample t-test showed that mean MM thickness on right side (10.82±2.24 mm) was greater than that on the left side (10.49±2.36 mm) in a relaxed position (r=0.740, P<0.001). In a clenched position, the right MM thickness was 13.01±2.79 mm and the left MM thickness was 12.89±2.76 mm (r=0.724, P<0.001).

Table 2. Mean masseter muscle thickness in relaxed and clenched position at first visit

Sex	RR_0	RC_0	LR_0	LC_0
Female	10.5±1.75	12.39±2.42	10.35±1.79	12.5±2.09
Male	11.18±2.70	13.71±3.38	10.65±2.92	13.28±3.07

RR_0: right masseter muscle in relaxed position, RC_0: right masseter muscle in clenched position, LR_0: left masseter muscle in relaxed position, LC_0: left masseter muscle in clenched position.
Values are presented as mean±standard deviation.

The 54 MMs (both sides) were scaled for all of the 27 patients. While 25 MMs (46%) were painless (NPRS=0), 6 MMs (11%) experienced mild pain (NPRS=1~3). 16 MMs (30%) had moderate level pain (NPRS=4~6) and 7 MMs (13%) felt high level pain (NPRS=7~10).

There was negative correlation between MM in both relaxed and clenched conditions and pain level in the results of a Spearman's correlation analysis (Relaxed position r_s=–0.077, P=0.481; Clenched position r_s =–0.077, P=0.581).

The 25 MMs (46%) were painless, the duration of pain for 23 MMs (43%) was longer than one year and in cases of 6 MMs (11%), the duration was longer than one year.

Descriptive statistics showed negative correlation between pain duration and MM thickness (Fig. 3).

2. Results of 6-month Follow-up Measurements after Treatment and Statistical Analysis

The mean MM thickness was 9.46±1.11 mm on the right side in a relaxed position (RR_1) and 11.21±1.62 mm in a clenched position (RC_1). On the left side, the mean MM thickness was 9.34±1.98 mm in a relaxed position (LR_1), 11.09±2.63 mm in a clenched position (LC_1).

A Wilcoxon Signed-Rank test showed that changes in the MM thickness were statistically significant for both sides in relaxed and clenched positions (RR_1 - RR_0 Z=–3.041, P=0.002; RC_1 - RC_0 Z=–3.040, P=0.002; LR_1 - LR_0 Z=–3.040, P=0.002; LC_1 - LC_0 Z=–3.180, P=0.001).

One-way ANOVA revealed that there was no significant difference between the amount of decrease in MM in 3 treatment groups (RR_1 - RR_0 P=0.298; RC_1 - RC_0 P=0.441; LR_1 - LR_0 P=0.662; LC_1 - LC_0 P=0.473).

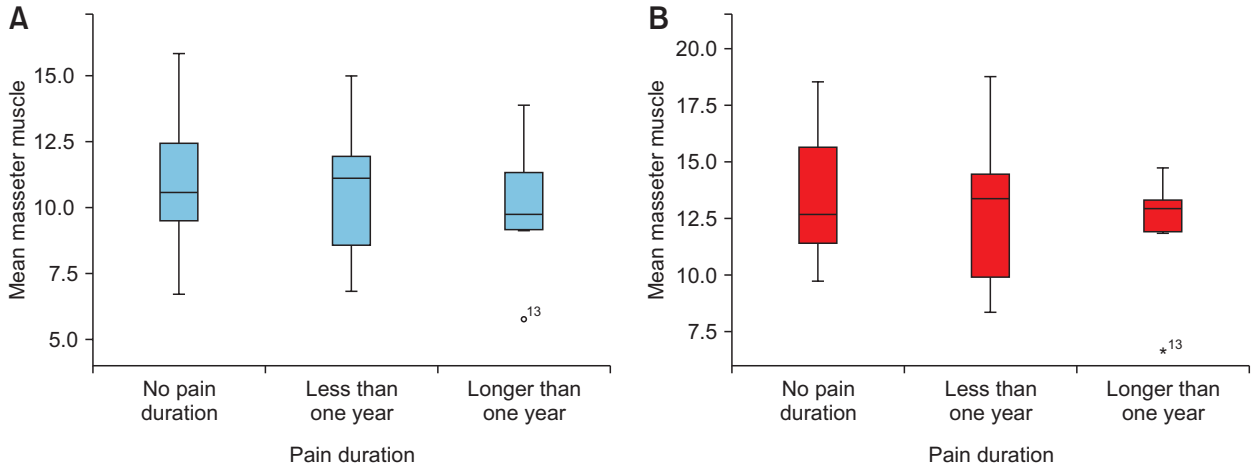

Fig. 3. Correlation between masseter muscle thickness and pain duration. (A) Relaxed position. (B) Clenched position.

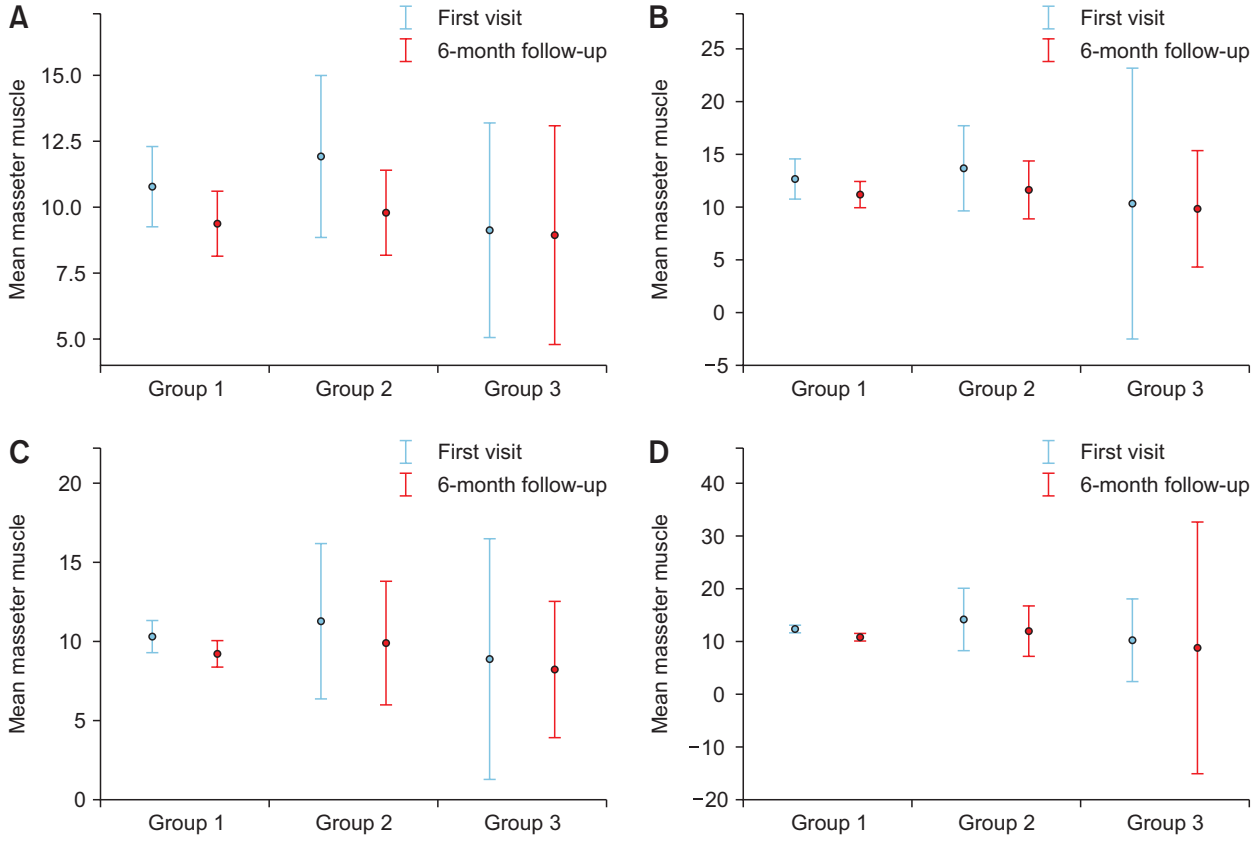

Fig. 4. Decreases of masseter muscle thickness. (A) Right masseter muscle in relaxed position. (B) Right masseter muscle in clenched position. (C) Left masseter muscle in relaxed position. (D) Left masseter muscle in clenched position.
Group 1: stabilization splint treatment, Group 2: Botulinum toxin A injection, Group 3: other treatments.

However, for group 2 (BTX-A injection group) the reduction in the MM thickness was greater than that in group 1 and 3 on both sides in both positions during 6 months. Also, group 1 showed an observable decrease in relation to the time than group 3, with the least decrease in group 2 (Fig. 4).

A Wilcoxon Signed-Rank test result was statistically significant for reduction in pain levels in a 6-month

follow-up check on patients (Z=–2.952, P=0.003). The mean value of pain level at first arrival was 2.50±3.24 in these 26 MMs (both sides of 13 patients) and that decreased to 0.31±0.88 at the 6-month follow-up.

Discussion

The main goal of the study was to measure and examine the pattern of reduction in the MM thickness and pain level using US before and after treatment, in patients with parafunctional habit. Bruxism is a common sign in TMD patients with a significant association, as found in Alamoudi et al.'s study[21]. Also, they revealed that MM thickness increased in TMD patients and that the thickness of masticatory muscles increased with bruxism[3,22,23]. Especially, there was strong association between painful TMD and bruxism[24]. A similar commonality is found in the association between sleep bruxism and TMD pain[25].

The MM thickness was measured at relaxed (10.66±2.85 mm) and clenched positions (12.95±2.75 mm) in patients with parafunctional habit in this study. There was significant difference in the mean MM thickness between the right and the left sides. The right MM thickness was greater than the left side in all patients at both positions, which was similar to Imanimoghaddam et al.'s study[8]. In Goller Bulut et al.'s study[3], however, no significant difference between the right and left thicknesses was found in patients with parafunctional habit.

There was negative correlation among pain duration, pain level and MM thickness. In the current study, patients who experienced pain on one side had smaller MM thickness than the painless side. This might be related to the fact that these patients did not use the side of mandible with pain for mastication and used the other side without the pain instead. Additionally, the MM thickness decreased when the pain duration was longer.

Several studies have found the BTX-A injection to be an effective method for reducing MM thickness and pain[2,26,27]. The maximum effect after BTX-A injection has been shown at 3 months after injection and the MM thickness was found to gradually increase thereafter[28,29]. Another study reported the reduction of MM thickness by 3.34 mm at 12 weeks after the BTX-A injection[30]. In this study, in the BTX-A injection group (Group 2) the MM thickness changed by –1.76±1.10 mm (5 patients=10MM) in the relaxed position and –2.12±1.15 mm (5 patients=10MM) in the clenched position. The decrease was greater in this group than in control groups.

The SS protects the teeth and the adjacent tissues from the negative effects of sleep bruxism[11]. In Tsuga et al.'s study[31], the SS treatment is defined as the first choice for the relief of MM pain. It was also confirmed that the SS treatment was effective in relieving pain for TMD patients[12,32]. In Kiliaridis et al.'s study[33], there was a 0.4 mm decrease in MM thickness after twin block appliances had been used for 9~17 months. In Aldemir et al.'s study[34] there was a 0.93 mm difference on the right side MM and a 0.90 mm difference on the left side MM after the SS treatment for 3 months. In this study, MM thickness decreased by –1.25±1.29 mm (6 patients=12MM in relaxed position) and –1.47±1.13 mm (6 patients=12MM in clenched position) in SS treatment group (Group 1) patients 6 months after follow-up. Moreover, the efficacy of the SS treatment for longer period of time remains to be confirmed.

In conclusion, Botulinum A toxin injection in the MM was the most effective way to reduce pain and reduce the thickness of the MM. Splint treatment also showed some effects in reducing the thickness of the MM.

Conclusion

Based on the findings, it can be claimed that US is simple, inexpensive and easily repeatable method to get real-time diagnosis and treatment results for masseter muscles.

This study shows the evaluation of MM thickness by using tablet-based US at first visit in 27 patients and at a 6-month follow-up in 13 patients with parafunctional habit.

This study is helpful to inform the clinicians of the need for evaluation of masseteric thickness using ultrasonographic examination patients with parafunctional habits.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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