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ORIGINAL RESEARCH

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Tongue base augmentation to improve swallow function in a cadaveric model

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Abstract

Objectives: To evaluate the feasibility of using Calcium Hydroxylapatite (CaHA) to augment the tongue base for patients with swallowing impairment due to tongue base atrophy.

Methods: A fresh human cadaver was obtained through the institution's body donation program and baseline lateral fluoroscopic images were obtained. A total of 2 mL of CaHA (Prolaryn Plus) were injected into three sites of the base of tongue under flexible endoscopic guidance with a 22G, 1.5-inch needle (Monoject, Cardinal Health). Post-lateral fluoroscopic images were obtained and pharyngeal area (cm^2) and tongue base to pharyngeal wall distance (cm) was measured pre- and postinjection using SwallowTail fluoroscopic measurement software (Belldev Medical).

Results: The procedure was easily performed and the CaHA flowed easily into the cadaveric tongue without evidence of extrusion. The pre-procedural pharyngeal area decreased from 24.36 to 23.14 cm after augmentation. The base of tongue to pharyngeal wall distance decreased from 2.21 to 1.32 cm after augmentation.

Conclusion: Tongue base augmentation with CaHA may be a feasible adjuvant therapy for the management of swallowing impairment secondary to tongue base atrophy. Further investigation is necessary to evaluate the clinical safety and efficacy.

Level of Evidence: 4

KEYWORDS

aspiration pneumonia, dysphagia, lingual atrophy, radiation toxicity, swallow impairment

1 | INTRODUCTION

The normal swallowing mechanism is a complex process that requires the coordination of numerous sensory inputs and multiple anatomic structures for safe and efficient execution. The tongue is a critical component of this process, and an atrophic or otherwise impaired tongue base can be an important contributor to oropharyngeal swallowing impairment.[1] Aging, toxicity from head and neck radiation, and neuromuscular disorders can all contribute to tongue base atrophy.[2–5] This can lead to decreased sensory feedback and poor clearance due to an increased pharyngeal area, reduced lingual-palatal apposition, and diminished intrabolus

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pressure. Existing therapies to address a weak, atrophic tongue base are limited and include tongue strengthening exercises, biofeedback-guided exercises such as those using the Iowa Oral Performance Instrument (IOPI), and myoblast cell therapy injection.[6–8] The purpose of this investigation was to assess the feasibility of tongue base augmentation with calcium hydroxylapatite (CaHA) as a potential treatment option for lingual atrophy.

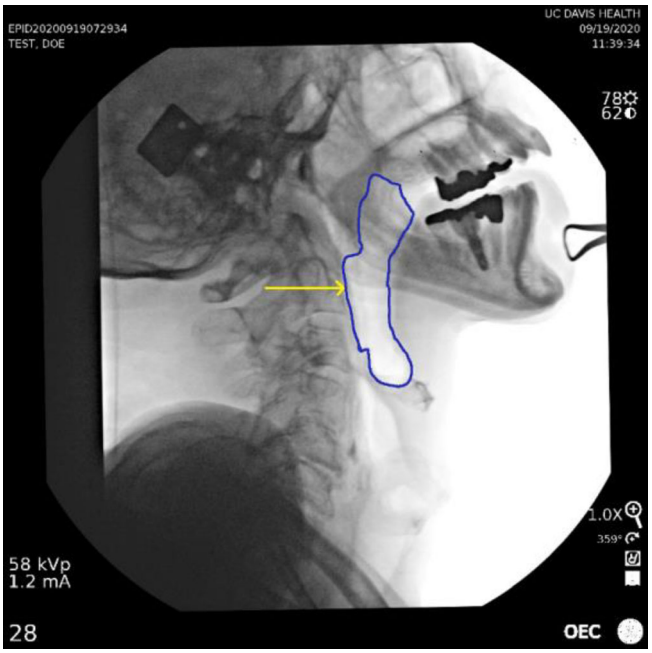

FIGURE 1 Fluoroscopy of cadaver prior to augmentation.

2 | METHODS

A fresh human cadaver (5′10″, Caucasian male) was obtained through the institution's body donation program. Equipment used included a properly collimated OEC Medical Systems 9800 Radiographic/Fluoroscopic unit that provided a 63-kV, 1.2-mA type output for the full field-of-view mode (12-inch input phosphor diameter). Baseline fluoroscopy was obtained with the tongue in a standardized lateral position. A fellowship-trained laryngologist injected 2 mL of CaHA (Prolaryn Plus) into three sites of the base of tongue under flexible endoscopic guidance with a 22G, 1.5-inch needle (Monoject, Cardinal Health). A postinjection lateral fluoroscopic image was then obtained. Pharyngeal area (cm^2) and tongue base to pharyngeal wall distance (cm) were measured pre- and postinjection using SwallowTail fluoroscopic measurement software (Belldev Medical).

3 | RESULTS

The procedure was easily performed and the CaHA was easily inject into the cadaveric tongue with minimal resistance and without evidence of extrusion. The pre-procedural pharyngeal area decreased from 24.36 to 23.14 cm after augmentation (Figures 1 and 2). The base of tongue to pharyngeal wall distance decreased from 2.21 to 1.32 cm after augmentation.

4 | DISCUSSION

Lingual atrophy can occur secondary to aging, stroke, neuromuscular pathology or radiation induced toxicity.[2–5] Tongue strengthening

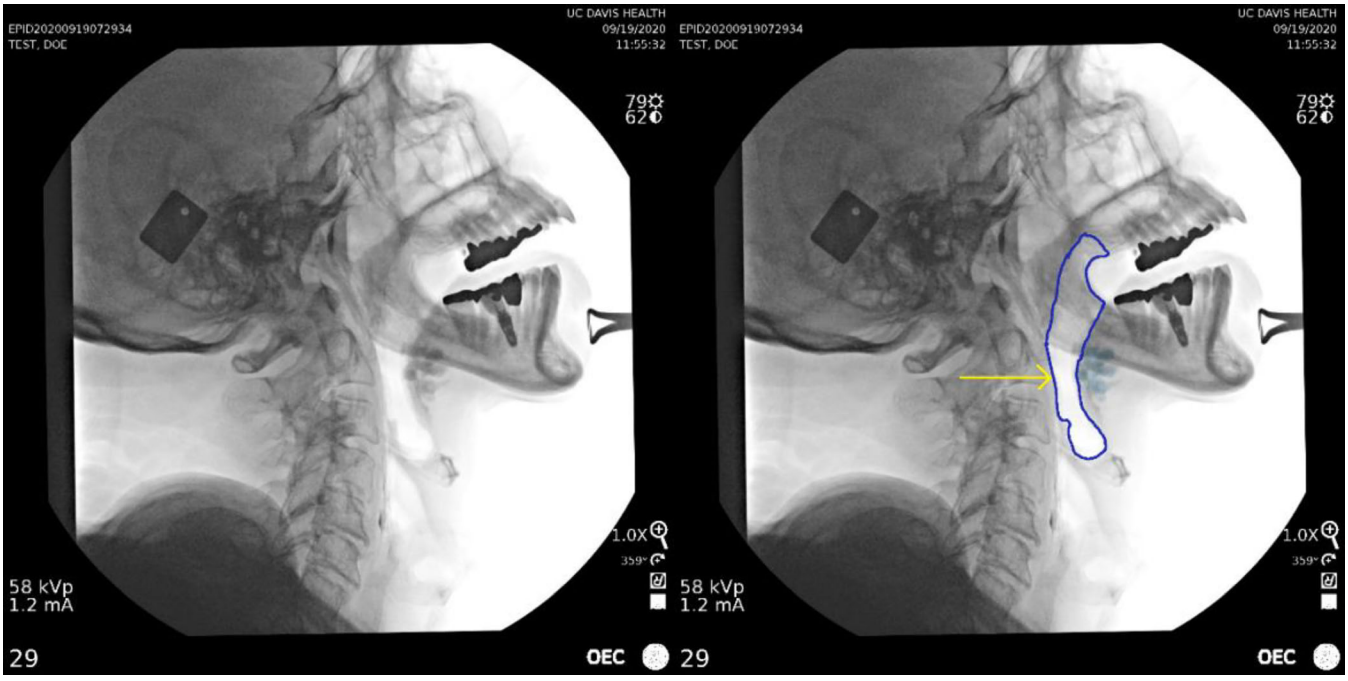

FIGURE 2 Fluoroscopy of cadaver after augmentation.

exercise is the most widely used treatment option and has uncertain efficacy.[8] Alternative therapies for this deficit have focused on innovative biofeedback techniques.[7] More recently, cell therapy with autologous myoblasts for radiation induced tongue atrophy has been investigated.[6,9] In 2022, Schar et al., described a novel surgical treatment which uses hyaluronic acid and lipofilling for pharyngeal tongue base augmentation.[10] They report increased pharyngeal pressure and improved dysphagia symptoms postoperatively. In this case report, we examine the feasibility of tongue base augmentation with CaHA to decrease pharyngeal area and improve lingual-palatal apposition. Injectable CaHA has been previously used in the upper aerodigestive tract to improve sphincteric function. Vocal fold augmentation with CaHA has been used as therapy for glottic insufficiency for nearly two decades.[11] More recently, CaHA has also been used in the posterior pharyngeal wall for velopharyngeal insufficiency, both in the pediatric and adult populations.[12] This is the 1st description of the use of CaHA for tongue base augmentation.

This single cadaver case report is not without limitations. It is uncertain if the decreased pharyngeal area and improved tongue base to pharyngeal wall apposition observed in this investigation will translate into improved swallow outcomes in a living individual with swallowing impairment. This study demonstrated feasibility of tongue base augmentation in a cadaveric model, however, it is possible that procedural pain or visualization challenges may make in-office tongue base augmentation impractical. Another concern for this procedure is potential intravascular injection of CaHA. Care must be taken to avoid intravascular injection to avoid ischemic damage. Nonetheless, the results of this cadaveric case report suggest that tongue base augmentation with CaHa is feasible. Future investigation is required to evaluate safety and potential efficacy in humans with swallowing impairment due to lingual weakness and atrophy.

5 | CONCLUSION

Two milliliters of calcium hydroxylapatite injected into three sites of the cadaveric tongue base decreased tongue base to pharyngeal wall distance from 2.21 to 1.32 cm. Results of this case report suggest that tongue base augmentation with CaHA is feasible. Future investigation is required to evaluate safety and potential efficacy in humans with swallowing impairment due to lingual weakness and atrophy.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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