Tongue anteriority in glossectomy versus control patient during the "s" sound

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INTRODUCTION

- The Center for Disease Control and Prevention estimates more than 30,000 new cases of oral and pharyngeal cancer each year. The lateral border of the tongue is the most affected site.[1]
- The 5-year survival rate is about 50% and Glossectomy is the standard treatment for affected patients
- Glossectomy involves the removal of the tongue tumor in addition to extra margin on tongue tissue. The resected area can either be closed with sutures or with a free flap usually from the radial arm. Resection size will be 2-3 cm larger than the tumor size. As a result, speech production may be affected
- "S" is the most important sound used to assess tongue function. It is very easy to test because it easily audible and reproducible. It is created at the alveolar ridge and forms a groove at the midline indicative of proper muscle function.
- The anterior portion of the tongue is the most important because this is where the constriction that produces the s sound is made.
- Anteriority (measure of anterior tongue displacement) is a parameter used to compare glossectomy patients to controls.
- **The goal of this project is to use anteriority as a parameter to assess the effect of glossectomy on normal tongue function. Anteriority differences are compared by measuring anterior volume change (mm3) during the repeatable speech task "a souk".**

AIM & HYPOTHESIS

The aim of this study is to test the following hypothesis:

A. Glossectomy patients will demonstrate a normal positioning of the tongue during pronunciation of /uh/ and increased anterior movement of the tongue during pronunciation of /s/.

Rational: Pronunciation of "uh" does not require the anterior movement of tongue and therefore will not be impacted with or without a flap. In contrast, decreased tongue volume and the regenerative properties of tongue will allow for normal anterior movement of the tongue during pronunciation of /s/.

B. There will be an increase in anteriority in non-flap patients versus flap patients.

Rational: Unlike non-flap patients, flap patients have additional volume from the free flap. This additional weight may cause the tongue to accommodate the change in structure and position posteriorly.

Fig. 1. Glossectomy patient

POST-SURGERY

24 MONTHS

MATERIALS AND METHODOLOGIES

Subjects: 25 subjects were used in this study:

- 2 Flap patients (Flap 1-lateral , Flap 2-tip of the tongue)
- 2 Non-Flap patients
- 21 Control patients

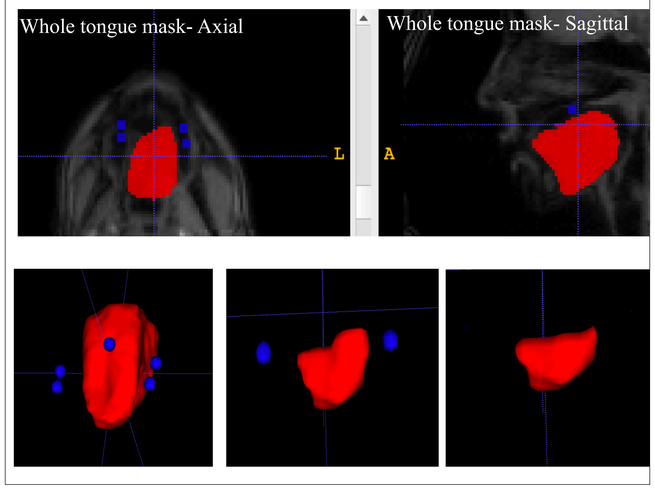
MRI data and whole tongue masks:

- We analyzed MRI images of test subjects during articulation of 'a-souk' via ITK-Snap[1].
- There were 128 slices per time frame displayed in axial, sagittal, and coronal planes.
- We created tongue masks using ITK-Snap for 2 frames: one during the pronunciation of "uh" and the other during the pronunciation of "s", for each patient.

Anteriority Cuts and Volume Calculations:

- The most mesial-anterior point of the 1st molars and most mesial-anterior point of the 2nd premolars were marked, along with the midline of the palate (total of 5 points).
- The 3-D tongue masks and the 5 points were imposed the MRI volume, and the points were used to cut the tongue as follows.
  - The plane that bisected the 1st molar points and midline point simultaneously was created and the first cut was made at m1.
  - Another plane was created by translating the first plane anteriorly until it intersected the premolar points to make the second cut.
  - The tongue was cut along these to planes to give us anteriority at m1 and pm2.
- The volumes of the tongue anterior to those planes were obtained and divided by the whole tongue volume to produce % anteriority at m1 and at pm2.

Fig. 2. Tongue mask and anteriority cuts on ITK-SNAP based on tooth roots and mid-palate (blue dots)



3D-image of the tongue. 1st cut at m1. 2ND cut at pm2

RESULTS

Comparison with control group:

- Means and SDs were calculated for control groups.
- Confidence interval calculated by doubling standard error.

Fig. 3. Change in tongue volume at m1 and pm2 during "s" in control versus glossectomy patients

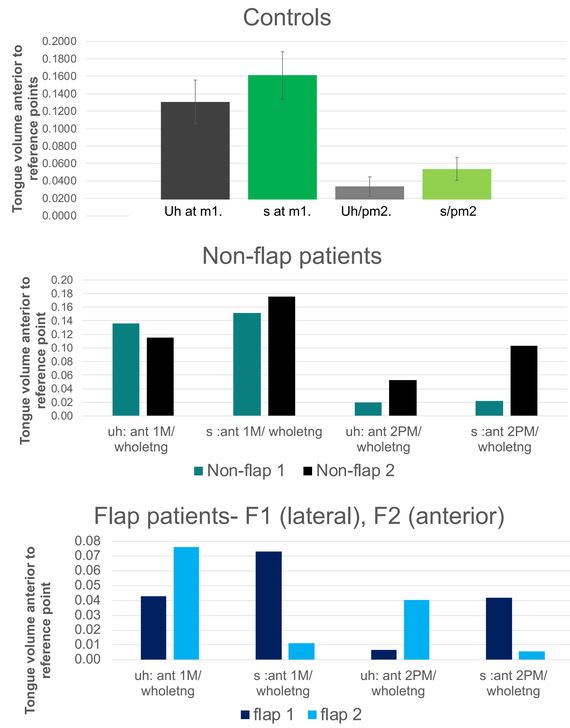


Fig. 4. % Change in anteriority at m1 and pm2 in glossectomy versus control patients

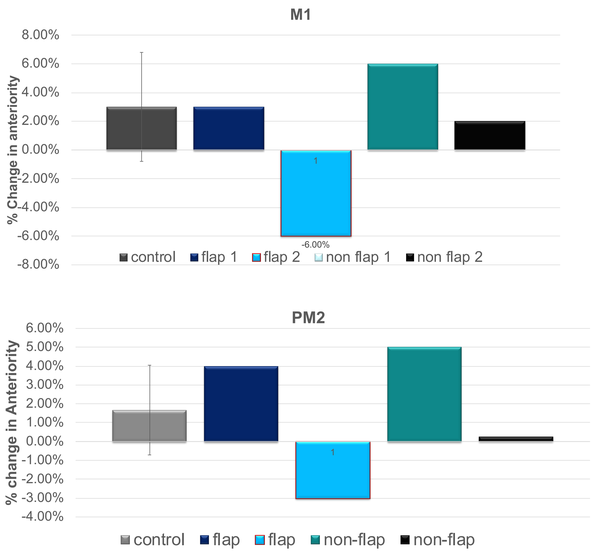
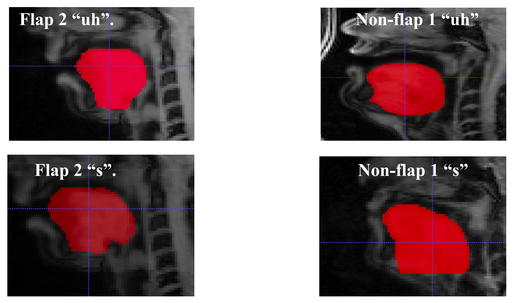


Fig. 5. Tongue masks at time frames "uh" and "s" for flap and non-flap patient.



DISCUSSION

- Non-flap patients (especially non-flap 1) showed similar patterns of anteriority to controls during pronunciation of "**a**-souk". Perhaps the tongue's repair mechanism permits regeneration and did not need increased anteriority to compensate for the resection.
- In comparison to non-flap patients and controls, flap patients showed significant reduction in anteriority at m1 and pm2 (Fig. 3.) This could possibly be as a result of the tongue compensating for the added volume, increased stiffness and reduced sensation.
- Flap patient 2 (tip of the tongue) moved posterior to the reference point and displayed the lowest anteriority among all patients at m1 and pm2 (Fig. 4.) The tip is the most anterior aspect of the tongue, thus inhibition (flap) of anterior movement may be more consequential than a lateral flap because the tip of the tongue makes the s sound (Fig. 5.)
- Limitations to this study include small sample size, variation in tongue size, flap size and extent of tumor.
- Future research will focus on how to help patients adapt to their unique flaps and optimize their speech outcomes.

CONCLUSIONS

- Even with the glossectomy procedure, most patients' fell within 1 standard deviation of control when measuring % change in anteriority at m1 and pm2 (Fig.4) supporting the first hypothesis.
- The results showed that flap patients will have a more posterior positioning of the tongue during speech, supporting the second hypothesis.

REFERENCES

1. Paul A. Yushkevich, Joseph Piven, Heather Cody Hazlett, Rachel Gimpel Smith, Sean Ho, James C. Gee, and Guido Gerig. User-guided 3D active contour segmentation of anatomical structures: Significantly improved efficiency and reliability. Neuroimage 2006 Jul 1;31(3):1116-28.

ACKNOWLEDGMENTS

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