

Comparison of clinical marking and ultrasound-guided injection of Botulinum type A toxin into the masseter muscles for treating bruxism and its cosmetic effects

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Summary

Background Botulinum toxin type A has been used for treating the hypertrophy of the masseter muscles and its cosmetic effects. Ultrasound is increasingly used in dermatology, along with the guidance of mini-invasive procedures.

Aims To evaluate the role of ultrasound for guiding the application of Botulinum A toxin in patients with cosmetic alterations due to bruxism, correlate the clinical landmarks with the ultrasound findings, and study the effect on the symptoms, cosmetics, and quality of life.

Patients/Methods Twenty individuals with bruxism and cosmetic alterations underwent an ultrasound-guided injection of Botulinum toxin type A in each masseter muscle. Clinical and ultrasound marking of the procedure was compared. Clinical and sonographic evaluation was performed at the time of injection and 3 months later. Ten normal individuals underwent ultrasound of the masseter muscles as a control group.

Results Up to 65% of individuals showed anatomical variants of the salivary glands. The method for clinically marking the skin showed a frequently erroneous location of the anterior point (up to 40% of cases) that was proven by ultrasound to be out of the muscle. In 20% of cases, ultrasound showed that the needle should be longer to enter the muscle. After injection, most of the patients demonstrated a decrease of the symptoms and cosmetic and quality of life improvements.

Conclusions Ultrasound can be a potent tool for guiding the injection of Botulinum toxin into the masseter muscles. It may contribute to a more personalized procedure, better cosmetic results, and help to avoid potential complications.

Keywords: botulinum toxin, botulinum toxin ultrasound, cosmetic procedures, cosmetic ultrasound, skin ultrasound, dermatologic ultrasound, ultrasound, ultrasound dermatology, skin imaging, bruxism

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Accepted for publication December 18, 2015

Introduction

Bruxism is defined as a diurnal or nocturnal parafunctional activity of the masticatory muscles, characterized by the compression and/or creaking of the teeth without purpose.¹ It has a prevalence of 20%, without

predilection of sex and with a great impact on quality of life.^{1,2}

To anticipate the complications of bruxism, early diagnosis and suitable treatment are very important. Nevertheless, conventional therapies are not always effective. For this reason, Botulinum toxin type A has been used as a therapeutic alternative for patients who suffer this problem.³

In 1987, Jankovic and Orman⁴ reported the use of Botulinum toxin type A in patients with cranial–cervical dystonia, using one point of application with 20–50 units in the masseter muscle as part of the treatment of this disorder.

In 1989, Lagueny *et al.*⁵ treated a cervical dystonia associated with bruxism, confirming the hypertrophy of the masseters and temporary muscles, helped by electrophysiological test. In 2001, Von Lindern *et al.*⁶ showed the effects of Botulinum toxin type A in the remodeling of the facial contour in Asian patients.

Later, Kim *et al.* demonstrated the use of Botulinum toxin in masseter hypertrophy with computed tomography.^{1,7}

The masseter muscle is the main mastication muscle and its hypertrophy may cause bruxism symptoms and undesired cosmetic alterations in the shape of the face.⁸

This muscle has a quadrangular shape with two fascicles: one anterolateral (superficially located) and the other posteromedial (deeply located). Arterial supply is mainly provided through muscular branches from the facial artery, the transverse facial artery, and the maxillary artery. The posterior border of the muscle is in contact with the parotid gland. Anatomical variants of the arterial and nerve supply have been described in about 24% of the population.^{8,9}

To clinically assess the location of the masseter muscle, the following procedure has been suggested: first, to draw a line that goes from the tragus to the angle of the mouth that supposedly corresponds to the level of the parotid duct and then ask the patient to bite to delimit the borders of the muscle. Third, to mark a central point and then 2–4 equidistant points separated by 1.5 cm (Fig. 1).^{1,2,10,11}

Nowadays, there is a wide range of reports with variable dosages of Botulinum A toxin that have been used in the injection of masseter muscles that can go from 10 a 35 units for each muscle; however, to date, there is no standard dose defined for this procedure.^{10,11}

High frequency (≥ 15 MHz) color Doppler ultrasound has been increasingly used in the dermatologic and



Figure 1 Drawing of the suggested reference line and application points for injecting Botulinum toxin type A.

soft tissue field for studying benign and malignant skin tumors, inflammatory diseases, cosmetic complications, nail pathologies, and vascular lesions.¹²

The aim of this work was to evaluate the role of ultrasound for guiding the application of Botulinum A toxin in patients with cosmetic alterations due to bruxism, correlating the cutaneous clinical landmarks with the ultrasound findings, and study the effect of the injection on the symptoms, cosmetics, and quality of life.

Material and methods

A prospective case–control study with 20 individuals took place between February and April 2015. Ten patients (5 females/5 males; mean age 47 years; age range: 30–64 years) underwent a bilateral color Doppler ultrasound-guided injection of 25 units of onabotulinum toxin type A (Reage[®]) in each masseter muscle with a 30-gauge needle insulin syringe.

The patients were selected from consecutive consultations in the Department of Dermatology due to facial cosmetic alterations in patients with bruxism.

All patients signed an informed consent form and the study was approved by the Institutional Review Board and followed the Helsinki principles of medical ethics.

The inclusion criteria were cases that presented both bruxism symptoms and cosmetic alterations due to the clinical hypertrophy of the masseter muscles, diagnosed by a dermatologist trained in cosmetics and by a dentist trained in maxillofacial pathology. Exclusion

criteria included the cases that had received previous Botulinum type A injections in the masseter muscles and present other dental or temporomandibular abnormalities as well as history of other cosmetic procedures.

Additionally, 10 control individuals (5 females/5 males; mean age 39 years; age range: 30–54 years) were examined on color Doppler ultrasound to assess the normal sonographic characteristics of the masseter muscles and the presence of anatomical variants. This group consisted of healthy individuals that belong to our institution without clinical symptoms of bruxism and no cosmetic alterations.

In the patients group, a pre-injection evaluation was performed which included a standardized color photograph of the face (1 meter away from the face), along with a questionnaire that evaluated clinical symptoms for temporomandibular disorders.^{13,14} Additionally, a cosmetic evaluation was made by measuring Liew's angle of beauty in the lateral aspect of the face. The ideal values for Liew's angle are between 9 and 12 degrees (Fig. 2).^{1,13}

Then, the cases underwent a pre-injection color Doppler ultrasound examination, to assess the location, echogenicity, and thickness (cm) of the masseter muscles as well as the presence of anatomical variants. The maximum thickness was measured at the level of the ramus of the mandible in transverse axis.

All sonographic examinations were performed by the same radiologist with experience in dermatologic and soft tissue ultrasound.

A Logic E9 XD Clear (General Electric Health Systems, Milwaukee, WI, USA) ultrasound machine working with linear and variable frequency probes (upper



Figure 2 Liew's angle of beauty marks.

range from 7 to 18 MHz) was used for the study. Gel was applied for contacting the ultrasound probe to the skin in the pre-injection and postinjection ultrasound examinations; however, during the injection procedure, antiseptic liquid isopropyl alcohol, chlorhexidine gluconate was used for skin to probe contact.

The same dermatologist that performed the cosmetic evaluation drew the lines and marked the points on the skin with a wax pencil as previously reported.^{1,2,10,11} Thus, a line between the tragus and the angle of the mouth was drawn. Then, the patient was asked to bite and three points on the skin were marked, one point in the center of the muscle, a second point 1.5 cm anteriorly (mouth direction), and a third point 1.5 cm located posteriorly (pinna direction). A correlation between the points marked and the actual location of the injection points was assessed, registered, and corrected if needed using ultrasound.

After a sonographic confirmation of the location of the tip of the needle within the muscle, an ultrasound-guided injection of Botulinum toxin type A was performed. During the procedure, the position of the tip of the needle was checked on the ultrasound screen at all times (Fig. 3; Video S1).

An immediate postprocedure ultrasound control was performed in all cases to check the presence of complications such as hematomas.

A 3-month follow-up was performed with standardized photography, a clinical evaluation that included a quality of life questionnaire, and a color Doppler ultrasound examination.

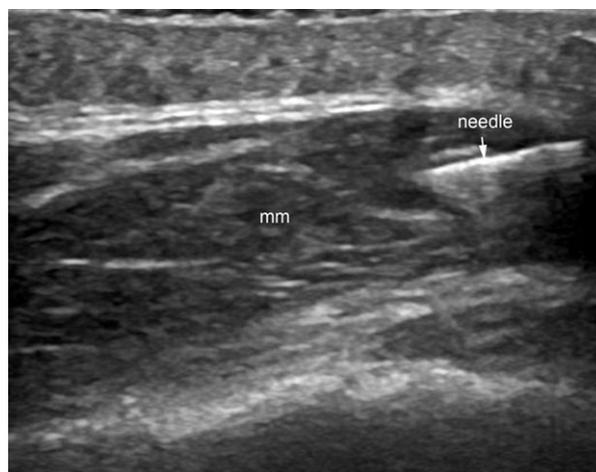


Figure 3 Ultrasound-guided Botulinum type A injection in the masseter muscle (gray scale, transverse view) shows the tip of the needle (arrow) within the muscle (mm).

Table 1 Salivary glands anatomical variants in patients and healthy controls

	Right side		Left side	
	%	<i>n</i>	%	<i>n</i>
Salivary glands anatomical variants				
Total anatomical variants	65	13	45	9
Anterior prolongation parotid gland*	45	9	30	6
Separate accessory gland	15	3	15	3
Large parotid gland covering the muscle	5	1	–	–

–, none.

*A segment of the parotid gland totally covering the upper third of the masseter muscle.

Results

On the pre-injection ultrasound examination, the mean thickness of the right and left masseter muscle in the bruxism group was 1.0 and 0.9 cm. The mean thickness of the right and left masseter muscles in the control group was 0.9 and 0.8 cm, respectively.

Considering both the patients and control groups, common anatomical variants of morphology and the location of salivary glands were detected. On the right side 65% (*n* = 13) and on the left side 45% (*n* = 9) of the cases presented variants. A more detailed description of these variants is shown in Table 1.

The correlation between the clinical marking and the sonographic location of the injection points in the right masseter muscle was positive in 70% (*n* = 7) of the patients. In 30% (*n* = 3) of the cases, there was no clinical-sonographic correlation, and in all these cases, the anterior point of marking was sonographically proven to be out of the muscle. In the left masseter muscle, the concordance of the clinical and sonographic location of the muscle was 60% (*n* = 6). In the remaining 40% (*n* = 4), there was lack of correlation due to an incorrect clinical marking of the anterior point that was not in the muscle.

In 80% (*n* = 8) of the patients, the 30 gauge × 8 mm long insulin syringe was successfully used. However, in 20% of cases (*n* = 2), there was a need for a longer needle to properly enter the muscle, and in these cases, a 30 gauge × 13 mm long needle was successfully used. In these latter cases, there was thick subcutaneous tissue in both cheeks that prevented the needle from entering the muscle, which was warned of by the ultrasound examination.

The range of Liew's angles pretreatment was from 6 to 10°, with a mean value of 7.7, and the post-treatment range was from 7 to 12°, with a mean value of 9.

In 60% (*n* = 6) of cases, the Liew's angles of beauty increased by 2 degrees; in 20%, it increased by 1 degree (*n* = 2), and in 20% (*n* = 2), there was no variation. However, in 80% (*n* = 8) of the cases, the patients had the perception of presenting thinner faces. In 40% (*n* = 4) of cases, there was an increased depth of the nasofold and labial mental lines and 10% (*n* = 1) showed limitation of movement of the lower lip when smiling at the clinical examination.

At the 3-month follow-up, the sonographic thickness of the right masseter muscle had decreased in 60% of the cases, showing a decrease of up to 2 mm in 40% (*n* = 4) of cases and 1 mm in 20% (*n* = 2) of cases (Fig. 4). In the remaining 40% (*n* = 4), there was no significant change in the thickness of the muscle.

In the left masseter muscle, there was a decrease in 40% of cases: 10% (*n* = 1) showed a decrease of up to 2 mm, 30% (*n* = 3) decreased by 1 mm, 10% (*n* = 1) showed an increased thickness of 1 mm (Fig. 4), and the remaining 50% (*n* = 5) showed no significant changes in thickness.

In all cases, the echogenicity of the masseter muscles changed from predominantly hypoechoic to a more heterogeneous pattern with larger hyperechoic areas at the 3-month follow-up (Figs 5 and 6). There were no signs of hypervascularity within or in the periphery of



Figure 4 Composite image with clinical photographs before (left) and 3 months after (right) the injection of Botulinum toxin type A in both masseter muscles. Notice the facial slimming after injection.

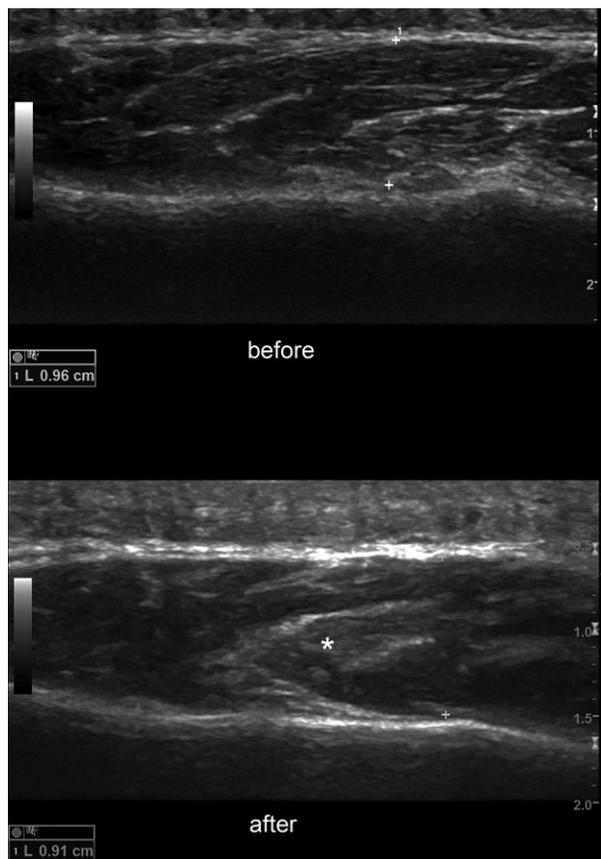


Figure 5 Composite sonographic images (gray scale, transverse views) of the left masseter muscle in the same individual before (top) and 3 months after injection (bottom). Notice the predominantly hypoechoic muscular pattern on top. At the bottom (after), there is a mostly heterogeneous pattern with an hyperechoic area (*) within the muscle as well as a slight decrease in the thickness (between markers).

the masseter muscles, immediately after injection or at the 3-month follow-up.

When comparing the basal and follow-up clinical examinations, there was a relevant improvement of the symptoms of bruxism (Table 2).

Discussion

To our knowledge, this is the first report of an ultrasound-guided injection of Botulinum toxin type A into the masseter muscles with clinical and sonographic correlation.

The sonographic data allows knowing in advance the presence of anatomical variants of the salivary glands that may potentially cause complications in facial procedures. These variants were much more common than expected and varied from 45% (left side) to 65% (right side). This may imply that performing a nonimaging guided facial procedure can increase the rate of puncture, trauma, and secondary inflammation of the salivary tissue that may be located on top of the masseter muscles.

Following the reported methodology for marking the points of injection of the masseter muscle, up to 40% of cases showed on ultrasound a discordance with the clinical location of the anterior point. This may be another source of potential complications that could also cause a partial loss of the injected volume and perhaps a decrease of the effect as well as the possible presence of Botulinum toxin in other anatomical layers. In the remaining clinical marks used as injection points, ultrasound confirmed their position within the muscle.

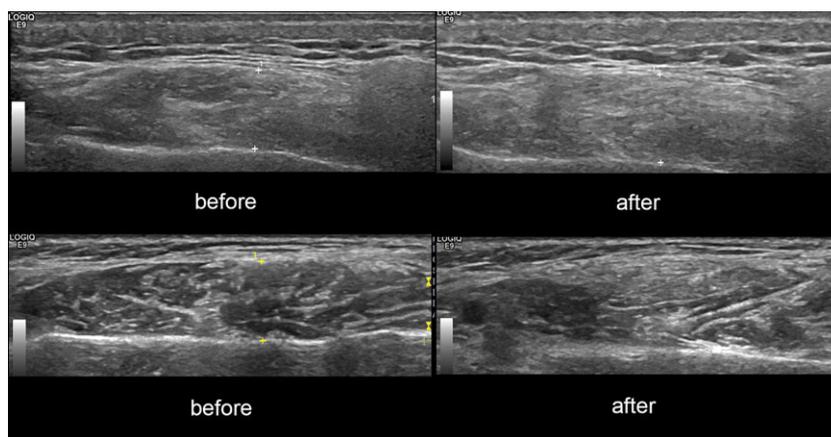


Figure 6 Composite sonographic images (gray scale, transverse views) of two different cases showing changes of echogenicity of the masseter muscle before and after injection. Notice the increased echogenicity of the muscle after the injection. The markers are showing the region of injection.

Table 2 Bruxism clinical evaluation

Clinical symptoms	Basal %	Follow-up %
Sleeping with their teeth clenched	100	20
Presented articular noises	90	50
Difficulties for opening their mouth	90	20
Several treatments for bruxism before this study	80	n/a
Frequent headaches	80	30
Mandibular blockage	70	10
Alteration in their quality of life	70	90
Wake up with headache	60	20
Alteration of the dental planes	50	n/a

n/a, nonapplicable.

Another interesting point with the use of sonography is that it was possible to know in advance that there was a need to modify the length of the needle to a longer one in 20% of the cases. This could help to avoid the loss of Botulinum toxin units and the erroneous injection of the toxin into thick subcutaneous tissue.

In spite of the minimal changes in the thickness of the masseter muscles that mostly ranged between 1 and 2 mm in 60% of cases in the right side and 40% of cases in the left side, a significant proportion of the cases demonstrated good cosmetic and symptomatic results. However, these small variations of the thickness may be subject of error and should be taken cautiously. This may imply that the therapeutic effect of Botulinum toxin relies more on the function than on the thickness of the muscle. Perhaps, the modification of the balance of contraction of the muscles of the face may also be a contributor to the cosmetic change.

To date, the echogenicity changes in the muscle secondary to the Botulinum toxin injection have not been reported. The latter alterations may be secondary to local inflammation or edema due to the trauma and/or the toxin itself. Nevertheless, as we only observed the patients during a short period (3 month follow-up), the duration of these changes still remains to be determined. These echogenicity variations may also suggest that segments of the muscle are partially functioning. Interestingly, no hypervascularity changes were detected within the muscles.

A limitation of this study is the small number of cases; nevertheless, this is the first series of cases that received treatment under ultrasound guidance.

Lastly, the usage of ultrasound has increased in dermatology¹² which has included the usage of sonography for guiding mini-invasive procedures.¹⁵ Thus, ultrasound may be a powerful tool for supporting and guiding the injection of Botulinum toxin A in the mas-

seter muscles in both bruxism and cosmetic contexts. Additionally, this diagnostic imaging technique may perhaps be used for guiding other cosmetic procedures such as fillers.

Conclusion

An ultrasound-guided injection of Botulinum toxin type A into the masseter muscles may provide anatomical data that is not possible to obtain by physical examination alone, such as the presence of facial anatomical variants, confirmation of the intramuscular location of the injection, and the need to modify the length of the needle according to the thickness of the facial layers. This imaging technique can be a powerful tool that can contribute to a more personalized procedure, better cosmetic results and help to avoid potential complications.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Video S1. Ultrasound-guided injection of Botulinum toxin into the right masseter muscle “*in vivo*” (transverse view).