

POINT-TOUCH TECHNIQUE OF BOTULINUM TOXIN INJECTION FOR THE TREATMENT OF SPASMODIC DYSPHONIA

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Intralaryngeal injections of botulinum toxin (Botox), under electromyographic guidance, have emerged as an effective treatment for adductor spasmodic dysphonia. To remain effective, these injections must be repeated every 3 to 9 months as the symptoms recur. One drawback to the current method is the need for electromyographic confirmation of needle placement into the thyroarytenoid muscle. This report describes an anatomic approach to Botox injection that requires only flexible nasopharyngeal endoscopy and careful evaluation of the anatomic landmarks. This technique has been used successfully on 13 patients, and objective pretreatment and posttreatment measures are reported.

KEY WORDS — botulinum injection, laryngeal dystonia, spastic dysphonia.

INTRODUCTION

Spasmodic dysphonia is a serious voice disorder characterized by a strained or strangled voice, and it often interrupts the fluency of continuous speech. Since the first description of the disorder by Traube¹ in 1871, its exact cause and treatment have been the subject of controversy.

In the past, this disorder was thought to reflect psychiatric problems. More recently, Blitzer et al² found through clinical and electromyography (EMG) evaluation that many patients with "spastic dysphonia" actually have a dystonia. Dystonia is a neurologic disorder of motor control processing characterized by abnormal, often action-induced, involuntary movements or uncontrolled spasms. The cause is usually idiopathic. The dystonia may be restricted to the larynx or present in other areas of the body as well, such as blepharospasm.²

There are a variety of treatments for adductor spastic dysphonia, which include speech therapy, psychotherapy, biofeedback, systemic medicine, nerve section, botulinum toxin (Botox) injection, and thyroplasty. Dedo³ was the first to describe recurrent laryngeal nerve section as a treatment for spastic dysphonia. The aim was to achieve a voice that was slightly breathy but easier to produce. After a 3-year follow-up, his group⁴ reported a 10% to 15% recurrence rate according to patient self-evaluations. Aronson and DeSanto⁵ reported an initial success rate of 97% at 6 months for recurrent laryngeal nerve

section. This success rate fell to 36% at 3 years' follow-up. The failures showed gradual hyperadduction of the intact vocal fold against the paralyzed fold. This was thought to be due to a worsening of the patient's underlying neurologic condition.

Biller et al⁶ reported, in 1979, crushing the recurrent laryngeal nerve as a treatment for spastic dysphonia. Although all patients had initial improvement, only 13% were improved at 3 years' follow-up.⁷

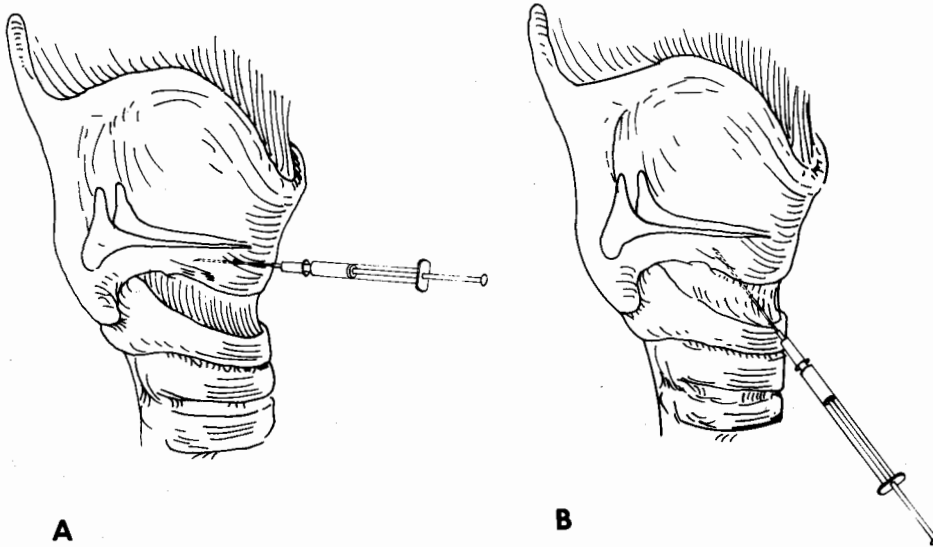
Blitzer et al^{8,9} reported the first series of patients with focal laryngeal dystonia to be treated with local vocal fold injection of Botox. This toxin acts presynaptically at nerve terminals to prevent calcium-dependent release of acetylcholine, which results in muscle paralysis. There were five patients in their series, and all, within 2 to 3 days, experienced benefit that lasted 3 to 6 months. Although the authors initially injected only one vocal fold, they now perform bilateral injections. There were no systemic side effects from the injections, but they state that the long-term systemic or local laryngeal effects are unknown.

Using EMG, Ludlow et al¹⁰ studied patients with adductor spastic dysphonia who failed unilateral recurrent laryngeal nerve section. They found that some of the failures were due, at least in part, to reinnervation of the thyroarytenoid muscle by the previously sectioned recurrent laryngeal nerve, and that compensation by the nonoperated side may have

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Location and direction of needle placement for transcutaneous injection of botulinum toxin into ipsilateral thyroarytenoid muscle. A) Through thyroid cartilage. B) Through cricothyroid membrane.

played a role in others.¹⁰ They treated these patients successfully with Botox injections.

Initial reports of Botox injections of the true vocal fold have relied on EMG localization of the thyroarytenoid muscle for injection. Recently, Ford et al¹¹ described an indirect laryngoscopic approach to Botox injection in which all patients studied demonstrated objective improvement after injection.

The technique for transcutaneous injection of the vocal fold was first described in connection with Teflon injections as a treatment for unilateral vocal fold paralysis.¹² Ward et al¹³ described insertion of a needle through the cricothyroid membrane into the subglottic space with monitoring of the actual fold injection through a fiberoptic nasopharyngoscope or a Hopkins rod laryngoscope. Hirano et al¹⁴ described a transcutaneous vocal fold injection technique in which the needle is inserted through the cricothyroid membrane directly into the edge of the vocal fold.

This report describes a relatively safe and accurate transcutaneous method of Botox injection that requires only flexible nasopharyngeal endoscopy.

METHODS AND SUBJECTS

Injection Technique. The patient was seated in an examination chair. Palpation of the neck was used to mark the outline of the thyroid and cricoid cartilage on the anterior neck skin with a surgical marking pen.

The nose and pharynx were topically anesthetized with lidocaine 2% spray. A flexible nasopharyngoscope (Olympus, Los Angeles, Calif) was passed through the nose into the hypopharynx to visualize the true vocal folds. The fiberoptic laryngeal image was viewed on a television screen and recorded on videotape.

The cutaneous needle injection site was prepared with alcohol. The injection was given with a 2-mL syringe and a 1.5-in 27-gauge needle. The injected material was botulinum A toxin (Oculinum Inc, Berkeley, Calif) that was supplied as a freeze-dried residue of the toxin at a concentration of 50 ng per vial (140 U). The freeze-dried toxin was stored at -20°C and reconstituted with 0.9% saline at a concentration of 25 U/mL and used immediately.

The injection was given through the thyroid cartilage into the ipsilateral thyroarytenoid muscle unless the cartilage was ossified (see Figure, A). The needle was oriented at 90° to the skin of the neck and directed posteriorly in the sagittal plane. From the previously marked outline of the thyroid cartilage the approximate location of the anterior commissure of the vocal folds was estimated as midway between the thyroid notch and the bottom edge of the thyroid cartilage, in the midline.¹⁵ The needle was placed 5 mm lateral and 5 mm inferior to this point. No previous or concurrent injections of local anesthetic were required. The accuracy of needle placement is assured by pointing the needle, on the basis of anatomic landmarks, into the ipsilateral thyroarytenoid muscle. The correct depth of needle penetration is judged by sensing the depth at which the needle passes through the thyroid cartilage to permit easy injection of toxin. While the needle is within the cartilage, injection pressures are high because of the density of the cartilage matrix. With further penetration, the injection pressure becomes low as the needle enters the thyroarytenoid muscle. We have termed this method the point-touch technique. Adequate needle positioning is confirmed through the flexible nasopharyngoscope before injection. Initially, 5 U of toxin was injected bilaterally by the point-touch technique. However, 2 U is routinely given now in order to

INITIAL 13 PATIENTS TREATED BY PERCUTANEOUS BOTOX INJECTION USING POINT-TOUCH OR CRICOTHYROID TECHNIQUE

Patient No.	Length of Symptoms (y)	Previous Injection or Surgery	Dose and Technique	Vocal Fold Motion	Response Time (mo)	Prel/Post Glottic Resistance (cm H ₂ O per liter per second)	Prel/Post Jitter (%)	Adverse Reactions
1	2		5 U bilat PT	Normal	3	60/43		
2	7		5 U bilat PT	Bowing	5	69/32	3	Breathy for 2 wk
3	7		4 U bilat PT	Normal	3	80/42	2	
4	6	Botox	2 U bilat PT	Bowing	4	63/28		Breathy for 4 wk
5	7		15 U CT	L fold paresis	5	76/42	1	Breathy for 4 wk
6	10	R RLN section	4 U R fold, no response; 2 U L fold, PT 1 wk later	L fold normal	6	75/37		
7	5		2 U bilat PT	Normal	5	83/42		Breathy for 2 wk
8	6		2 U bilat PT	Normal	6	90/50		2 wk before improvement
9	5	Botox	2 U bilat PT	Normal	5			
10	6	Botox	1 U bilat PT	Normal	2			
11	5		2 U bilat PT	Normal	5	72/40	4	
12	10		15 U L fold CT	L fold paralysis	4	70/—		
13	10		2 U bilat PT	Bowing	4	84/40		Breathy for 3 wk

RLN — recurrent laryngeal nerve, PT — point-touch trans-thyroid cartilage technique, CT — cricothyroid membrane technique.

reduce the incidence of vocal fold bowing and breathiness.

If the thyroid cartilage could not be penetrated with the needle because of ossification, the injection was performed through the cricothyroid membrane (see Figure, B). In this case, the needle was placed just under the edge of the thyroid cartilage, approximately 1.5 cm from the midline, and directed superiorly, medially, and posteriorly. The proper depth of penetration and accuracy of needle placement into the ipsilateral thyroarytenoid muscle were monitored through the flexible nasopharyngoscope. Patients undergoing transcutaneous cricothyroid injection routinely receive 15 U into one vocal fold.

Subjects and Evaluation of Vocal Function. During the period April 1990 to October 1991, a total of 13 patients (5 men and 8 women) with a diagnosis of adductor spasmodic dysphonia underwent transcutaneous intrafold injection. The Table describes these 13 patients. The length of symptoms varied from 2 years to 10 years. Three of the 13 patients had undergone previous Botox injection with EMG control. One patient had previously undergone a right recurrent laryngeal nerve section. The usual dose for most patients was 2 U. Three patients developed vocal fold bowing after injection, and 2 patients after cricothyroid injection developed a fold paresis or

paralysis.

Each patient was evaluated by an otolaryngologist and a speech pathologist. Ten of the 13 patients had previously seen a neurologist. Their ages ranged from 32 to 74 years with a mean of 50 years. Eleven of 13 patients underwent preinjection vocal function evaluation consisting of laryngostroboscopy, acoustic analysis of sustained phonation, and laryngeal resistance estimation. In addition, a 1-minute speech monologue was recorded. Of these 13 patients, 4 had acoustic measurements both before and after Botox injection, consisting of jitter of the vowel /a/. Ten of the 13 patients underwent both preinjection and postinjection evaluation of laryngeal resistance by the technique described by Smitheran and Hixon¹⁶ with a modification: to reduce the chance that quick fluctuations in phonation influenced the results, we averaged the amplitude of the airflow signal over the steady-state, vocalic portion of the syllables, rather than measuring the amplitude of one point in the middle of the syllable.

For stroboscopic imaging of the larynx, a Bruel & Kjaer laryngostrobe unit (model 4914, Orange, Calif) was used. The stroboscope was connected to a Wolf 90° telescope via a fluid-filled light cable. The image was detected by a Toshiba CCD (charge-coupled device) video camera (Toshiba IK-C30A,

Buffalo Grove, Ill) and a Sony U-matic videocassette recorder (Sony, VO-9850, Teaneck, NJ).

RESULTS

Videostroboscopy and Jitter. The preinjection analysis of all 13 patients with adductor spasmodic dysphonia demonstrated complete glottic closure with episodes of glottic spasm and supraglottic overclosure during phonation. The true vocal folds had full symmetric abduction and adduction. All patients demonstrated frequent, intermittent periods of strained vocal quality with occasional episodes of aphonia interrupting speech fluency.

Response to the injection lasted from 2 months to 6 months. Perceptually, all 13 patients had an increase in speech fluency and were pleased with the result. Moreover, they have all returned for subsequent injections. The Table presents subject information and results after injection. Our findings indicate the 95% confidence interval of vocal tract resistance is 37 to 51 cm H₂O per liter per second for normally speaking men and 41 to 57 cm H₂O per liter per second for normally speaking women. (See similar normative results reported by Netsell et al.¹⁷) Although normative values for laryngeal resistance varied with sex and age, 10 of the 11 patients evaluated for laryngeal resistance demonstrated elevated laryngeal resistance before injection. Nine of these 10 subjects returned to the normal range 4 weeks after injection. The Table also compares the preinjection and postinjection percent jitter for 4 of the 13 injected patients. Three of the 4 patients had a decrease in jitter after injection. The one patient with an increase in jitter qualitatively demonstrated a breathy voice, although with increased fluency in continuous speech. The mean preinjection jitter for these 4 patients was 2.08%, compared to the postinjection value of 0.682%. There were no patients in this group with a posterior glottic chink leak during phonation after injection.

Complications. There were no airway complications or infectious complications from this method. All patients, immediately after injection, had a mild degree of true vocal fold edema that resolved. There were no cases of postinjection aspiration. The major adverse reaction included breathiness, lasting a maximum of 4 weeks in 5 of the 13 patients. One patient noted improvement 2 weeks after the injection, rather than the typical 36 hours.

DISCUSSION

The Botox injections paralyze the thyroarytenoid muscle by blocking the release of acetylcholine from the presynaptic nerve terminals of the recurrent laryn-

geal nerve. Using a canine model of laryngeal hyperadduction, Green and Berke¹⁸ have shown that hyperadduction can be reduced through selective thyroarytenoid muscle paralysis alone. The unilateral absence of thyroarytenoid contraction (despite a vocal fold in the adducted position) allowed the intraglottic and subglottic pressures to fall during phonation.

During their initial experience, Miller et al¹⁹ described two patients with unilateral vocal fold adductor paralysis after Botox injection of 20 and 30 U. This was thought to be due to migration of the toxin to the lateral cricoarytenoid muscle. The posterior cricoarytenoid muscle was not affected. Brin et al²⁰ noticed sluggish vocal fold motion with injection doses of 7.5 U. They were able to achieve selective thyroarytenoid muscle paralysis and reduce the degree of overall fold paralysis by injecting both folds with a reduced dose of 3.75 U. The point-touch technique presented in this report was also able to achieve selective thyroarytenoid muscle paralysis bilaterally with preservation of vocal fold adduction and abduction. It should be noticed that the three patients who had previously undergone Botox injection using EMG-guided injection underwent injection of the same number of units using the point-touch technique with the same effective response.

This study found subjective perceptual improvements in speech fluency in all patients after injection. Also, all patients evaluated before and after injection in this study showed improvement in laryngeal resistance with this technique. In one patient, the improvement in fluency was not accompanied by a decrease in jitter because of an increase in the breathiness of the patient's phonation after injection. This patient was pleased with the result despite the increase in jitter. This problem emphasizes the need to examine a wide variety of speech variables, including measures of continuous speech and pitch breaks, to more fully document patients' speech.

The optimal treatment for spasmodic dysphonia, like its fundamental cause, has yet to be found. Until more is known about the disorder, treatments will continue to be directed at the laryngeal symptoms it produces. Although Botox injections do improve the patient's ability to phonate, the improvement is not permanent. Reinjection is required every 3 to 6 months.

The advantages of the transcutaneous injection of Botox are as follows.

1. No EMG equipment or EMG technician is required.
2. The working distance is shorter than the transoral route.

3. Patients with a sensitive gag reflex or difficulty with full mouth opening can be injected.

The disadvantages are as follows:

1. The procedure requires a flexible nasopharyngoscope.
2. A second person is required to hold the nasopharyngoscope during injection.
3. In obese patients the external laryngeal landmarks may be difficult to locate.
4. Successful placement of the needle requires a working knowledge of the intralaryngeal position of the thyroarytenoid muscle as discerned from

external laryngeal landmarks.

Efforts have been made to obtain permanent selective bilateral paralysis of the thyroarytenoid muscle surgically. Carpenter et al²¹ divided the adductor branch of the recurrent laryngeal nerve in dogs and humans. This procedure was able to preserve the abductor movement of the vocal fold, but eliminated the adductor movement, as well as thyroarytenoid muscle contraction. This operation holds out the promise of a permanent selective denervation of the thyroarytenoid muscle. In the interim, the point-touch technique of Botox injection will allow patients with spasmodic dysphonia to be effectively treated by otolaryngologists within their own communities.

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