Abductor Laryngeal Dystonia: A Series Treated With Botulinum Toxin

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Abductor laryngeal dystonia (LD) is characterized by a hoarse voice quality which is broken up by breathy or whispered portions. Botulinum toxin injection (Botox) has been a safe and effective treatment for adductor laryngeal dystonia and is currently accepted medical therapy. As an extension of the established treatment program, in 1989 treatment of abductor LD was initiated. Thirty-two patients have been treated by sequential percutaneous electromyogram-guided (EMG) injections of the posterior cricoarytenoid (PCA) muscles. Most patients required treatment of both PCA muscles and improved to an average of 70% of normal voice. Patients who had a preexisting tremor, evidence of dystonia in other muscle groups, vocal tremor, or respiratory dysrhythmia had less improvement. Ten patients also required injection of the cricothyroid muscles and/or type I laryngoplasty.

INTRODUCTION

Laryngeal dystonia (LD) or spasmodic dysphonia is a speech disorder characterized by breaks in speech fluency.[1,2] Aronson and Hartman[3,4] have identified two subtypes. The adductor type is due to irregular hyperadduction of the vocal folds resulting in a choked, strain-strangle voice quality with abrupt initiation and termination of voicing resulting in short breaks in phonation and effortful speech. The abductor type is due to intermittent abduction of the vocal folds resulting in a reduction of loudness and aphonic whispered segments of speech. Aronson's description is "a voice in which normal or hoarse voice is suddenly interrupted by brief moments of breathy or whispered (unphonated) segments."[3] The voice disorder may begin as a nonspecific hoarseness or breathiness and over a period of days or weeks begin to show signs of intermittent breathy breaks.

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Some patients have a mixed abductor-adductor type with a mixture of breathy breaks and tight, harsh sounds.[3] Connito and Johnson[5] proposed that both conditions exist in all patients and symptoms depend on whether there is more adductor or abductor activity.

Disability from abductor LD may be profound. Telephone calls and stress typically exacerbate the disorder making the speech pattern more unintelligible.[1,3] Speech therapy, psychotherapy, and relaxation therapy may temporarily help to moderate the symptoms but provide little if any long-term benefit. Pharmacotherapy provides little for the long-term relief of symptoms. Early benefits have been reported in some patients with anticholinergics,[1] but the early success was not maintained.

Fiberoptic laryngoscopy[6,7] reveals "a synchronous and untimely abduction of the true vocal folds exposing an extremely wide glottic chink."[3] These spasms are triggered by consonant sounds, particularly when they are in the initial position in words. Patients usually are worse under stress or on the telephone and often have a normal laugh, normal yawn, normal humming, and, occasionally, normal singing.[1,8]

Several groups have reported impressive success in the treatment of adductor laryngeal dystonia with localized injections of Botox into the thyroarytenoid muscle(s).[1,8–13] In recent reports of 200 patients,[8,13] patients recovered to an average of 90% of normal function. The injections could be given comfortably via a percutaneous route in an ambulatory setting. The side effects from such injections were minimal. The injections lasted an average of 4 months.

From an understanding of the anatomy and physiology of the larynx, it was believed that successful treatment of abductor LD required effective weakening of the PCA muscles, thereby reducing the abductor spasms. Although initially reluctant to treat the PCA muscle with Botox because of concern of airway compromise, a severely disabled patient urged treatment of his symptoms, even if it ultimately required a tracheostomy. The evolution of this technique and the results of treating 32 patients over the past 2⅓ years are reviewed in this paper.

TABLE I.
Characteristics of Patients With Abductor Laryngeal Dystonia: Treatment With Botox (N = 32).

21 Male (66%)
11 Female (34%)
(50/50 in adductor)
Mean age of onset: 39.8 (range 5-76)(38.8 in adductor)

TABLE II.
Characteristics of Patients With Abductor Laryngeal Dystonia: Treatment With Botox.

Average initial percentage of function: 31% (Range 5%–85%)
Average best postinjection of function: 70% (Range 40%–95%)
Average percentage of improvement: 39% (Range 5%–85%)

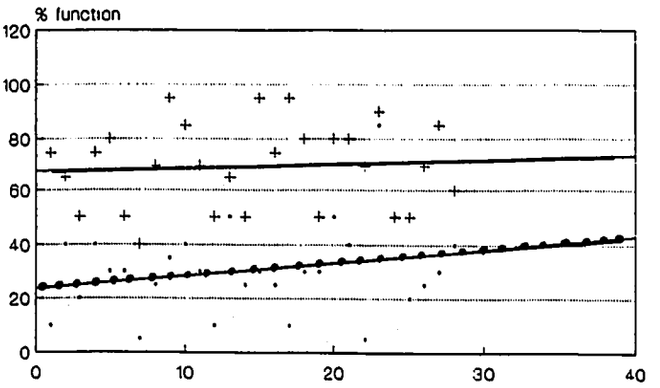

Fig. 1. Percentage of normal function for patients with abductor laryngeal dystonia. Series A (pretreatment) = ——— ; series B (after Botox) = ———.

PATIENTS AND METHODS

For this study, patients at the Dystonia Clinical Research Center of the Columbia-Presbyterian Medical Center who had voice characteristics consistent with the diagnosis of abductor spasmodic dysphonia were invited to participate. Prior to Botox injection, all patients underwent comprehensive neurological, otolaryngological, and speech-language assessments. All patients signed informed consent forms.

Botulinum type A toxin was obtained from Oculinum Inc. (Irvine, Calif.) Frozen lyophilized toxin was reconstituted with normal saline (without preservative) to a final concentration of 25 U/mL.

After receiving approval from the Institutional Review Board, an initial injection attempt was via a direct laryngoscopy approach whereby one PCA muscle was injected directly through the laryngoscope. This attempt proved difficult for the patient; it had no EMG control and no benefit. Therefore, an EMG-guided percutaneous technique was developed. The larynx was manually rotated, and the Teflon-coated hollow EMG recording needle was placed posterior to the thyroid lamina until reaching the cricoid cartilage, directly impaling the PCA. The patient was asked to sniff which yielded maximum abduction. The EMG signal was observed for correct needle placement, and the Botox injection was given when the needle was in an area of brisk electrical activity.

Initially, an attempt was made to weaken or paralyze one PCA muscle with an injection of 3.75 U in 0.15 mL. After 1 to 2 weeks, fiberoptic laryngoscopy was performed to observe vocal cord function. For some patients, weakening or paralyzing just one PCA produced significant voice improvement. Most required additional toxin injections. For those who still had abduction in the vocal cord, an additional 2.5 to 3.75 U was given to paralyze the PCA. If the PCA was already paralyzed, and the voice was not improved, conservative serial doses of .675 to 2.5 U in 0.1 mL were given into the contralateral PCA. No further injections were given if there had been stridor or if the glottic chink had been significantly narrowed. If both PCAs had been treated, weakening both PCAs and narrowing the glottic chink, and the voice was still breathy or had significant tremor, 2.5 U in 0.1 mL of Botox was given into the cricothyroid muscle. Three additional patients had a combination of Botox injections of the PCA and type I thyroplasty.

The results of the injections were scored several ways. One score uses a subjective rating scale which has been used since 1984 with adductor LD patients. Patients, doctors, and speech pathologists independently score the patients' voice. Videotapes of patients reading standard passages are also made on each visit. The most conservative rating is used as the percentage of normal function, where 0 = no phonation and 100 = normal.[1,8,13]

In addition, the Unified Spasmodic Dysphonia Rating Scale, which is being validated in a multi-institution study, has been used. Fifteen items are rated in a 1 to 7 scale from 1 = normal to 7 = very severe; where 2 = mild, 3 = mild/moderate, 4 = moderate, 5 = moderate/severe, and 6 = severe. The most significant items for the abductor LD patients are the overall severity, breathy voice quality, aphonia, and tremor. These parameters are defined as follows:

1. Overall severity: Examiner's estimation of the extent to which overall speech is unusual, peculiar, or bizarre.[14]

2. Breathy voice quality: Is the voice breathy, weak, and thin? Is there an audible escape of air resulting in thin, weak phonation, which is related to a functional inability to firmly adduct the vocal folds?[15]

3. Aphonia: An absence of a definable laryngeal tone; the voice is either severely breathy or whispered.[3]

4. Voice tremor: Is the voice tremulous or tremorous?[14] Are there rapidly occurring fluctuations in pitch and/or loudness, giving an impression of a tremulous voice?[15]

RESULTS

Thirty-two patients with abductor laryngeal dystonia were treated with Botox; they consisted of 21 (66%) men and 11 (34%) women. They ranged in age at the onset of their disease from 5 to 76 with a mean age of 39.8. There were 11 (34%) Jewish and 21 (66%) non-Jewish patients. The adductor LD patients from previous studies are 50% men and 50% women with a mean age at onset of 38.8 years. There are 23% Jewish and 77% non-Jewish in a large series of adductor LD (Table I).

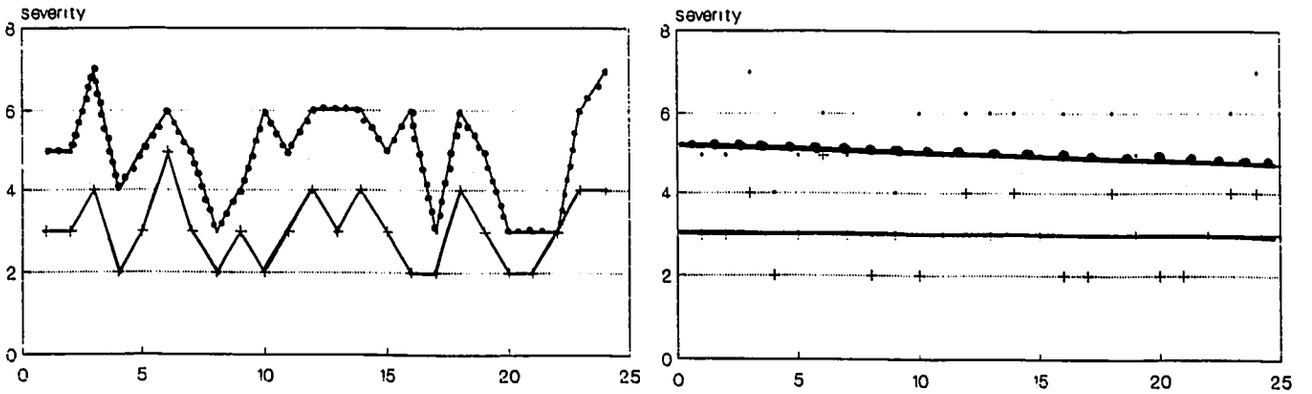

Fig. 2. Overall severity of adbuctor laryngeal dystonia plotted for each patient. Right—same information as left in a linear plot to demonstrate the average improvement. Series A (pretreatment) = ——— ; series B (after Botox) = ———.

Of the group of 32 patients, 6 patients had only one PCA muscle injected. This group started with an initial average percentage function of 46.6% as compared to 31% for the entire group. (Tables II, III). Nine patients had both cricothyroid muscles injected as well as both PCAs. These were in patients who, despite significant limitation of abduction, still had breathy breaks or tremor. Three patients had a unilateral type I thyroplasty in addition to the Botox injection to prevent significant abduction. This combination brought these patients to a best average percentage of normal function of 82% with an average improvement of percentage function of 52%.

Using the functional rating scale, the entire group of patients started with an average initial function of 31% (range 5% to 85%). The average best post-treatment function was 70% (range 40% to 95%). The average percentage of improvement was 39% (range 5% to 85%) (Fig. 1).

When this group of patients is analyzed further, most had only focal laryngeal abductor spasms, but eight had tremor, five had segmental cranial or axial dystonic involvement, and three had combined tremor, and segmental and/or respiratory involvement. The highest percentage of improvement was found in the focal group with an average of 42.3% improvement and the segmental cranial group with 38%. The worst percentage of improvement was found in the group with combined dystonic abnormalities, with only a 30% improvement (Table III).

Using the standardized rating scale, the average pretreatment overall severity was 5 with an average post-treatment overall severity of 3; the average pretreatment aphonia was 3.2 with an average post-treatment aphonia of 1.8; the average pretreatment breathy voice quality was 4.5 with an average post-treatment of 1.8; and the average pretreatment tremor was 2.2 with an average post-treatment of 2.0.

TABLE III.
Treatment Results of Patients With Abductor Laryngeal Dystonia.

	Initial (%)	Best Avg. (%)	Improvement (%)
1. Focal	27.6	70	42.4
2. Tremor	30	65	35
3. Combined dystonia and tremor	28.3	58	30
4. All patients	31	70	39

The pretreatment and post-treatment overall severity, aphonia, and breathy voice quality, when graphed, show an improvement in almost all of the cases (Figs. 2–4). Figure 5 shows the average pretreatment and post-treatment tremor when graphed. Notice that several of the patients were worse after treatment. This is probably due to an underlying unvoiced tremor that becomes more apparent when there is increased phonatory ability.

The adverse experiences have included two patients with exertional wheezing/stridor when going up stairs or jogging and two patients with dysphagia. The dysphagia is probably related to some toxin leakage diffusing into the inferior constrictor muscle. These side effects have been transient, typically resolving within 1 week.

DISCUSSION

This current technique of Botox injection into the PCA muscle was developed to allow for percutaneous EMG control for accurate needle placement. Using this technique, 32 patients with varying severity in their condition were treated. Six patients (19%) required only one PCA muscle to be injected for a marked improvement of symptoms. In general, they had less severe pretreatment symptoms, averaging an initial 46.6% of normal functions (as compared to 31% for the entire group). The remainder of the patients received bilateral injections. These patients achieved an overall improvement to 70% of normal function. In reviewing the graphs of data from the standardized vocal rating scale (Figs. 2–4), an improvement was seen in all cases when evaluated for overall rating, breathy voice quality, and aphonia. Several of the

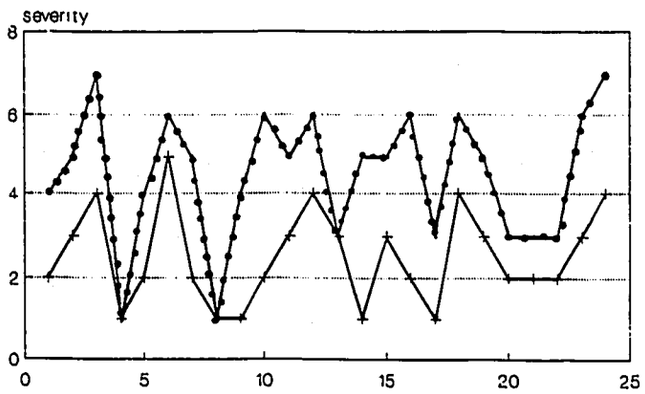

Fig. 3. Breathy voice quality in abductor laryngeal dystonia. Series A (pretreatment) = ⟵⟵ ; series B (after Botox) = ———.

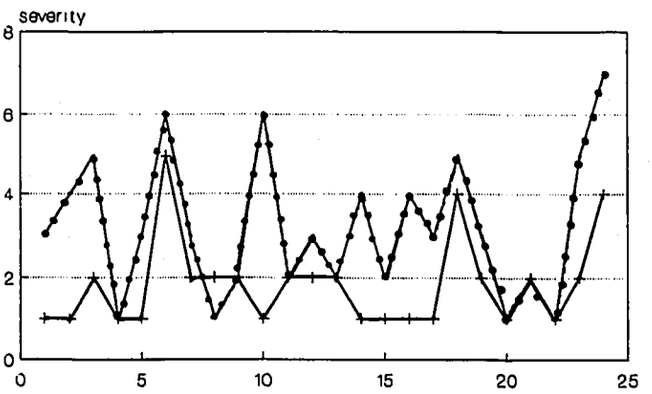

Fig. 4. Aphonia in abductor laryngeal dystonia. Series A (pretreatment) = ⟵⟵ ; series B (after Botox) = ———.

patients had a worsening of their tremor after treatment (Fig. 5). The reason for this may be that the tremor existed prior to therapy but was visual and not voiced, and as phonation improved with the PCA weakening, the tremor became audible, and the quality of speech was improved but still disabling in some cases. Other patients had a pretreatment tremor which was exacerbated after treatment.

Some patients did not do as well as others. In reviewing the data, those who had more extensive disease such as segmental cranial or axial involvement, and/or tremor, and/or respiratory involvement had only a best average improvement to 58% of normal function. Those with tremor had an improvement to 65% of normal function. Many of the patients in these groups required additional treatment.

Nine patients had bilateral cricothyroid injections in addition to the PCA injections. This addition led to a best percentage of function of 64%. These injections were based on work reported by Ludlow, *et al.*[16] They reported hyperactivity of the cricothyroid (CT) muscles in patients with abductor spastic dysphonia. Ten patients in their series were found to have EMG bursts of the CT during voice breaks on speaking. They therefore postulated that these patients would benefit from Botox injection of the CT. Their patients received bilateral CT injections of 5 to 10 U/side. When they performed the spectrographic analysis of speech rate, the percentage periodicity, and the length of voiceless consonants, the patients all improved. This treatment was not helpful in patients with activation abnormalities only in the PCA muscle.

In this series, three patients had type I thyroplasties. This was based on the experience of one patient who was totally aphonic before therapy. Prior to Botox injections for abductor dysphonia, he was offered a type I thyroplasty in the belief that this would prevent a wide-open glottic chink on speaking and allow him to have some voicing. He had an initial success after surgery to about 70% of normal function. With time, however, his voice quality deteriorated. The vocal cord appeared normal on laryngoscopy. It was postulated that the PCA became stronger with the isometric contraction against the implant. With increasing strength, the breathiness became worse. Then both PCAs were injected with small amounts of toxin, and an allowance for an improvement to 80% of normal function was made. With this knowledge, two additional patients who had limited benefit from bilateral PCA and CT injections underwent unilateral type I thyroplasty. Both patients had considerable improvement with this combination; there was an overall improvement to 81% of normal function in the three patients.

Since there is a variable response to toxin, the patients were carefully observed for clues to predict their response to therapy. Certain preinjection factors were found which led to a better or worse result. Therefore, a staging system was devised for abductor LD patients (Table IV), where stage 1 represents those patients with focal symptoms; stage 2 patients have segmental cranial or axial involvement; stage 3 patients have a tremor; and stage 4 patients have a tremor with segmental axial/cranial and/or respiratory dyssynchrony. This staging system will prospectively be evaluated as to whether it will predict a response to therapy.

CONCLUSION

It has been found that the abductor LD can be safely and effectively treated with either unilateral or bilateral posterior cricoarytenoid Botox injections

TABLE IV.
Abductor Laryngeal Dystonia Staging System.

Stage I	Focal disease
Stage II	Segmental cranial or axial
Stage III	Tremor
Stage IV	Tremor with segmental dystonia and/or respiratory dysynchrony

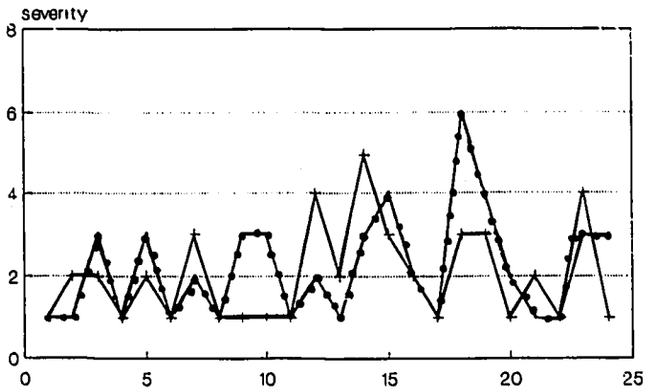

Fig. 5. Tremor in abductor laryngeal dystonia. Series A (pretreatment) = ⟶ ; series B (after Botox) = ———.

using a percutaneous technique. In this series of 32 patients, the average improvement was to 70% of normal function. Several patients also benefited from cricothyroid injections and/or type I thyroplasty to maximize the benefit. Pretreatment signs of tremor, and/or multifocal dystonic involvement, and/or respiratory involvement usually denoted a poorer functional result and/or a more extensive treatment course. Only mild, transient stridor upon exertion or dysphagia was noted in a few patients.

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DISCUSSION

ROBERT MILLER, MD, New Orleans: Dr. Blitzer's paper was interesting and very well done, as usual. And Dr. Blitzer's group probably has the largest experience with the use of botulinum toxin in both adductor and even the more unusual less common abductor spasmodic dysphonia. The documentation was by a subjective scale which I know Dr. Blitzer and his group have been very active in developing, but I would also suggest that we consider analyzing some of this data with objective measures as well.

Lastly, the comment I would like to make is that botulinum toxin is now available to everyone. It's been approved by the Federal Drug Administration for use in ocular pathologies and other ocular conditions. It has not been approved by the FDA for spasmodic dysphonia, but it is available to everybody.

I would encourage anyone interested in using botulinum toxin for spasmodic dysphonia to avoid what has been done with functional endoscopic sinus surgery. This is a very unusual condition and much more needs to be learned about spasmodic dysphonia, as well as the role of botulinum toxin in the treatment of this disease. For example, we don't know what the proper dosage is, we don't know whether it's better to inject unilaterally or bilaterally, nor do we know the proper route of administration, whether it's percutaneous with EMG control or whether it should be done by direct laryngoscopy.

I would encourage those who have an interest in neurolaryngology and an interest in using botulinum toxin to work with others so that we can all learn something from a study of this disease and this treatment.