CASE SERIES STUDY

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# Ultrasound-guided intraoral botulinum toxin injection into the lateral pterygoid muscle for chronic temporomandibular joint dislocation

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**Abstract** (J Korean Assoc Oral Maxillofac Surg 2024;50:41-48)

**Objectives:** Botulinum toxin type A (BTX), a powerful neurotoxin, can be an effective treatment choice for diverse muscular disorders and can reduce abnormal muscle activities. Abnormal movements of the mandible can be caused by involuntary and uncontrolled contractions of the lateral pterygoid muscle (LP) in various pathological situations. Previous reports have shown that BTX can reduce abnormal contractions of the LP. However, needle placement into the LP for BTX injection requires skill, experience, and sufficient anatomical knowledge. To place the needle precisely into the LP, ultrasonography (USG) can be used as an effective needle-guidance modality. USG is a non-invasive imaging modality able to create real-time images without any potential risks, including radiation exposure.

**Patients and Methods:** The patients who had been performed USG-guided BTX injection into the LP using an intraoral approach were included in this study with a literature review and case presentations. Using the USG, four patients received BTX injections to treat recurrent temporomandibular dislocation and oromandibular dystonia resulting from involuntary LP activity.

**Result:** Involuntary movements of the mandible were improved successfully in all patients, and showed satisfactory results without significant complication.

**Conclusion:** The intraoral approach could prevent potential complications during needle placement. USG-guided BTX injection is an effective, convenient, and safe method that provides real-time imaging without unnecessary pain to the patient.

**Key words:** Botulinum toxin type A, Temporomandibular joint disorders, Ultrasonography, Pterygoid muscles

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## I. Introduction

Botulinum toxin type A (BTX) reduces the release of acetylcholine at the muscular junction, alleviating the tension and improper activity of the targeted muscles. It is widely used not only for the cosmetic purpose of improving wrinkles, but also for reducing abnormal muscle activities, such as strabismus, blepharospasm, and dystonia[1].

The lateral pterygoid muscle (LP) is a triangular-shaped muscle with upper and lower heads that originate from the temporal crest and pterygoid plate before inserting into the temporomandibular joint (TMJ) disc/capsule and the condylar process of the mandible, respectively. The LP is the main muscle responsible for opening the mouth, and involuntary contractions of the LP can cause uncontrollable mandible movements.

BTX can be an effective treatment choice for such pathologic situations, and its efficacy and safety for reducing or relieving abnormal LP activity to treat TMJ disc displacement[2-4], orofacial pain[5], habitual TMJ dislocation[6,7], and oromandibular dystonia (OMD)[8] have been documented in various studies. The LP is located deep in the facial structure, and proper injection of BTX to the deeply located LP can prevent complications, such arterial bleeding or facial nerve damage. Moreover, the maxillary artery is located commonly on the outer side of the LP[9-11], and the risk of hemorrhage or intravascular injection into the maxillary artery is increased when needle insertion is performed extraorally[9,11]. The LP can be approached via an intraoral[2,12-14] or extraoral (transcutaneous)

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approach[6,7] for needle placement to inject BTX. Some authors have used an extraoral approach to observe needle insertion easily with ultrasonography (USG) imaging[7]. However, using an extraoral approach compared to an intraoral approach increases patient anxiety, and there is a risk of needle breakage due to muscle spasm[2,11].

LP injection is a fundamentally blind technique and requires skill, experience, and sufficient anatomical knowledge. For precise placement of the needle into the LP, additional radiographic imaging techniques may be used, such as pairing computed tomography (CT) with a computer-aided design/computer-assisted manufacture (CAD/CAM)-derived needle guide[13,15,16]; using a tooth-supported guide[13]; and adopting other electromyography (EMG)[2,14,17], CT[6], or magnetic resonance imaging-guided navigation approaches[18]. Recently, USG has been used as an alternative diagnostic method because of various advantages such as lower cost, reduced invasiveness, no need for special facilities, and provision of real-time images. Application of USG in TMJ disorders during diagnosis[19] or treatments such as arthrocentesis[4] has been documented. Following the first report of BTX injection for treatment of recurrent TMJ dislocation[20], USG-guided BTX injection to treat recurrent TMJ dislocation was performed via an extraoral approach[7]. To the best of our knowledge, however, intraoral injection of USG-guided BTX injection to LP has not been reported.

In this report, we present four patients who underwent BTX injections into LPs using USG with intraoral approaches to treat recurrent temporomandibular dislocation and OMD due to involuntary LP activity. Involuntary movements of the mandible were alleviated successfully in all patients, and all showed satisfactory results without significant complications. This study was approved by the Institutional Review Board of Kyungpook National University Dental Hospital (No. KNUDH-2023-09-001). Informed consent was not required for the case series study because images did not contain patient-specific information.

## II. Patients and Methods

The following four patients underwent BTX injection intraorally under the guidance of USG according to the following procedure. The patient was placed in a semi-reclined position on the dental unit chair, and their head was shifted to the opposite side to the injection, with slight opening of the mouth. The USG probe (E-CUBE 7; Alpinion Medical Systems) was positioned in the coronal plane on the extraoral side. On USG, the LP was visible between the coronoid process

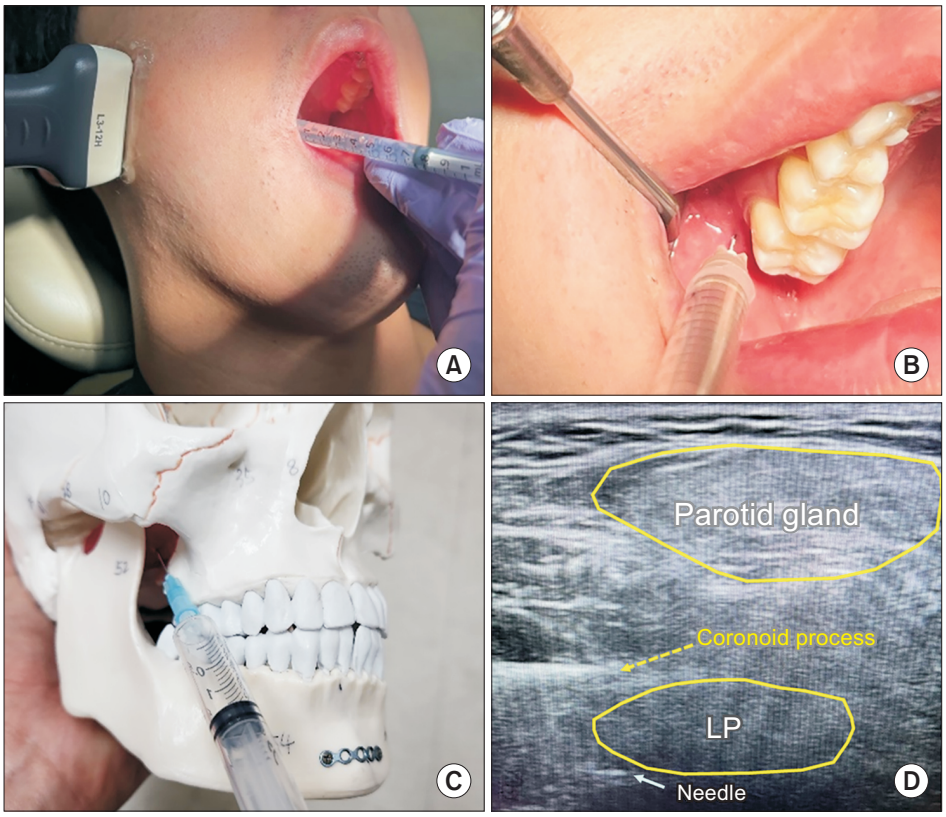


**Fig. 1.** Ultrasonography (USG)-guided intraoral botulinum toxin type A (BTX) injection in the lateral pterygoid muscle (LP). A. Injection of BTX in the LP via the intraoral approach, with placement of the ultrasound probe on the extraoral side. B. The BTX injection needle was advanced lateral to the maxillary tuberosity, directed toward the neck of the condyle. C. A skull model demonstrates the needle entry point into the LP. D. USG image of BTX injection into the LP. The broken arrow indicates the coronoid process (hyper-echoic), whereas the short arrow indicates a needle inserted into the LP.
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and parotid gland. Medial to the hypoechoic coronoid process, a hypoechoic LP was visible. When the patient opened their mouth, LP contraction and forward movement of the mandible were visible, which facilitated the identification of LP orientation. The point of needle insertion was the lateral point of the maxillary tuberosity directed toward the neck of the condyle. To prevent injury to the maxillary artery, the indicated unit of BTX was injected as a single injection after aspiration.

The authors diluted one vial (100 units) of BTX (*Clostridium botulinum* toxin A, Wondertox; Chong Kun Dang Pharmaceutical Co.) in 1 mL of saline to yield a solution of 10 units/0.1 mL. The authors used 15-25 units of BTX according to patient age and anticipated muscular volume.(Fig. 1)

## III. Results

### 1. Case 1

An 82-year-old female patient presented with Parkinson's disease and dementia for 7 years. She was uncooperative with the examination and treatment due to prolonged dementia. Four weeks prior, the patient had experienced bilateral TMJ dislocation for the first time, which was reduced manually in the emergency room. TMJ dislocations recurred five times, and she visited the emergency room for manual reduction. Due to repetition of her TMJ dislocation, the patient was referred to the authors' department for further treatment. The patient's recurrent TMJ joint dislocation was attributed to involuntary movements of the LP. Considering the patient's difficulty in behavior control and lack of cooperation, BTX injection into the LP was planned. BTX was injected into bilateral LPs (15 units/side), under USG guidance following manual reduction of the dislocated mandible. The day after BTX was injected, the patient's bilateral TMJ dislocation recurred, and manual reduction was repeated. No further recurrence of TMJ dislocation was noted until 12 months after BTX injection. The patient was not able to continue further follow-up because of her poor general condition and dementia.(Fig. 2)

### 2. Case 2

A 22-year-old male patient visited the Department of Oral Medicine of the authors' hospital because of severe pain in both TMJs for 2 years. Following use of a stabilization splint, his discomfort and pain subsided. However, a few months later, the patient experienced a recurrence of pain in the left TMJ during mastication, along with TMJ dislocation. Over time, the pain and frequency of TMJ dislocation gradually increased to once or twice a week. Although the patient's TMJ pain and discomfort were decreased temporarily after pain medication, recurrent TMJ dislocation continued repeatedly. Radiographic findings confirmed synovial chondromatosis in the left TMJ space, for which the patient wanted conservative treatment. The patient was referred to our department to treat recurrent TMJ dislocation. BTX was injected into bilateral LPs (25 units/side) under USG guidance using an intraoral approach. After BTX injection, the patient did not experience TMJ dislocation recurrence up to 14 months and has not reported any complications. Currently, the patient continues periodic follow-up.

### 3. Case 3

A 45-year-old male patient, physically handicapped after a traffic accident 18 years prior, was referred to the authors' department. The patient was planned to undergo mandibular dental implant treatment and subsequent implant-supported overdenture. However, from the moment he opened his mouth or began to speak, involuntary movements of the mandible and tongue started. Dull pain also developed in the left

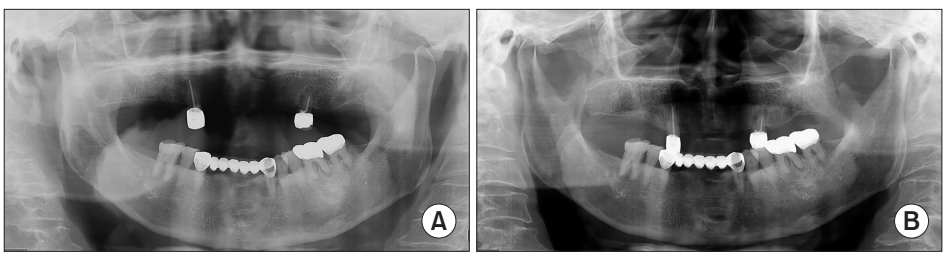


**Fig. 2.** A. An 82-year-old female patient with recurrent bilateral temporomandibular joint (TMJ) dislocation. B. After injection of botulinum toxin type A (15 units/side) into the lateral pterygoid muscle, no further recurrence of TMJ dislocation was noted for up to 12 months.
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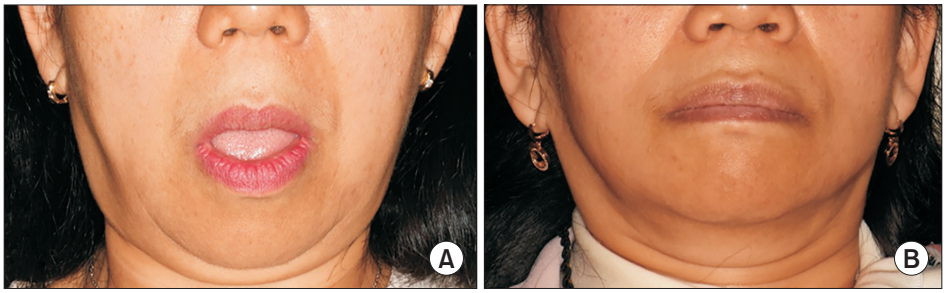


**Fig. 3.** A. A 56-year-old female patient with involuntary mouth opening, involuntary closing of the right eye, and pain on mouth opening in the right temporomandibular joint. After botulinum toxin type A (BTX) injections into bilateral lateral pterygoid muscles (LPs) (25 units/side) and the anterior belly of digastric muscles (10 units/side) under ultrasonography guidance, her involuntary mouth opening was alleviated. Upon recurrence, additional BTX injection was performed into bilateral LPs and digastric muscles. B. After 6 months, involuntary mouth opening resolved, with no complications or discomfort.
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TMJ on opening, and his mandible was protruding and deflected to the left side. Simultaneously, protrusion and curling movements of the tongue were observed. The patient was diagnosed with OMD caused by involuntary movements of the bilateral LPs and tongue muscles. Based on the left deflection of the mandible on mouth-opening path, excessive activity of the right LP and rigidity of the left LP were attributed to involuntary movement of the mandible. To reduce the excessive activity of the right LP, BTX (20 units) was injected into the right LP using an intraoral approach under USG guidance. After 4 weeks, involuntary movements of the mandible and tongue significantly improved, even without injection of BTX into the tongue muscles because of concerns about the potential occurrence of severe complications, like dysphagia, dysarthria, and breathing difficulty. Although the patient's symptoms improved, limitations of movement in his left TMJ were observed. Therefore, BTX (20 units) was injected into the left LP using an intraoral approach under USG guidance. Involuntary movements of the mandible and tongue recurred 3 months later. Thereafter, following injection of additional BTX into the bilateral LPs, his symptoms improved without any complications. Based on the stable condition of the patient, implant placement and overdenture fabrication were successfully completed 8 months after BTX injection.

### 4. Case 4

A 56-year-old female patient was referred to our department for involuntary mouth opening. Two years prior, the patient had experienced involuntary closing of the right eye and pain in the right TMJ on mouth opening. Despite undergoing various examinations, including brain CT and blood testing, her pathologic condition could not be diagnosed at another hospital. To alleviate her symptoms, the patient was prescribed carbamazepine, clonazepam, baclofen, and alprazolam in turn for 2 months each. However, the patient's symptoms did not change, and she was referred to our hospital for further treatment.

Based on the patient's symptoms of combined jaw-opening type of OMD and blepharospasm and degenerative disease of both TMJs due to repetitive mandibular movements, she was diagnosed with Meige's syndrome. To alleviate involuntary mouth opening, BTX was injected into the bilateral LPs (25 units/side) and the anterior belly of bilateral sides of the digastric muscles (10 units/side) under USG guidance. The patient was referred to the department of neurology for BTX injections, and blepharospam resolved after BTX injection in the right periocular area. Even though the patient's involuntary mouth opening was alleviated following the first injection of BTX in bilateral LPs, it did not resolve completely. Therefore, additional BTX (25 units/side) injection into bilateral LPs was performed after 2 months, and BTX was injected into the bilateral anterior bellies of the digastric muscles (10 units/side). After 6 months, involuntary mouth opening of the patient was no longer observed, and there were no complications or discomfort. No recurrence of symptoms was observed for up to 2 years after the initial BTX injection. (Fig. 3)

## IV. Discussion

The LP is a two-headed muscle with upper and lower heads that insert into the temporomandibular disc/capsule and the neck of the mandible, respectively. The lower head of the

LP protrudes into the mandible anteriorly and is the primary muscle responsible for opening the mouth. In various pathological situations, involuntary and uncontrolled contractions of the LP can occur, as shown in the current case series of patients exhibiting recurrent TMJ dislocation and muscular dystonia.

TMJ dislocation, also referred to as TMJ luxation, involves displacement of the mandibular condyle, outside of its functional positions within the glenoid fossa, and causes the patient to experience TMJ pain and an inability to close their mouth. There are three subtypes of TMJ dislocations: acute, chronic, and recurrent[21]. Among these subtypes, recurrent dislocation is defined as repeated acute dislocation of the TMJ with the condyle head situated in the glenoid fossa between episodes, which is not observed in patients with chronic dislocation. There are numerous treatments available for recurrent TMJ dislocation, including surgical interventions like eminectomy[22]. However, surgical interventions may not be suitable for elderly patients with poor health or neurologic disorders like the patient of Case #1. Conservative or minimally invasive treatments, including autologous blood injection, sclerotherapy, and BTX injection, should be considered[22]. Among these conservative treatments for recurrent dislocations, BTX injection can be a first choice for elderly patients because it is a simple procedure that can be performed on an outpatient basis with minimal complications. Most often, the muscle that is targeted is the LP, which is frequently involved in myospasm related to TMJ dislocation. The LP is weakened by BTX injection, limiting one's ability to open their mouth and suppressing the occurrence of dislocation. Because the effect of the BTX peaks 2 weeks after injection and may be lost at 2-4 months, repeated injections might be needed for recurrent TMJ dislocation[14] if the first injection was not sufficient for improving symptoms[11]. Some reports have recommended successive BTX injections every 3 months until no TMJ dislocation is experienced for 6 months[11].

OMD is a form of focal dystonia that involves the masticatory system, affecting the facial, masticatory, and/or lingual muscles. It usually presents as involuntary muscular contractions with repetitive movement, but clinical characteristics of OMD can be divided clinically into jaw-opening dystonia, jaw-closure dystonia, jaw-deviation dystonia, lingual dystonia, and combinations of these subtypes[23]. LP is the main muscle responsible for jaw-opening and deviation dystonia. There is no known cure for OMD, although various unverified pharmacological interventions have been prescribed, including oral benzodiazepine, anticholinergics, benzodiazepine, levodopa, dopamine receptor blockers, and atypical antipsychotics[24]. Local injections of BTX can be the first-choice treatment for OMD patients[8,12,25,26]. Muscle selection for BTX injection should be determined by clinical features of the OMD. For treatment of jaw-opening dystonia, the target muscles can be the LP and digastric muscles[8,12,26].

For treatment of the mixed type of OMD, seen in the patient of Case #4 with jaw-opening and lingual dystonia, LPs and lingual muscles can be targeted for BTX injection. However, as in our Case #4, there have been previous reports of resolved tongue dystonia when BTX was injected only into the LPs[27]. Considering the severe complications that may occur when BTX is injected into tongue muscles, such as dysphagia and breathing difficulty, injection into the tongue muscles should be a lower priority for treating mixed types of OMD, including those involving lingual dystonia. If OMD occurs with blepharospasm and leads to uncontrollable blinking and closure of the eyelids, it is diagnosed as Meige's syndrome[25,28,29]. Meige's syndrome can also be associated with involuntary movement of facial and masticatory muscles. Various oral medicines, like clonazepam, trihexyphenidyl, and diazepam, have been prescribed for Meige's syndrome[28,29]. However, the effectiveness of these medications is limited, with blepharospasm exhibiting a better response to treatment than OMD. When the effects are unsatisfactory or when systemic complications are observed, consideration is given to BTX injections. The effect of BTX injections for treatment of blepharospam is proven, and BTX injection was approved by the U.S. Food and Drug Administration in 1989; however, the effect of BTX in the treatment of OMD is less effective[28]. As shown in Case #2 in this report, the muscles targeted for BTX injections should be the right periocular and bilateral LPs. BTX is more effective in alleviating blepharospasm than OMD; however, BTX injection into the LPs is sufficiently effective for improving involuntary movement of the mandible.

Complications of BTX injection into LPs, which include hemorrhage, intravascular injection, and untargeted or unwanted muscle atrophy, are caused typically by inaccuracies in dosing and/or injection techniques for needle placement. It is important to inject the appropriate dose to prevent local diffusion of BTX. However, the optimal dose for LP injection is not clearly defined. According to previous publications, the administered dose of Botox (Allergan plc) depends on the muscular volume, which usually ranges from 15-50 units per side to the LP is effective without complications[2,6,11,12].

Selection of BTX dosage is empirical, and we recommend a starting dose of about 20 units per muscle, titrating higher if needed.

Because the LP lies close to the maxillary artery, inappropriate needle placement may lead to severe hemorrhage due to damage to the maxillary artery. The maxillary artery is one of the terminal branches of the external carotid artery and originates behind the neck of the mandible, within the thickness of the parotid gland, and travels distally and anteriorly, penetrating the infratemporal region. It reaches the lower head of the LP and runs along its lower edge. The course of the maxillary artery can vary depending on a lateral or medical trajectory of the artery to the LP. Many studies have reported these variations, indicating that the maxillary artery is predominantly situated laterally or superficially near the LP[9,10,16]. During needle placement, the intraoral approach has a greater advantage relative to the extraoral approach in protecting the maxillary artery from damage. Moreover, due to anatomical proximity, the risk to the parotid gland and facial nerve by BTX is also greater when the extraoral approach is used compared to the intraoral approach[30]. Furthermore, there is possibility of needle breakage during the extraoral approach due to mouth closure as the needle traverses the space between the zygomatic arch and the mandible[16]. These factors justify selection of the intraoral approach over the extraoral approach when injecting BTX into the LP.

Since BTX injections into the LP without proper guidance can significantly increase the risk of complications, various methods have been reported for needle placement, including customized appliance with a needle guide[15,16] or the use of EMG to guide the LP approach[2,14,17]. However, in situations where patients are unable to open their mouth voluntarily as per the clinician's instructions, as demonstrated in Case #3, confirming correct needle placement via EMG becomes challenging. Moreover, electrode placement can cause unnecessary pain and discomfort. Yoshida[11] reported the use of appliances customized to the patient with a needle guide, fabricated using CAD/CAM technologies, to increase the precision of BTX injection into LPs. These appliances provide the advantage of preventing complications and being usable by relatively inexperienced clinicians; however, disadvantages such as increased treatment costs due to additional visits and appliance fabrication and increased radiation exposure due to CT imaging also exist. In contrast, USG does not carry significant disadvantages such as additional radiation exposure, patient visits, or increased costs, and it has the advantage of being painless and providing real-time images.

Guo et al.[7] and Chen et al.[5] both reported on BTX injection techniques under USG guidance. In particular, they noted that USG was convenient and safe to guide needle placement for BTX injection into the LP. However, they selected the extraoral approach, not the intraoral approach, as the method to access the LP with the needle. In our department, we adopted USG guidance as they did, but we selected the intraoral approach to prevent the potential complications mentioned earlier.

In our department, we used the intraoral approach for BTX injections into the LPs under USG guidance in most cases as it has a lower risk of complications compared to the extraoral approach. Moreover, our preference for the intraoral approach is due to its similarity to postero-superior alveolar nerve block, a local anesthesia method commonly used in dentistry. During BTX injection into the LP, the probe is placed on the sigmoid notch of the mandible, and the hypoechoic space near the coronoid of the mandible is equivalent to that of the lower head of the LP. Each patient was asked to open their mouth slightly, increasing the gap between the zygomatic arch and the coronoid process. The movement of the condyle head forward also caused a contraction of the LP, which can be seen on the USG images, helping with identification of the LP. With an intraoral approach to the LP, the needle is advanced laterally to the maxillary tuberosity while being directed toward the neck of the mandibular condyle. This accurate injection technique could be another factor contributing to successful results after BTX injection without significant complications.

## V. Conclusion

BTX injection into the LP is a very effective treatment for recurrent TMJ dislocation and muscular dystonia, which are caused by involuntary movement of the LP. USG-guided BTX injection is an effective, convenient, and safe method that provides real-time imaging without unnecessary cost and pain to the patient. Furthermore, we recommend the intraoral approach over the extraoral approach to prevent potential complications during needle placement, and USG was effectively applied even in the intraoral approach.

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## Authors' Contributions

S.T.L. conceptualized the study and participated in the treatment and study design. D.K. collected patient data. S.T.L. and D.K. drafted the manuscript. S.T.L. and J.H.P. reviewed the manuscript. T.G.K. organized the study and critically revised and finalized the manuscript.

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## Ethics Approval and Consent to Participate

This study was approved by the Institutional Review Board of Kyungpook National University Dental Hospital (No. KNUDH-2023-09-001). Informed consent was not required for the case series study because images did not contain patient-specific information.

## Conflict of Interest

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

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