



Sonographic observation of the paradoxical masseteric bulging and clinical implication of functional compartment

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Abstract: Masseter are commonly botulinum neurotoxin targeted muscle for facial contouring in aesthetic field. However, paradoxical masseteric bulging is common adverse effect that has not been discussed with ultrasonographic observations. Retrospective study has been conducted from October, 2021 to January, 2023, out of 324 patients have done blinded botulinum neurotoxin injection in the masseter at the middle and lower portion of the masseter with each side of 25 units (letibotulinum neurotoxin type A), 3 patients demonstrated paradoxical masseteric bulging has been reported and the image observed by ultrasonography by physician. Based on the observations made, we can infer that the function of the moving muscle involves twisting of the muscle fibers during contraction, along with the twisting of the deep inferior tendon, which causes the muscle to be divided into anterior and posterior compartments rather than into superficial and deep compartments of masseter. In ultrasonographic observe the skin surface of a patient with paradoxical masseteric bulging, it is observable that either the anterior or posterior part contracts significantly. The functional units of anterior and posterior compartment are observable as muscular contraction of inward movement of the muscle from either the anterior or posterior functional unit.

Key words: Paradoxical masseteric bulging, Functional compartment, Masseter muscle, Deep inferior tendon, Ultrasonography

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Introduction

The botulinum neurotoxin (BoNT) injection is commonly used non-surgical treatment for reducing the size of their

masseter muscle to improve their lower facial appearance in patients with masseteric hypertrophy [1, 2]. However, since its first reported use in 1994, there have been several side effects reported, including swelling, bruising, muscle weakness, and unexpected changes in facial expressions [2-4].

Several studies have tried to find the best injection points for BoNT and achieve the best results while minimizing complications [5]. In 2012, Lee and colleagues [6] reported a side effect called paradoxical masseteric bulging that can occur after BoNT injection into a hypertrophied masseter muscle. As per the most recent research, the occurrence rate of paradoxical masseteric bulging ranges from 0.5% to 18.8% [7].

According to the study of Lee et al. [2] suggest that the superficial part of the masseter muscle is made up of lamel-

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lar structures consisting of overlapping muscle and tendon structures. However, it is hard to distinguish the layers and classify as orders of superficial muscle belly, deep inferior tendon, and deeper muscle belly [2]. Through encountering thousands of cases of ultrasonographic guided masseteric injection, from a clinical perspective, it is important to distinguish the functional units of the masseter muscle based on the presence of the deep inferior tendon and inject them accordingly, in order to prevent paradoxical masseteric bulging. The study is an observational ultrasonographic study of masseteric muscle and its clinical implication of functional units.

Materials and Methods

This study was performed in accordance with the principles outlined in the Declaration of Helsinki. All procedures performed in this study were approved by the Yonsei University Institutional Review Board (approval no. 2-2019-0008; date of approval: April 11, 2019). Retrospective study has been conducted from October, 2021 to January, 2023, 324 patients have done blinded BoNT in the masseter muscle at the middle and lower portion of the masseter with each side of 25 units (leti-BoNT), 3 patients demonstrated paradoxical masseteric bulging has been reported and the image observed by ultrasonography by one physician.

The injection point was as guided as the previously suggested article by Yi et al. [1] The BoNT injection has been administered in the lower half of the masseter muscle, in two separate points, as per guidelines. Injection into the upper part of the muscle may cause damage to the parotid duct and superficial aponeurosis, as well as being less effective due to less distributed intramuscular neural arborization. Care should be taken when injecting into the anterior part of the muscle to avoid superficial injection, which may result in diffusion of the toxin to the risorius muscle and cause asymmetrical smiling. Moreover, the facial artery runs immediately anterior to the masseter muscle, so the anterior portion should be avoided. Injection has been performed retrograde and layer by layer into the superficial and deep layers. The ultrasonography image of the masseter muscle has been observed at the line connecting the earlobe and cheilion (Fig. 1).

The study presents three cases of paradoxical masseteric bulging with the consent of the patients. The ultrasonographic analysis of paradoxical masseteric bulging in regard to functional units has been observed with each case.

Results

The cases have demonstrated with paradoxical masseteric bulging at the both the posterior and anterior portion of the masseter muscle with dynamic observation of ultrasonography rather than superficial and posterior portion.

Case 1

A 30-year-old male received a BoNT injection four days ago. Today, he presented with an unusual bulging of the masseter muscle, which was detected through ultrasonography (Fig. 2, transverse view). The injection had been administered in the middle portion of the masseter muscle using a dual layered injection technique by a single practitioner. In Fig. 2, the contraction of the masseter muscle is illustrated by shaded areas—red indicating the anterior part and blue indicating the posterior part of the muscle compartment.

Case 2

A 37-year-old woman had BoNT injection 5 days ago had come with paradoxical masseteric bulging observed by ultrasonography (Fig. 3, transverse view). The patient had been injected in the middle belly of the masseter with dual layered injection technique with the single practitioner. In Fig. 3, the compartment of masseter muscle when in resting status as the following of compartment as shaded by red and blue areas. Red shaded area represents anterior part of the masseter muscle and blue shaded area represents posterior part of the masseter muscle.

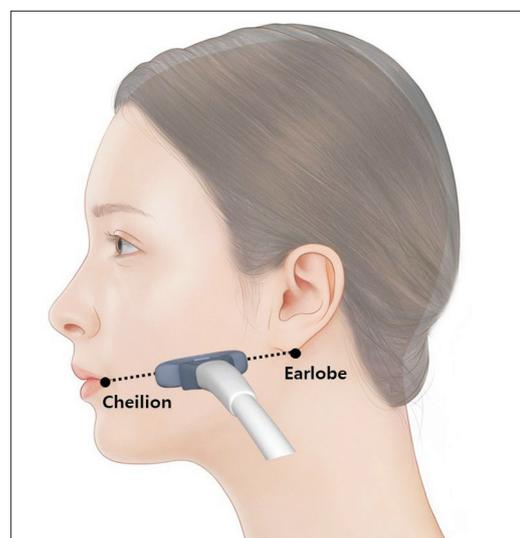


Fig. 1. The placement of the probe of ultrasonography has been placed in the line connecting ear lobe and cheilion.

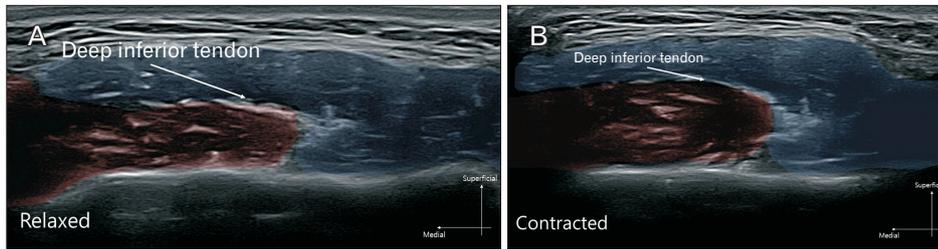


Fig. 2. The area within the masseter muscle at rest (A) and when contracted (B) can be depicted by the highlighted sections in red and blue. The red shading indicates the front portion of the masseter muscle, while the blue shading indicates its rear section.

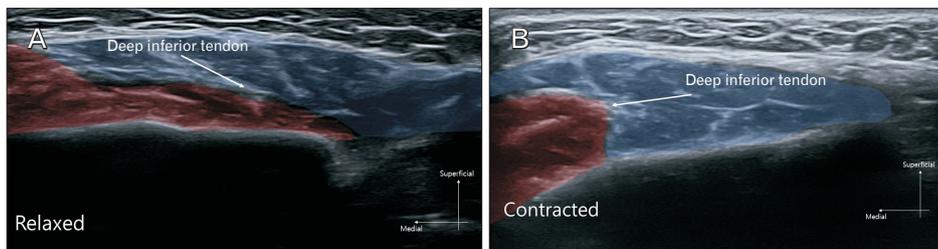


Fig. 3. The compartment of masseter muscle when in resting (A) and contracted (B) status as the following of compartment as shaded by red and blue areas. Red shaded area represents anterior part of the masseter muscle and blue shaded area represents posterior part of the masseter muscle.

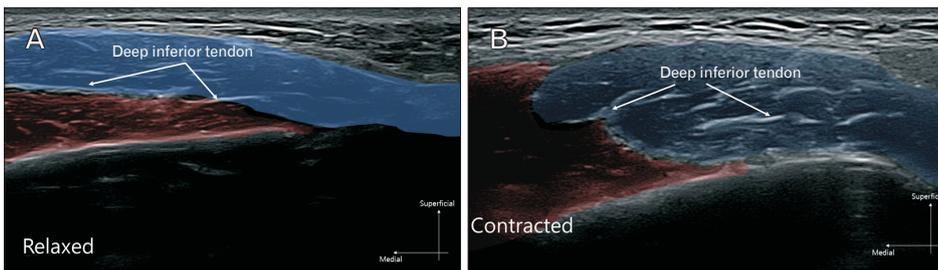


Fig. 4. The region within the masseter muscle during relaxation (A) and contracted (B) is represented by highlighted red and blue sections. The red shading signifies the anterior part of the masseter muscle, while the blue shading represents its posterior section.

Case 3

A 33-year-old male experienced an unusual bulging of the masseter muscle, as depicted in Fig. 4. Seven days prior, he had received a BoNT injection and subsequently presented with this paradoxical masseteric bulging, which was observed through ultrasonography. The injection had been administered in the middle belly of the masseter muscle using a dual layered injection technique by a single practitioner. In Fig. 5, the paradoxical masseteric bulging is visible, characterized by the anterior part of the masseter muscle and superficial part at the middle portion of the masseter muscle. Additionally, the posterior part of masseter muscle and deep part at the middle portion of the masseter muscle contract simultaneously [8].

Discussion

Through this study, it was possible to observe in detail with ultrasound that the different compartments of the masseter muscle have different moving patterns and directions. This explains that the deep inferior tendon does not simply



Fig. 5. The paradoxical masseteric bulging has been observed with ultrasonography, the acts with the anterior part and superficial part at the middle portion of masseter. In posterior and deep part of the masseter muscle contracts together.

Adapted from *Ultrasonographic anatomy of the face and neck for minimally invasive procedures: an anatomic guideline for ultrasonographic-guided procedures*. Springer, 2021, with permission [8].

separate the deep and superficial layers in a one-dimensional structure, but rather divides the masseter muscle into anterior and posterior compartments.

BoNT injection in delicate locations, where it can be effectively administered, has been previously published [7, 9-12]. Currently, many papers are focused on anatomical classification, specifically the separation of the deep and superficial layers by the deep inferior tendon, and many articles have been published regarding dual plane injection based on this concept [6, 13]. However, there have been several cases where paradoxical masseteric bulging occurred even with dual plane injection, and in those cases, it was often found that further injections to distinguish the anterior and posterior muscle bellies helped alleviate paradoxical masseteric bulging. Based on the observations, it can be seen that the posterior part and deep part of the masseter muscle, or the superficial part of the masseter muscle and the anterior part and superficial or deep part, often move as a single functional unit.

When observing the appearance of paradoxical masseteric bulging using ultrasound, it is generally possible to interpret it by dividing it into anterior muscle belly and posterior muscle belly (Fig. 3). In other words, when paradoxical masseteric bulging occurs, most cases involve either the back bulging out or the front bulging out.

Based on the observations made, we can infer that the function of the moving muscle involves twisting of the muscle fibers during contraction, along with the twisting of the deep inferior tendon, which causes the muscle to be divided into anterior and posterior compartments rather than into superficial and deep compartments. It is difficult to observe the deep inferior tendon at the marginal areas of the anterior and posterior masseter. Most papers have divided the masseter into superficial and deep layers by observing it from the middle. In this paper, the functional compartment refers to the compartment of muscle fibers that move together, which should be divided into anterior and posterior functional units by involving the deep inferior tendon. In resting state, the deep inferior tendon is not in the middle of the muscle, but is mostly diagonal. This is why paradoxical masseteric bulging occurs mostly in the front or back when it occurs.

A common side-effect of paradoxical masseteric bulging occurs, the functional unit becomes more prominent. In fact, if you closely observe the skin surface of a patient with paradoxical masseteric bulging, you can see that either the anterior or posterior part contracts significantly. If patients are asked to slowly clench their teeth, within ultrasonographic

observation a pushing inward movement of the muscle from either the anterior or posterior functional unit.

To reiterate, the functional unit is usually not the deep or superficial layer, but rather, mostly the anterior or posterior. Many practitioners think that the deep or superficial layer is the main cause because they only look at the middle part, which appears clearly divided by the deep inferior tendon. In most cases of blind injection, practitioners tend to target the middle part of the masseter muscle. This is because the posterior part is often buried in the parotid gland and difficult to touch, while the anterior part is usually avoided because BoNT can spread to the risorius muscle.

If paradoxical masseteric bulging occurs, it can be easily treated with additional injections, and not everyone experiences it with blind injections. However, it is a common side effect with many cases, so it is important to consider these factors. One thing is clear: before the injection, it is important to confirm that it is divided into functional units that move when clenching, and ultrasonographic guided injection is necessary to confirm this.

The limitation of this paper is that it did not classify the moving units. As mentioned earlier, the intra-muscular running of the deep inferior tendon can generally be classified as above. However, detailed classification is necessary, and in subsequent papers, it is necessary to observe the upper, middle, lower, front, and back of the masseter muscle in a patient's relaxed and clenched state using a 6 cm long ultrasonographic probe for detailed classification.

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Conflicts of Interest

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

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