A Novel Injection Technique to the Lateral Pterygoid Muscle for Temporomandibular Disorders: A Cadaveric Study

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Background: Lateral pterygoid muscle activity is associated with the pathological mechanisms of some temporomandibular disorders. The authors aimed to define and demonstrate a novel, practical, and safe technique for botulinum toxin type A injection to the lateral pterygoid muscle based on their findings. Their secondary aims were to standardize the injection pattern according to the variations of the lateral pterygoid muscle and its surrounding anatomical structures, and to establish its advantages over intraoral injection.

Methods: Twenty cadaver heads were dissected. The lateral pterygoid muscle and its surrounding structures were investigated for anatomical variations. Based on these findings, a standardized extraoral injection protocol was defined and compared with the intraoral technique for accuracy and safety.

Results: The average depth of the lateral pterygoid plate from the skin surface was 49.9 ± 2.2 mm, and the mean width of the lateral pterygoid plate was 10.5 ± 3.9 mm. The extraoral injection approach based on the location of the maxillary tuberosity, tragus, and lateral pterygoid plate was consistent in all dissections for the accuracy of the intramuscular injection. In the intraoral approach, standardization of the entry point of the needle through the oral mucosa is difficult, which makes adjustment of the depth of the injection challenging while increasing the risk of neurovascular injury.

Conclusions: The clinical significance of the lateral pterygoid muscle makes it worthwhile to implement minimally invasive treatments before considering more invasive options. The authors define a safe, accurate, and reliable approach with ease of administration in patients with temporomandibular disorders. (*Plast. Reconstr. Surg.* 148: 785e, 2021.)

The lateral pterygoid muscle is active in protrusion, depression (mandibular opening), and mediotrusion (lateral movement) of the mandible, with its horizontally oriented fibers. Hyperactivity or uncoordinated function of the muscle is associated with the mechanisms of some pathological conditions, such as recurrent temporomandibular joint dislocation, neurogenic temporomandibular joint dislocation, oromandibular dystonia, lateral pterygoid muscle dystonia, lateral pterygoid muscle spasm in subcondylar and condylar fractures, bruxism with myofascial pain, temporomandibular joint clicking, and stroke-induced trismus, where botulinum toxin type A injection is indicated.[1–16]

Botulinum toxin type A injection is a safe and effective treatment option for the aforementioned conditions, such as temporomandibular disorders in patients for whom the initial conservative approach has failed.[17] Both intraoral and extraoral approaches are used for botulinum toxin type A injection into the lateral pterygoid muscle. As most of these techniques use a blind approach, their precise location remains uncertain during injections.

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In the present study, we aimed to define and demonstrate a novel, practical, and reliable extraoral injection technique for the lateral pterygoid muscle, based on our findings obtained from cadaver dissections. Our secondary aims were to standardize the injection pattern according to the variations of the lateral pterygoid muscle and its surrounding anatomical structures, and to establish its advantages over intraoral injection in terms of accuracy and safety. Our study was compliant with the principles of the Declaration of Helsinki.

MATERIALS AND METHODS

A total of 20 cadaver half-heads (10 fresh-frozen and 10 embalmed) were dissected with the aid of loupe magnification. The anatomy of the lateral pterygoid muscle and its relationship with the surrounding structures, such as the lateral pterygoid plate, mandibular condyle, and infratemporal surface of the sphenoid bone, were investigated by making an incision beginning from the upper temporal region to the tragus and mandibular angle, making a curve toward the mentum. After the zygomatic arch, temporalis, and masseter muscles were reached, the zygomatic arch was osteotomized and removed after complete removal of the temporalis and masseter muscles. [**See Figure, Supplemental Digital Content 1**, which shows dissection of the zygomatic arch, temporalis, and masseter muscles (*left*); the zygomatic arch is osteotomized and removed after complete removal of the temporalis and masseter muscles (*right*). *SCM*, sternocleidomastoid muscle, ***http://links.lww.com/PRS/E651***.] A transverse osteotomy was then performed at the condylar neck below the pterygoid fovea, and another vertical osteotomy was performed at the corpus of the mandible to expose the infratemporal fossa. Removal of the mandibular segment along with the medial pterygoid muscle was performed, and the lateral pterygoid muscle was exposed. (**See Figure, Supplemental Digital Content 2**, which shows the infratemporal fossa anatomy after removal of the osteotomized mandibular segment and zygomatic arch, ***http://links.lww.com/PRS/E652***.)

The depth of the lateral pterygoid plate from the skin surface (entry point), the thicknesses of the upper and lower heads of the lateral pterygoid muscle at the midpoint of the muscle, the vertical lengths of the upper and lower heads at their insertion to the sphenoid bone, the width of the lateral pterygoid plate (after removal of the lateral pterygoid muscle), and the pterygomaxillary angle formed between the maxillary tuberosity and lateral pterygoid plate were measured. Based on these findings, a standardized extraoral injection protocol was defined and compared with the intraoral injection technique for accuracy and safety.

RESULTS

All specimens were from white cadavers, and their mean age (±SD) was 67 ± 9.5 years. The lateral pterygoid muscle had two bellies (upper and lower) in all dissections. The average depth of the lateral pterygoid plate from the skin surface was 49.9 ± 2.2 mm. The mean lateral pterygoid plate width was 10.5 ± 3.9 mm. The average pterygomaxillary angle formed between the maxillary tuberosity and the lateral pterygoid plate was 168.3 ± 15.8 degrees. The average thicknesses of the upper and lower heads of the lateral pterygoid muscle at the midpoint of the muscle were 3.1 ± 1.2 mm and 10.2 ± 1.8 mm, respectively. The average vertical lengths of the upper and lower heads at their insertion to the sphenoid bone were 10.9 ± 2.4 mm and 22.9 ± 1.8 mm, respectively. The postdissection anatomical data are listed in Table 1.

Our standardized injection technique, based on the location of the maxillary tuberosity, tragus, and lateral pterygoid plate, was consistent in all dissections for the accuracy of the intramuscular injection rather than an injection technique based on the injection angle between the skin and needle, which was approximately 60 degrees horizontally in our study (range, 50 to 70 degrees). In 10 cadaver half-heads, India ink was injected (0.1 ml) before the dissections, and the stained areas were detected at the right locations in all dissections. [**See Figure, Supplemental Digital Content 3**, which shows India ink injections (0.1 ml) performed before the dissections; the stained areas were detected at the right locations in all dissections, ***http://links.lww.com/PRS/E653***.]

In addition, we simulated the intraoral injection to the lateral pterygoid muscle [5] and found it to be unreliable in terms of being intramuscular due to its blind nature. The entry point of the needle through the oral mucosa is difficult to standardize, making the depth of the injection highly variable and dangerous, as it could pass through the lateral pterygoid muscle and injure the neurovascular structures (Fig. 1). Moreover, it was challenging to perform intraoral injections in cases with extremely limited space between the maxilla and the coronoid process.

Table 1. Postdissection Anatomical Data

Cadaver No.	Lateral Pterygoid Plate Depth* (mm)	Lateral Pterygoid Plate Width (mm)	Pterygomaxillary Angle† (°)	LPM Thickness‡ (mm)		LPM Length§ (mm)	
				Upper Head	Lower Head	Upper Head	Lower Head
1	49	8	170	2	10	9	22
2	50	11	170	3	9	13	23
3	47	8	120	2	7	13	21
4	46	19	170	3	9	11	25
5	47	10	130	2	8	7	21
6	48	8	170	3	8	10	22
7	50	11	180	3	10	11	25
8	50	12	170	5	12	10	21
9	54	10	170	6	12	8	23
10	52	16	170	6	13	10	21
11	50	9	180	3	8	8	22
12	51	12	170	3	12	12	25
13	50	12	180	3	11	14	23
14	55	8	185	2	9	14	21
15	50	7	170	3	9	11	21
16	49	14	175	3	11	7	24
17	52	10	165	3	13	16	27
18	50	10	170	2	10	12	24
19	49	10	180	3	12	10	25
20	49	14	170	2	10	11	22
Mean	49.9	10.5	168.3	3.1	10.2	10.9	22.9
SD	2.2	3.9	15.8	1.2	1.8	2.4	1.8

LPM, lateral pterygoid muscle.
*Depth of the lateral pterygoid plate from the skin (entry point).
†The pterygomaxillary angle formed between the maxillary tuberosity and the lateral pterygoid plate.
‡The thicknesses of the upper and lower heads of the lateral pterygoid muscle at the midpoint of the muscle.
§Vertical lengths of the upper and lower heads at their insertion to the sphenoid bone.

Injection Technique

Our approach is an extraoral injection technique performed bimanually, with one hand palpating the maxillary tuberosity intraorally while the other performs the injection. The entry point of the needle (27 gauge × 50 mm) is within the preauricular safe zone[18] and located 10 mm anterior to the most anterior point of the tragus, with its tip pointed 5 mm posterior and 15 mm superior to the maxillary tuberosity. (**See Figure, Supplemental Digital Content 4**, which shows extraoral injection technique, ***http://links.lww.com/PRS/E654***.) The needle is advanced through the sigmoid notch (Fig. 2, *above*) until the lateral pterygoid plate is felt, then it is pulled back 2 to 3 mm, and the material is injected after a gentle aspiration, to ensure that the needle is not inside any vascular structure. By doing so, the physician verifies the precise intramuscular injection as the inferior belly is directly inserted into the lateral pterygoid plate, and there is no other anatomical structure that can be injured between the plate and the lateral pterygoid muscle (Fig. 2, *below*). Understanding the anatomy of the sphenoid bone is crucial in this technique, as its infratemporal surface is located just caudal to the late pterygoid plate (Fig. 3).

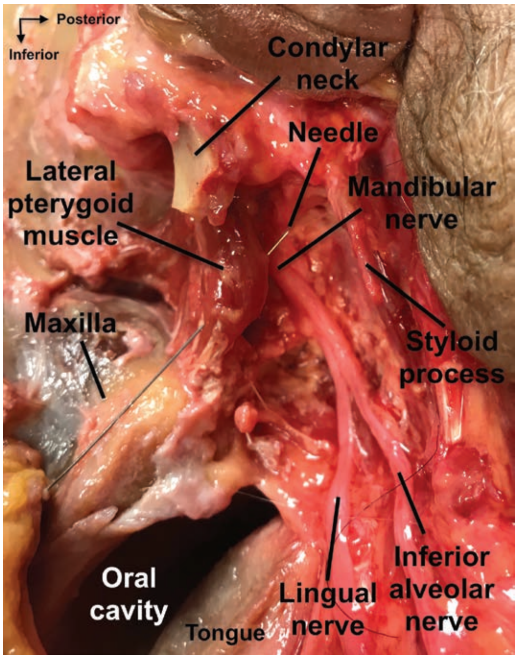

Fig. 1. The entry point of the needle through the oral mucosa is difficult to standardize, which makes the depth of the injection highly variable and dangerous, as it could pass through the lateral pterygoid muscle and injure the neurovascular structures.

DISCUSSION

The prevalence of temporomandibular disorders is 30 percent to 75 percent, with up to 10

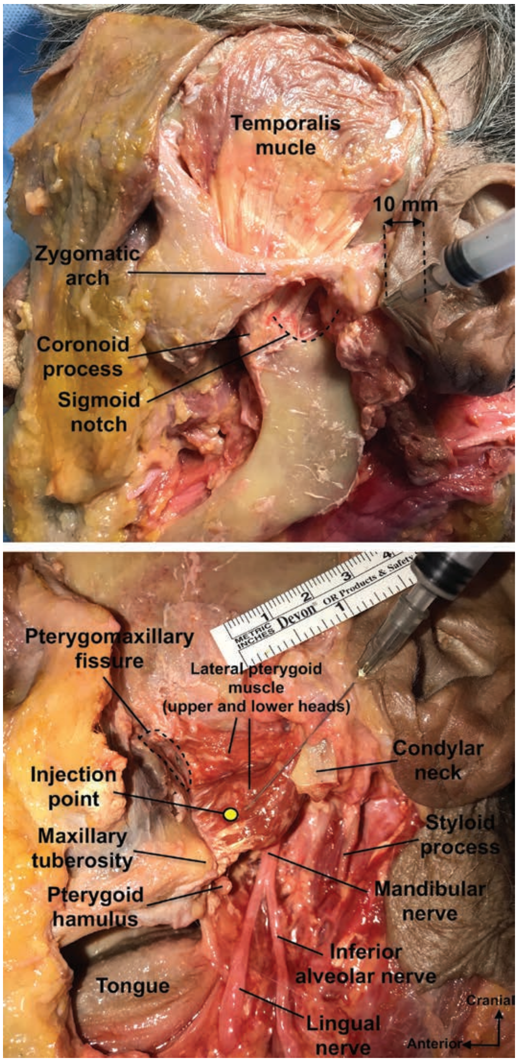

Fig. 2. (*Above*) The entry point of the needle is located 10 mm anterior to the most anterior point of the tragus, with its tip pointed 5 mm posterior and 15 mm superior to the maxillary tuberosity. The needle is advanced through the sigmoid notch. (*Below*) Intramuscular injection to the inferior belly of the lateral pterygoid muscle after feeling the lateral pterygoid plate.

percent to 25 percent of the population seeking professional care for their symptoms.[16,19–22] The clinical significance of the lateral pterygoid muscle makes it worthwhile to implement minimal invasive treatments before considering more invasive options.

Blind injections into the lateral pterygoid muscle remain controversial with regard to accuracy and safety. In our cadaveric simulation of the intraoral approach, we found this technique to be unreliable without the guidance of additional instruments. In the literature, there are many additional tools recommended for increasing the accuracy of the intramuscular injections, including ultrasonography, electromyography, computer-aided design/computer-aided manufacturing–derived customized guides, and arthroscopy.[23–27] Electromyography is commonly used to confirm the correct needle tip placement by having the patient move the mandible.[26] Ultrasonography can locate the lateral pterygoid muscle through the gap between the coronoid process and the zygomatic arch as a triangular muscle when the patient is asked to open the mandible.[28] The computer-aided design/computer-aided manufacturing–derived needle guides can be used for precise injection into the lateral pterygoid muscle. Patients' computed tomographic images are analyzed for this process.[23] Injection under direct vision during arthroscopy is an invasive alternative for lateral pterygoid muscle injections.[25] Although the guidance of these instruments makes intramuscular injections more precise, they are not handy for physicians who are unfamiliar with them and they may have a steep learning curve. Furthermore, the use of extra instruments increases treatment costs, and it may be time-consuming as well as invasive (e.g., arthroscopy).

In the current study, we defined an extraoral injection technique based on individual anatomical landmarks (e.g., maxillary tuberosity, tragus, and lateral pterygoid plate). Understanding the anatomy of the infratemporal fossa is fundamental in this approach. The average pterygomaxillary angle was 168.3 ± 15.8 degrees, which is appropriate for extraoral injections considering the orientation of the lateral pterygoid plate and needle vector. It is also important to use the right needle for this technique; we used a 50-mm × 27-gauge hypodermic needle in our study, taking into consideration the average distance between the entry point of the needle and the lateral pterygoid plate, which was 49.9 ± 2.2 mm. Aiming the point of the needle 5 mm posterior and 15 mm superior of the maxillary tuberosity is safe, as the average lateral pterygoid plate width was 10.5 ± 3.9 mm and the average vertical length of the inferior head at its insertion to the sphenoid bone was 22.9 ± 1.8 mm. In addition, we found that the inferior head of the lateral pterygoid muscle is approximately three to four times larger than the superior head, considering the average thicknesses and vertical lengths of the upper and lower heads, consistent with the findings reported by Melke et al.[29]

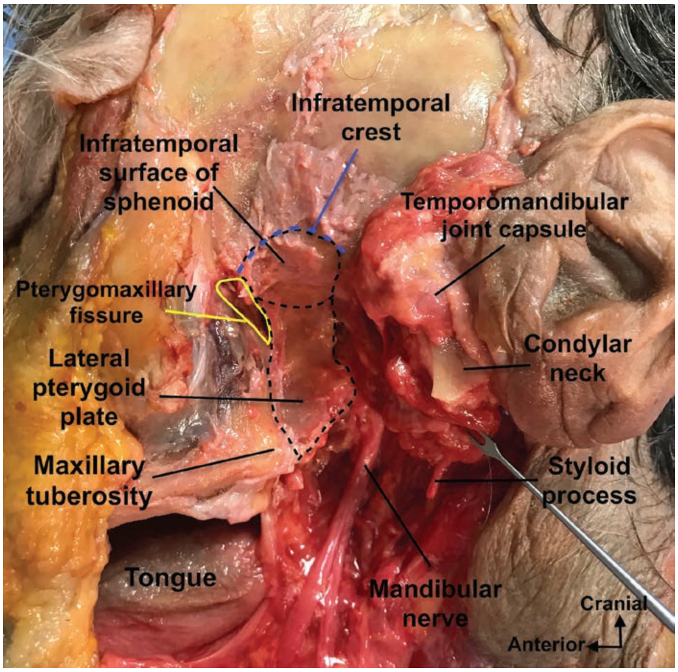

Fig. 3. Anatomy of the pterygomaxillary fissure, lateral pterygoid plate, infratemporal surface of the sphenoid bone, and infratemporal crest after removal of the lateral pterygoid muscle.

CONCLUSIONS

It is clinically vital to determine the best technique to reach the lateral pterygoid muscle given its unique anatomical location and orientation. In the current study, we proposed an extraoral injection technique to the lateral pterygoid muscle based on individual anatomical landmarks. It is a safe, accurate, and reliable approach, with ease of administration in patients with temporomandibular disorders (Fig. 4). Further clinical studies are indicated to evaluate its efficacy in the management of temporomandibular disorders and to make it a part of routine practice.

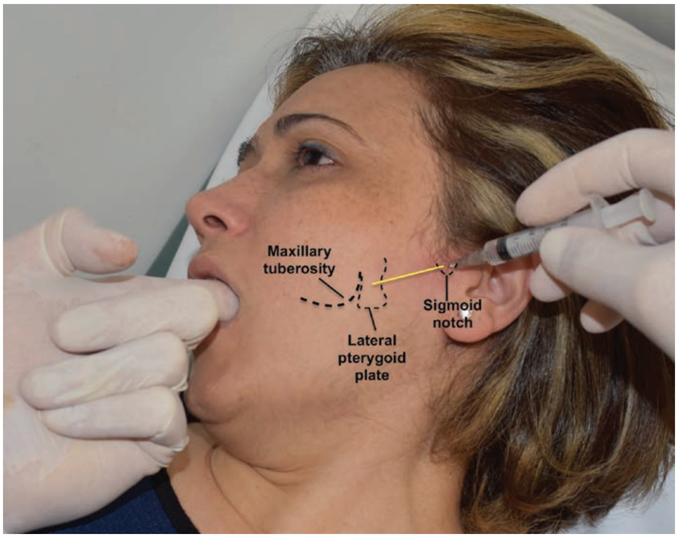

Fig. 4. Application of an extraoral botulinum toxin type A injection to the lateral pterygoid muscle of a patient.

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PATIENT CONSENT

The patient provided written informed consent for the procedure performed and for her image to be used for research purposes.

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