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Novel anatomical guidelines for botulinum neurotoxin injection in the mentalis muscle: a review

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Abstract

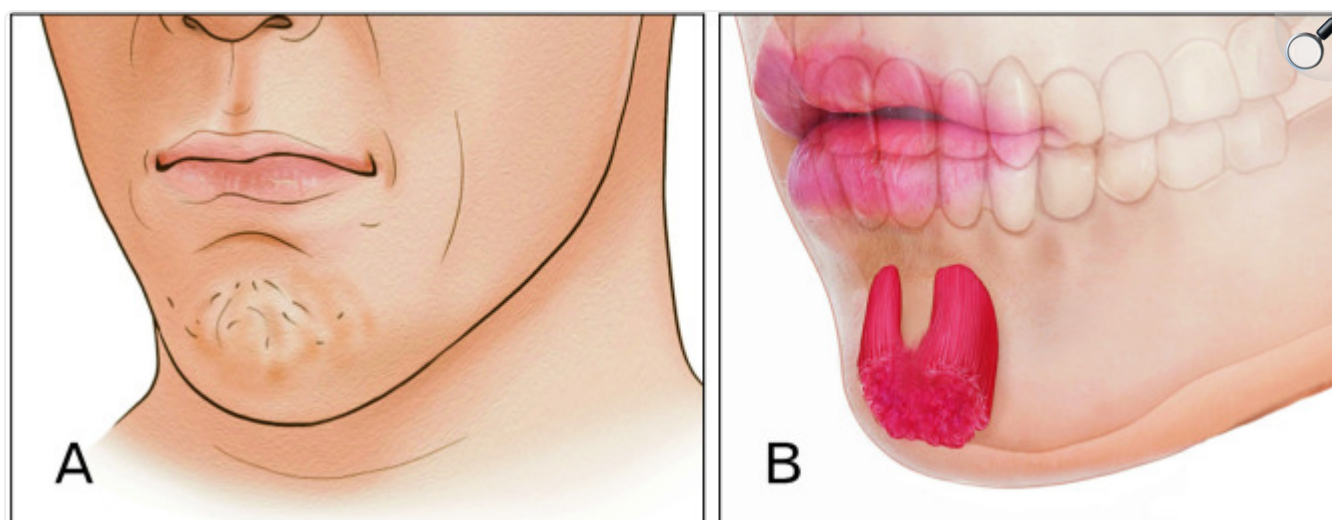
The mentalis muscle is a paired muscle originating from the alveolar bone of the mandible. This muscle is the main target muscle for botulinum neurotoxin (BoNT) injection therapy, which aims to treat cobblestone chin caused by mentalis hyperactivity. However, a lack of knowledge on the anatomy of the mentalis muscle and the properties of BoNT can lead to side effects, such as mouth closure insufficiency and smile asymmetry due to ptosis of the lower lip after BoNT injection procedures. Therefore, we have reviewed the anatomical properties associated with BoNT injection into the mentalis muscle. An up-to-date understanding of the localization of the BoNT injection point according to mandibular anatomy leads to better injection localization into the mentalis muscle. Optimal injection sites have been provided for the mentalis muscle and a proper injection technique has been described. We have suggested optimal injection sites based on the external anatomical landmarks of the mandible. The aim of these guidelines is to maximize the effects of BoNT therapy by minimizing the deleterious effects, which can be very useful in clinical settings.

Keywords: Botulinum neurotoxin, Facial wrinkle, Mentalis muscle, Cobblestone chin, Injection point

Introduction

Botulinum neurotoxin (BoNT), produced by *Clostridium botulinum*, prevents the release of acetylcholine at the neuromuscular junction and blocks muscular contraction [1, 2]. BoNT is frequently used to target the mentalis muscle and diminish the appearance of the “cobblestone” or dimpled chin (Fig. 1A). The cobblestone chin results from hyperactivity of the mentalis muscle as the muscle inserts several fibers in the dermis of the chin.

Fig. 1.



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Schematic image of the cobblestone chin. The mental crease also appears marked in the cobblestone chin (A). Schematic image of the mentalis muscle (B). The muscle fiber originates from the alveolar bone of the anterior mandible (2 cm inferior to the intercheilion line), where the structure is inferior to the lateral incisors and inserts to the dermal layer of the chin.

Given that the mentalis muscle elevates the chin and lower lip, hyperactivity of the mentalis muscle appears in the shortened chin. BoNT injections relax the mentalis muscle, protruding the chin and leading to a more refined appearance of the chin.

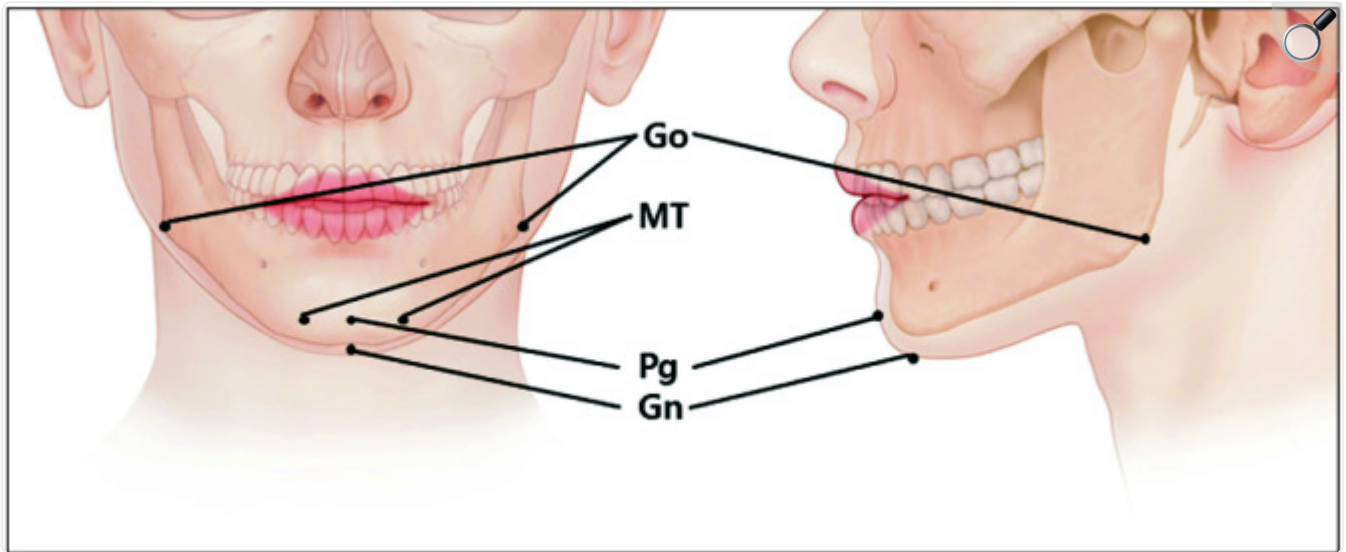
The mentalis muscle is also related to the aging process as it produces a mental crease (MC) and an “orange-peel” appearance (when relaxed) on the chin. The MC is the deep groove between the lower lip and the chin prominence, formed by aging and repetitive use of the mentalis muscle. When a cobblestone appearance settles into static wrinkles, the chin can display an orange-peel appearance, with atrophy of the fat tissue and dermal collagen loss. BoNT injections in the mentalis muscle can be used to compensate for and delay this aged appearance.

BoNT injections to treat the cobblestone chin are associated with complications (such as mouth dysfunction with ptosis of the lower lip), often due to a lack of information regarding anatomical factors involved in the procedure [3]. Complications occur when BoNT is injected or diffused into muscles other than the mentalis, particularly the orbicularis oris and depressor labii inferioris. To prevent undesirable results, anatomical-based precise injection in the mentalis muscle and primary treatment with a lower quantity of BoNT are recommended.

Another factor to consider is the effect of BoNT treatments. Consecutive, short-term injections of BoNT create antibodies that result in poor treatment outcomes [4-7]. Recent anatomical studies have administered BoNT

injections in specific locations of particular muscles on the basis of external anatomical landmarks ([Fig. 2A](#)) [[8-30](#)].

Fig. 2.



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The external anatomical landmarks of the chin region around depressor anguli oris. Pg, pogonion; Gn, gnathion; MT, mental tubercle; Go, gonion.

Clinicians treating lower facial rhytides must require a good understanding of the anatomy of the mentalis muscle; however, few anatomical findings regarding BoNT injection in the mentalis muscle have been reviewed with clinical application based on location, injection technique, and dosage.

In this study, we reviewed the anatomical morphology and location of the mentalis muscle to determine the optimal landmarks for guiding BoNT into the mentalis muscle ([Fig. 2](#)).

Review

Anatomy of the mentalis muscle

The mentalis muscle fiber originates from the alveolar bone of the anterior mandible (2 cm inferior to the intercheilion line) The anterior mandible is inferior to the lateral incisors and inserts into the dermal layer of the chin. The mentalis originates roughly 0.8 cm lateral to the midline of the chin. The insertion of the mentalis muscle is closer to the midline of the chin than to the origin of the muscle itself. Usually, both sides of the muscle bellies are separated, and fatty tissue lies between their separate origins [[31-33](#)].

As the muscle fiber is attached to the skin, contraction of the muscle forms MCs at the chin. The mentalis muscle consists of medial, lateral, upper, and lower fibers. The medial fibers, found on both sides of the mentalis muscle, descend anteromedially in a dome-shaped manner ([Fig. 1B](#)). The lateral fibers descend obliquely and attach to the skin ipsilaterally. The lateral fibers partially intermingle with the depressor labii inferioris muscles [[32](#)]. Lastly, the upper fibers run horizontally and connect to the inferior margin of the orbicularis oris. The upper fibers' connections act to elevate the lips. Each side of the mentalis muscle belly has an average length and width of 2.0 and 1.2 cm, respectively [[32](#)]. [Fig. 3](#) presents an ultrasonographic image of the mentalis muscle observed in the hypoechoic band.

Fig. 3.



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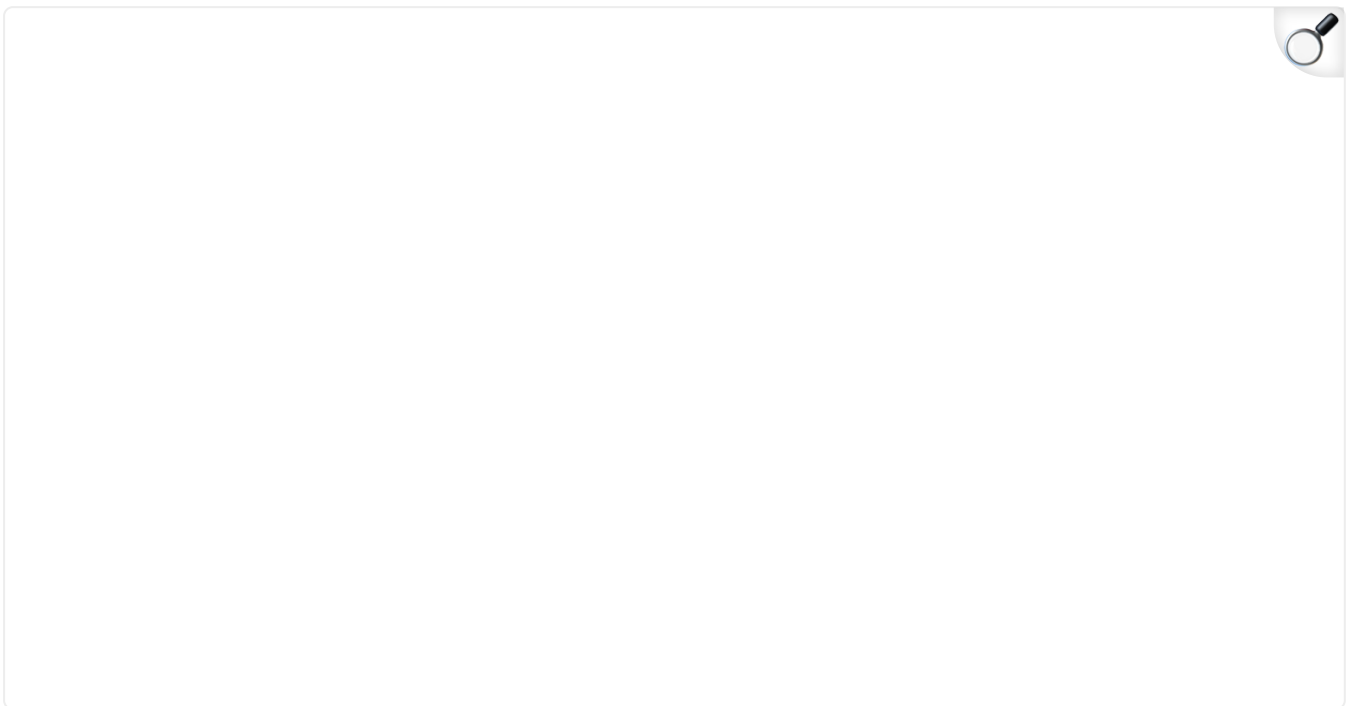
Ultrasonography image of the mentalis muscle. (A) The probe was applied horizontally at the Pg, perpendicular to the skin surface. (B) The hypoechoic mentalis is observed directly above the periosteum. Pg, pogonion; PL, 0.5 cm left to Pg; PR, 0.5 cm right to Pg.

Injection points for mentalis muscle

The type of the BoNT used was onabotulinum toxin-A. The author diluted with 2.5 ml of normal saline to use at a concentration of 4 U/0.1 ml. Large dilution volumes are associated with easier diffusion to the surrounding tissue.

At each point, a deep injection of 3 U per side is injected 0.5 cm lateral to the pogonion (Pg). A superficial injection of 1 U per side is performed at the same injection point ([Fig. 4](#)). Injection of BoNT at the upper and lateral sides may affect the orbicularis oris and depressor labii inferioris muscles, leading to asymmetric expression changes of the lower lip or mouth dysfunction with ptosis of the lower lip [[32](#)]. Intramuscular and subdermal injections are recommended according to injection depth. The mentalis muscle has a deep muscle belly. The distance between the periosteum and mentalis muscle is 1.1 mm. After touching the mandibular bone, the needle should be slightly retracted, and 3 U of BoNT must then be injected for deep injection. After deep injection and retracting the needle, further subdermal injection of 1 U is recommended. The injection should be performed gently and slowly to prevent the diffusion of BoNTs [[34](#)].

Fig. 4.



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The injection points for the mentalis muscle. Each point is 0.5 cm lateral to the pogonion, where botulinum neurotoxin injections consist of a deep (3 U) and superficial (1 U) injection.

Conclusion

Understanding of the three-dimensional morphology of facial expression muscles is necessary because the muscles are densely located in the lower face with layers without fascial structures insertion and origins.

Therefore, when BoNT injections target facial muscles, clinicians should consider the delicate anatomical information of the target muscle and the adjacent muscles as well as the positional relationships of these structures.

BoNT is injected into the mentalis muscle to ease or prevent the appearance of a cobblestone chin. However, anatomical considerations for this procedure have not been well described, despite the possibility of side effects resulting from this procedure. Targeting the mentalis muscle with BoNT can cause problems (such as asymmetrical ptosis of the lower lip and dysfunctional mouth opening), which can be critical to patients [35, 36].

In treating the cobblestone appearance of the chin, BoNT diffusion does not often affect nearby muscles such as the orbicularis oris muscle and depressor labii inferioris muscle. Injection of BoNT above and laterally targeting mentalis muscle, however, may affect orbicularis oculi and depressor labii inferioris muscles. Diffusion of BoNT to these muscles may lead to asymmetric expression changes in lower facial expressions [32]. Lower facial muscles intermingle with each other and are duplicated on either side of the face; therefore, BoNT diffusion should be carefully considered during injection procedures.

Yu et al. [37] reported a patient who received BoNT injection in the mentalis muscle, which caused paradoxical bulging. The authors speculate that, when the injection of BoNT fully covers the whole thickness of the muscle, paradoxical bulging may occur. In cases of severe mentalis hyperactivity, an anatomical-based injection is required to prevent imbalanced paralysis and paradoxical chin bulging. Paradoxical bulging occurs when BoNT is unevenly injected [34].

Previous studies have proposed different injection points for the mentalis muscle. Louran [35] suggested superficial injection into the upper part of the muscle. Carruthers and Carruthers suggested the distal-most point from the orbicularis oris muscle to the mentalis muscle as an injection point [38]. Choi et al. [3] found that the mentalis muscle was located 5–10 mm from the midsagittal line and 20–30 mm inferior to the intercheilion line.

The researchers suggested that the area 5 mm lateral to the Pg had the muscle presentation with 4 mm depth of the muscle belly. At this point, the depth of the mentalis muscle to the skin was, on average, 6.7 mm deep. The mean thickness of the muscle was 4 mm, and the length of the muscle to the periosteum was 1.1 mm. The researchers' results indicate that deep injection is important for targeting the mentalis muscle. However, the cobblestone appearance of the chin is due to the muscle fibers that attach to the skin of the chin; therefore, deep injection alone is insufficient in treating the cobblestone appearance. Superficial BoNT injection should thus be used in conjunction with deep injection to reduce the appearance of the cobblestone chin.

The practice of accurate injection points allows for lower doses of BoNT to be used during injection procedures. To achieve this, broad and thorough anatomical knowledge of the mentalis muscle is crucial. If the preferred clinical result is not achieved, further treatment should be conducted. In summary, deep and superficial injections should be administered at each injection point, lateral to the Pg. In deep injections (3 U of BoNT), after touching the mandibular bone, the needle should be slightly retracted. For superficial injections (1 U of BoNT), after needle retraction from deep injection, a further subdermal injection of 1 U is recommended. With

suggested technique, BoNT can affect in resolving MC since the mentalis contraction makes chin moving upward as well as cobblestone appearance for affecting dermal attached muscle fibers.

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Author Contributions

Conceptualization: KHY, HJK. Data acquisition: HB. Data analysis or interpretation: HJP, HWH. Drafting of the manuscript: KL. Critical revision of the manuscript: JHL. Approval of the final version of the manuscript: all authors.

Conflicts of Interest

The authors have all considered the conflict of interest statement included in “Author Guidelines”. To the best of our knowledge, no aspect of the authors’ current personal or professional life might significantly affect the views presented on this manuscript. The authors declare no conflicts of interest.

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