A comparison of methods of botulinum toxin injection for abductory spasmodic dysphonia

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Treatment of abductory spasmodic dysphonia with botulinum toxin injection into the posterior cricoarytenoid muscles often results in only partial symptom relief. In contrast, excellent results can be achieved after thyroarytenoid injection for the adductory type of spasmodic dysphonia. One reason for disappointing results may be inaccurate placement of the botulinum toxin into the posterior cricoarytenoid muscles. We describe a new approach to posterior cricoarytenoid injection used in 18 patients for treatment of abductory spasmodic dysphonia. Of the 30 patients treated for abductory spasmodic dysphonia at Loyola University–Chicago, 6 underwent both a retrocricoid approach and the newer transcricoid method, thus allowing patient and clinician comparison of techniques. We and all six of our patients preferred the transcricoid approach because of less discomfort, equivalent or better voice results, and fewer side effects. (Otolaryngol Head Neck Surg 1997;117:487-92.)

Spasmodic dysphonia (SD) results from a focal laryngeal dystonia of unknown origin, characterized by involuntary movements of the vocal folds causing breaks in speech fluency.[1] This disorder has been subdivided into adductory, abductory, or mixed variants.[2,3] The most common form is the adductory type, characterized by tight closure of the true vocal folds during phonation causing phonatory breaks and a strangled sound to the voice. The less common abductory type is typified by involuntary abduction of the vocal folds with sudden interruption of speech by low intensity and breathy, or whispered, voice segments.[4] The mixed form requires more intense classification because it may present with voice characteristics representative of both types. SD may be associated with other focal dystonias such as blepharospasm, torticollis, writer's cramp, or oromandibular dystonia (Meige's syndrome).[4,5]

Treatment options described for SD include voice therapy, recurrent laryngeal nerve transection, electrical stimulation of the recurrent laryngeal nerve, anterior laryngoplasty, and botulinum toxin injection.[6] Presently, most experts consider botulinum toxin injection to be the therapy of choice for patients with SD, especially the adductory form, with reported voice recovery to an average of 90% of normal function in response to each injection.[6] However, botulinum toxin therapy for the abductory and mixed forms of this disorder is less successful, with average voice improvement to 70% of normal function.[1] Inconsistent results may also be seen after treatment of these latter two forms and may be partially attributable to technical difficulty in accurately localizing and injecting botulinum toxin into the posterior cricoarytenoid (PCA) muscles.

Approaches to the PCA muscles for botulinum toxin injection previously reported include either anterior supracricoid or lateral retrocricoid routes. Rontal et al.[7] describe anterior supracricoid placement of an electromyography (EMG) needle under flexible transnasal laryngoscopic surveillance. The needle is directed percutaneously through the cricothyroid membrane and then posterior and superior along the superior border of the posterior cricoid lamina and between the arytenoid cartilages. Injection of the botulinum toxin is not directly into the PCA, but rather above the muscle, requiring diffusion of the toxin into the muscle for therapeutic effect.

Blitzer et al.[1] describe rotation of the larynx away

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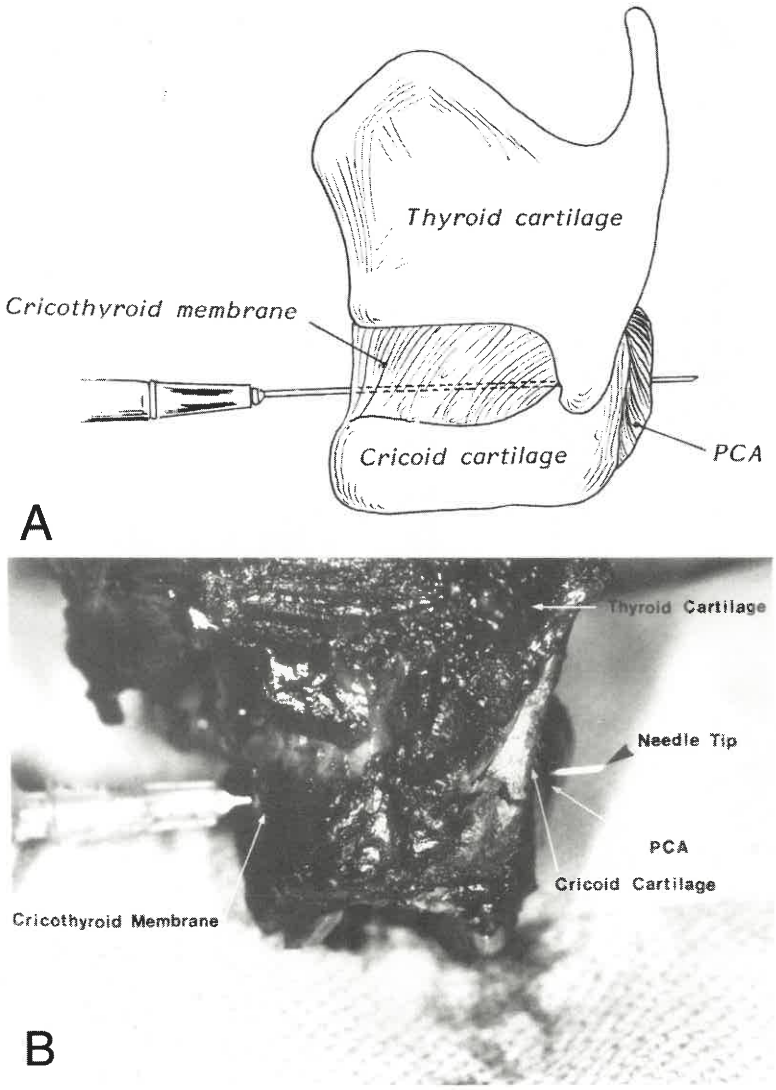

Fig. 1. Lateral view of larynx **(A)** and total laryngectomy specimen **(B)** demonstrating the injection needle directed through the cricothyroid membrane, 15 to 20 degrees superiorly toward the posterior lamina of the cricoid cartilage and finally into the PCA muscle. The needle tip is shown protruding through the PCA muscle, instead of within it, for clarification of proper needle trajectory.

from the injection site, then percutaneous placement of the EMG needle lateral to the larynx along the posterior and inferior border of the thyroid cartilage, and finally into the PCA muscle. This lateral retrocricoid technique is currently the most popular approach for botulinum toxin injection of the PCA muscle. However, despite extensive experience with this particular method, from 1990 until adopting the new method reported here in 1993, consistently accurate localization seemed difficult to achieve by the senior author (R. W. B.). In addition, it was often noted that patients had considerable discomfort from both laryngeal manipulation and needle placement.

In April 1993 a patient with newly diagnosed disease could not be injected at Loyola University Medical Center by this lateral retrocricoid technique, despite protracted attempts, because of her small, poorly mobile larynx and unusually large sternomastoid muscles. Of necessity, a plan was devised to pass the needle through the cricothyroid membrane, across the lumen, through the posterior cricoid lamina, and into the PCA muscle. Because of the surprising simplicity, effective-

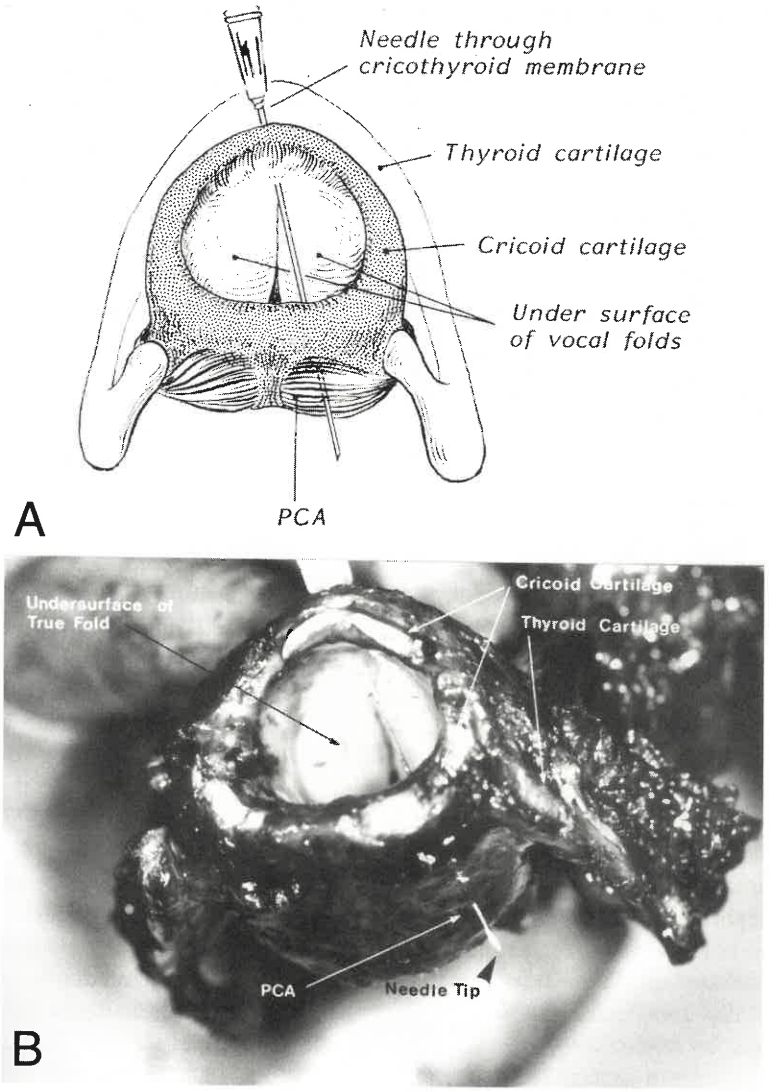

Fig. 2. Inferior view of the undersurface of the true vocal folds in schematic form **(A)** and in a total laryngectomy specimen **(B)** demonstrating the injection needle directed through the cricothyroid membrane, 30 degrees laterally through the posterior cricoid lamina, and into the PCA muscle. The needle tip is shown protruding through the PCA muscle, instead of within it, for clarification of proper needle trajectory.

ness, and relative painlessness of this first transcricoid injection, as compared with the lateral retrocricoid technique, it immediately became the senior author's exclusive method of PCA muscle injection.

METHODS

Patients

From 1990 to 1995, 30 patients with voice characteristics consistent with the diagnosis of abductory SD were treated with botulinum toxin injection to the PCA muscles by the senior author at Loyola University Medical Center in Chicago. From April 1993 to January 1995, 18 patients were treated by only a transcricoid approach to the PCA muscles (55 sittings, 108 individual PCA muscles injected). Of these 18 patients, 8 were treated before April 1993 with the lateral retrocricoid approach to the PCA muscles. All 8 were subsequently injected by the transcricoid approach, allowing for patient and clinician comparison of the two techniques. Most of these patients had undergone more than one injection by each method. Two of 8 patients were not

Table 1. Patient profile summary comparing the lateral retrocricoid and transcricoid injection techniques

Patient no.	Sex	Age (yr)	Which method provided better voice?	Discomfort scale (1-5) RC	Discomfort scale (1-5) TC	Which method produced more discomfort?	Injection technique preferred by the patient	Overall satisfaction scale with either technique (1-7)
1	F	61	Same	4.5	1.0	RC	TC	5.5
2	F	32	TC	3.0	1.5	Same	TC	6.5
3	M	21	Same	5.0	1.0	RC	TC	5.0
4	M	42	Same	4.0	2.0	RC	TC	5.5
5	M	52	TC	3.0	2.0	RC	TC	5.5
6	F	47	Same	3.0	3.0	Same	TC	7.0
Mean	—	43	—	3.75	1.75	—	—	5.83

The discomfort scale ranges from 1-5: 1, minimal discomfort; and 5, extreme discomfort. The overall benefit scale, regardless of injection technique used ranges from 1-7: 1, very dissatisfied; 4, neutral; and 7, very satisfied.
RC, Lateral retrocricoid injection technique; *TC,* transcricoid injection technique.

available for study or questioning at the time of this writing because 1 had cognitive deficits and therefore could not be effectively interviewed, and another was lost to follow-up. The study group thus consisted of 3 male and 3 female patients ranging in age from 21 to 61 years (mean, 43 years). The duration of symptoms ranged from 2 to 5 years (mean, 3.2 years).

Injection Technique

With the patient in a sitting position and the neck extended, the cricothyroid membrane was palpated. The skin over the cricothyroid membrane was anesthetized with approximately 0.2 ml of 2% lidocaine with 1:100,000 epinephrine. The needle was then passed through the cricothyroid membrane and into the subglottic airway. Approximately 2 ml of Xylocaine was instilled to topically anesthetize the subglottic mucosa. While waiting a few minutes for mucosal anesthesia to occur, electromyogram ground and reference electrodes were connected to the patient. The active electrode was a 2-inch, Teflon-coated, 27-gauge, hollow EMG needle (Allergan Inc., Berkeley, Calif.) attached to a tuberculin syringe containing botulinum toxin A. The needle was inserted directly posteriorly through the cricothyroid membrane (Figs. 1 and 2). After the laryngeal lumen was entered, the needle was directed 30 degrees laterally and approximately 15 degrees superiorly toward the posterior cricoid lamina. It was then passed through the cricoid cartilage and into the PCA muscle immediately behind the cartilage. Infrequently, if the cartilage was partially ossified, a slight change of entry point allowed for better penetration of the lamina. EMG documentation of increased activity when the patient was asked to sniff ensured that the needle was accurately placed into the PCA muscle. Botulinum toxin was injected into the muscle. The needle tip was then withdrawn into the laryngeal lumen, and injection of the opposite PCA muscle was performed by the same technique. The botulinum toxin dosage varied according to the patient. Typically, 1.25 to 1.7 units were injected on one side, and 0.9 units were injected on the opposite side. Although not required for any of the patients reported here, this procedure can be performed with transnasal flexible endoscopy to visualize needle vector, with simultaneous use of EMG monitoring to ensure accurate botulinum toxin placement within the muscle.

Questionnaire

A telephone survey was conducted to obtain a global assessment of the two injection methods with regard to voice improvement, injection technique discomfort, side effects, and overall degree of satisfaction (Table 1). Voice change after Botox injection was rated by patients as either the same, better, or worse. A discomfort scale of 1 to 5 was also used: 1, minimal discomfort; and 5, extreme discomfort. Typical discomforts evaluated included pressure applied to the larynx during the maneuver, pain from the needle itself, and coughing. In addition, side effects such as hematoma, neck discomfort, dysphagia, infection, and breathing difficulties were sought for each technique. For each injection technique, overall satisfaction with voice result was graded by patients from 1 to 7: 1, very dissatisfied; 4, neutral; and 7, very satisfied.

RESULTS

All six patients preferred the transcricoid approach to the PCA muscles (Table 1). Two of six patients believed their voices were better with the transcricoid approach, and four of six had similar voice improvement with either technique. Patients undergoing the transcricoid approach had less discomfort (mean score, 1.75 out of 5) compared with the lateral retrocricoid

approach (mean score, 3.75 out of 5). Four of six patients reported more side effects with the lateral retrocricoid approach, including subcutaneous hematoma formation and increased postinjection neck discomfort. Two of six patients believed that side effects were the same for both procedures. No dysphagia, infection, or significant breathing difficulties were reported with either technique. Overall satisfaction with results of PCA muscle injections, regardless of technique, ranged from 5 to 7 (mean, 5.83 out of 7). It should be noted that the senior author preferred the transcricoid approach because it was technically easier, faster to perform, and perceptibly less stressful to the patient.

DISCUSSION

Botulinum toxin injection for treatment of adductory SD routinely results in dramatic benefit. Results of treatment for abductory SD, however, have been less uniformly satisfying. The explanation for this difference may relate partly to the difficulty in accurate injection of the botulinum toxin into the PCA muscles with the usual lateral retrocricoid technique and partly to dose limitations because of concern for potential airway compromise.

Rontal et al.[7] describe an anterior supracricoid approach to the PCA muscles. This technique relies on diffusion of the toxin into the PCA muscles from an injection site superior to the muscle belly, rather than by direct injection into the muscle. Some clinicians may find this reliance on diffusion objectionable. Furthermore, inadvertent injection of the interarytenoid muscle may occur with this method, resulting in marked breathiness and aspiration. On the other hand, the lateral retrocricoid approach described by Blitzer et al.[1] can be technically difficult and accordingly may not reliably result in accurate placement of the EMG needle into the PCA muscles because of the multiplicity of other muscles in the region. Furthermore, the technique requires considerable manual displacement of the larynx, which may cause significant patient discomfort.

The paired, symmetrically positioned PCA muscles are fan-shaped structures originating near the posterior midline of the cricoid lamina, where the muscle is broadest in dimension. The muscle tapers and becomes thicker as it passes superiorly and laterally to insert on the muscular process of the arytenoid cartilage.[8,9] Retrospectively, we discovered that Mu and Yang[10] used this anatomic relationship and described a transcricoid electromyographic technique for the PCA muscle. They applied this method to more than 1200 patients with no adverse effects such as hematoma formation or infection. Although this group reported no complications, all methods (retrocricoid, supracricoid, and transcricoid) could potentially cause cricoarytenoid joint dysfunction if the needle were to inadvertently enter the joint capsule. In fact, Rontal et al.[7] described one patient in whom moderate-to-severe breathiness developed because of "cricoarytenoid arthritis" after supracricoid PCA muscle injection. A technique combining transnasal fiberoptic visualization of needle placement with EMG monitoring can be used by those concerned about this possibility.

Severe airway distress developed soon after injection in one recent patient not included in this study. Treatment required tracheotomy. This is a complication that may occur equally with any of the three methods reported to date, provided both PCA muscles are injected. It should be noted that transient and clinically insignificant airway restriction after injection is an expected and desired side effect to some degree, regardless of methodology. Typically, patients sense less transient airway restriction with each subsequent injection procedure.

Patient perceptions and preferences concerning efficacy and discomfort are subjective. Nevertheless, these kinds of data are highly valued and commonly used in the clinical arena. All six patients who underwent both lateral retrocricoid and transcricoid approaches to the PCA muscles perceived equal or greater benefit from the transcricoid technique. All six also clearly preferred the transcricoid approach primarily because of decreased discomfort during the procedure and fewer needle-related side effects. Given these patient perceptions and preferences and the parallel observations of the senior author, the transcricoid approach to the PCA muscles for treatment of abductory SD appears to have several advantages when compared with the more commonly used lateral retrocricoid technique: (1) it is simpler technically, (2) it appears to allow more accurate placement of the needle into the PCA, (3) equivalent or better voice results are obtained, (4) patients have less discomfort, and (5) no adverse reactions such as excessive postinjection discomfort, dysphagia, hematoma, or infection have occurred. As noted above, severe airway distress developed soon after injection in one recent patient not included in this study. This complication can occur with any of the methods reported to date, provided both PCA muscles are injected.

CONCLUSION

Botulinum toxin injection into the PCA muscles for abductory SD is typically less effective than similar injections into the thyroarytenoid muscles for adducto-

ry SD. One of several possible reasons for this discrepancy may be the technical difficulty in accurately targeting the PCA muscles with the more commonly used lateral retrocricoid technique of injection. The alternate transcricoid injection method reported here for treatment of abductory SD appears to be preferred by patients. It is also preferred by the authors because, by comparison with the lateral retrocricoid approach, it is relatively simple to perform, is well tolerated, and provides accurate localization of the PCA muscles for injection.

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