# LINGUAL PROTRUSION AND ELEVATION IN LINGUAL DYSTONIA: A HYPOTHESIS

**Allyson D. Dykstra, M.Sc.[1], Scott G. Adams, Ph.D.[2], and Mandar Jog, M.D.[3]**
[1]Doctoral Program in Rehabilitation Sciences, [2]School of Communication Sciences and Disorders,
[3]Department of Clinical Neurosciences
University of Western Ontario, London, Ontario Canada

## INTRODUCTION

Dystonia is a neurological movement disorder characterized by sustained or tonic muscle contractions that can result in abnormal posturing and positioning of specific body regions. These tonic muscle contractions frequently are associated with abnormal and sometimes painful posturing and positioning, twisting and repetitive movements (Duffy, 1995; Fahn, Marsden & Calne, 1987). When dystonia affects the tongue it is known as lingual dystonia. Lingual dystonia, a hyperkinetic dysarthria, is characterized by abnormal contractions of the intrinsic or extrinsic muscles of the tongue that result in sustained tongue postures. In severe cases, lingual dystonia can have devastating effects on speech production and intelligibility.

There is no cure for lingual dystonia or any dystonia. The principle goals of therapy focus on reducing abnormal postures of the tongue, improving orofacial aesthetics, and ultimately restoring functional speech, masticatory and swallowing capabilities. One contemporary management technique that has produced generally favourable results is Botulinum toxin type A (BtA) injections to the intrinsic and/or extrinsic muscles of the tongue (Blitzer, Brin & Fahn, 1991; Charles, Davis, Shannon, Hook & Warner, 1997; Dykstra, Adams & Jog, 2004). Side effects of BtA are usually well tolerated but can include mild dysarthria, difficulty chewing, and mild dysphagia (Goldman & Comella, 2003; Munchau & Bhatia, 2000).

In 1969, Darley, Aronson and Brown studied 30 patients with hyperkinetic dysarthria associated with dystonia. These researchers established the most deviant speech dimensions of dystonia from most to least severe to be imprecise consonant articulation, vowel distortion, harsh voice, irregular articulatory breakdown, strained-strangled voice quality, monopitch and monoloudness. Speech rate in dystonia also was found to be generally slow, with abnormal direction and rhythm of movement. It should be noted, however, that Darley, Aronson and Brown's 30 subjects with dystonia included individuals with oromandibular dystonia (OMD) and individuals with spasmodic dysphonia.

In a study examining the speech characteristics of patients with Meige's syndrome (OMD and blepharospasm), Golper, Nutt, Rau and Coleman (1983) described one patient with severe lingual dystonia and a severe speech intelligibility deficit as having difficulty with forward tongue postures. As an example, the vowel /a/ was fronted, raised and diphthongized to become /aI/. A similar fronting of lingual fricatives was noted in Dykstra, Adams and Jog's (2004) acoustic and perceptual study of lingual dystonia.

Intelligibility deficits were associated with palatal fricatives being perceived as more fronted alveolar fricatives (i.e. /ʃ →s/. These phonetic errors were clearly associated with a corresponding abnormal increase in the frequency of the fricative spectra. An informal review of published audio and videotaped samples of OMD (Darley, Aronson & Brown, 1975; Klawans, Goetz & Tanner, 1988) suggests that abnormal lingual protrusion or fronting and lingual elevation or raising are fairly common sources of imprecise consonants, vowel distortions and intelligibility deficits in subjects with OMD. For example, two OMD patients in the Darley, Aronson and Brown audiotapes (#10 and #11) show very clear fronting and raising during connected speech and also during prolonged vowels (i.e. shift from /a → i/ or /a → æ/) and syllable repetitions (i.e. tʌ tʌ→ tI tI).

The nature of dystonic lingual contractions is poorly understood and described in the literature. The purpose of this paper is to examine and describe the speech deficits associated with lingual dystonia using acoustic analyses. It will be proposed that the most common features of lingual dystonic contractions involve lingual protrusion and lingual elevation during speech production. Evidence from a case study of lingual dystonia is presented to support this hypothesis.

## 2. METHOD

Retrospective acoustic analyses of a previously published case study of lingual dystonia (see Dykstra et al., 2004) was undertaken to determine and describe the nature of lingual dystonic contractions. This case-study involved an examination of the effect of BtA injections to the intrinsic muscles of the tongue on speech intelligibility. In the present investigation, acoustic analyses focusing on lingual-fricative spectra was conducted using spectrographic displays produced by the Time Frequency Response (TFR) software program (Avaaz, 1999) to investigate the hypothesis of abnormal lingual fronting and elevation.

## 3. RESULTS

Acoustic and phonetic analyses of this case suggest that lingual fronting and elevation are predominate features during lingual dystonic contractions. A prominent phonetic

error was the misperception of the palatal fricative / ʃ / for the alveolar fricative /s/. Upon examination of these fricatives acoustically, the frequency of / ʃ / was elevated (6639 Hertz (Hz)) relative to a normal range of above 3000 Hz (Kent, 1997). The increased frequency of / ʃ / likely caused an incorrect perception of / ʃ / as /s/ in the pre-treatment condition. Following treatment, the frequency of / ʃ / approached a normal range and decreased to approximately 4300 Hz. The decrease in the frequency of / ʃ / was reflected in the correct perception of the /s—ʃ/ contrast post-BtA treatment (Figure 1).

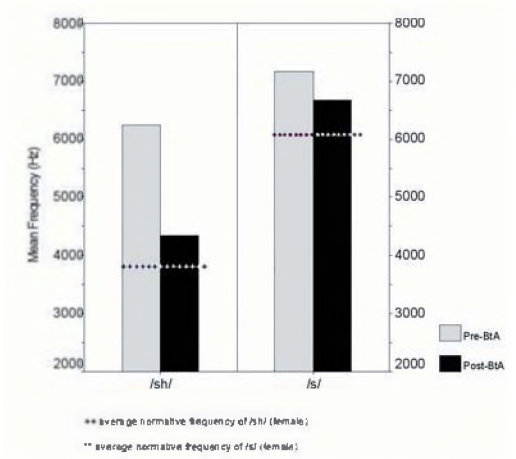


Fig. 1. Mean Frequency of fricatives /s/ and / ʃ / - Pre and Post BtA Treatment.

Another prominent phonetic error was the misperception of /θ/ for / ʃ / prior to treatment with BtA. Acoustically, the frequency of / ʃ / was in the 7000-9000 Hz range pre-BtA which is much higher than the normal range of above 3000 Hz. This elevated frequency likely contributed to the misperception of /θ/ for / ʃ /. After treatment with BtA, the frequency of / ʃ / approached a normal range of 4300 Hz, reflecting the correct perception of the /θ—ʃ/ contrast.

## 4. DISCUSSION

Results of the above acoustic analysis, in addition to an informal perceptual evaluation of published audio and videotapes (Darley et al., 1975; Golper et al., 1983; Klawans et al., 1988) suggest that a common feature of lingual dystonic contractions involve lingual fronting and lingual elevation during speech production. A possible explanation for this phenomenon may be biomechanical in nature. The tongue is a muscular hydrostat in that it lacks a rigid skeletal framework (Kent, 1997). Muscular hydrostats are unique because any decrease in one dimension results in a corresponding increase or change in another dimension. Since the tongue is fixed posteriorly, there may be less resistance to movement in more anterior dimensions, than in posterior dimensions, perhaps accounting for the observed tendency for lingual protrusion. Similarly, the tongue is attached to the floor of the mouth, and lingual elevation may predominate because of less resistance to upward (superior) versus downward (inferior) movement.

This examination lends preliminary support to the hypothesis of lingual fronting and elevation in lingual dystonia. Future directions include larger scale studies that systematically evaluate the exact mechanisms contributing to the speech deficit associated with lingual dystonia. Additional scientific investigation is merited to help evaluate this hypothesis.

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