MAGNETIC RESONANCE IMAGING AND VIDEOFLUOROSCOPY OF PARTIAL GLOSSECTOMEES' SPEECH: PRELIMINARY RESULTS

Janette Quintero[1], Tim Bressmann[1], Katalin Mady[2] and Ambros Beer[3]
[1]Dept. of Speech-Language Pathology, University of Toronto, 500 University Ave., Ontario, Canada, M5G 1V7
[2]Institute for Phonetics and Speech Communication, Ludwig-Maximilians University of Munich, 80799 Munich, Germany
[3]Dept. of Nuclear Medicine, Krankenhaus Rechts der Isar, Munich University of Technology, Germany
Janette.quintero@utoronto.ca

1. INTRODUCTION

A partial glossectomy results in a lingual defect that can have detrimental effects on speech. The speech defects may negatively impact patients' quality of life and well-being. The biomechanical consequences of a partial tongue resection are still not well understood (Bressmann et al., 2004).

In a recent study using ultrasound imaging, Rastadmehr et al. (2008) found that there was an increase in tongue velocity postoperatively, in comparison to tongue velocity measures before the surgery and to tongue velocity measures in normal controls. This finding challenges the assumption that a tongue resection will tether the tongue (Korpijaako-Huuhka et al. 1999).

One of the goals of this study was to replicate Rastadmehr et al.'s (2008) findings, using cine-MRI and videofluoroscopy. The main research objective of this study was to determine the effects of a partial glossectomy on tongue velocity and movement range during speech.

2. METHOD

2.1 Subjects

The six patients in this study were diagnosed with anterior and/ or lateral carcinomas of the tongue. All subjects were male, with a mean age of 55.8 years (SD 12.0 years). They were recruited from the Department of Oral and Maxillofacial Surgery of the Technical University of Munich, Germany. The diameters of the tumours ranged from <1 to 4 cm. The smaller defects were closed using either primary wound healing or local closures. The larger defects were closed using platysma flaps.

2.2 Materials and Procedures

The imaging data sets were originally collected by Mady and Beer. The videofluoroscopies were recorded to VHS video in PAL format with a frame rate of 25 fps. The movies were later digitized for the quantitative analysis. Patients swallowed barium to display the tongue and hypopharynx. The patients repeated a list of ten words three times. Audio recordings were made simultaneously. For each participant, tongue velocity and movement range were calculated for each word production.

The MRI data were recorded using a T1 echo gradient sequence on Phillips ACS NT Gyroscan (TR=4.0ms, TE=1.1 ms, midsagittal slice thickness=10mm), with a frame rate of 8 fps. The movies were converted to .avi format for analyses. The patients repeated each of the ten words for 10 s, resulting in approximately 4-6 repetitions. Audio data was not concurrently recorded. For each patient, tongue velocity and movement range were calculated over the entire 10 s word repetition task, rather than for each word production.

3. DATA ANALYSES

The speakers' tongue movement was analyzed using the Ultrasonographic Contour Analyzer for Tongue Surfaces (Ultra-CATS) software, which permits a frame-by-frame analysis of the recordings. For each frame, the surface of the tongue and the outer contour of the mandible were traced. The program uses a semi-circular grid to make measurements. Figure 1 displays tongue movement over several frames during the production of the word <Theke> 'bar'. Figure 2 shows the corresponding surface plot of the tongue movement observed in Figure 4.

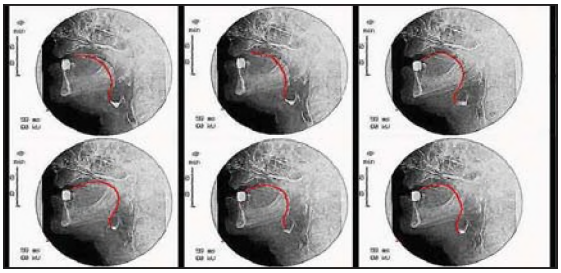

Figure 1: Sequence of videofluoroscopic frames shows tongue movement for the German word <theke> (bar).

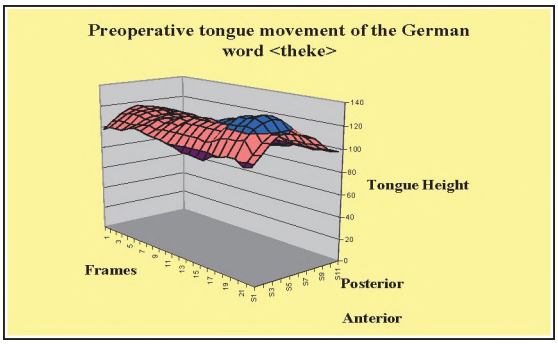

Figure 2: Three-dimensional chart displaying the tongue movement for the videofluoroscopic frame sequence in Figure 1.

For each participant, tongue velocity was calculated by dividing the total tongue distance traveled at various angles along the surface of the tongue by the time lapsed. The difference between the minimum and maximum tongue height was calculated for each angle, giving the tongue movement range for each angle of the measurement grid.

4. RESULTS

Since the project is still in its early stages, only one of the nine words has been analyzed. Principle Component Analyses were used to identify functional segments of the tongue. The analysis revealed three components that corresponded with the anterior, centre, and posterior regions of the tongue. Statistical analyses were limited to the three functional segments.

Multiple paired sample *t*-tests were conducted to compare the preoperative and postoperative tongue velocity measures at the different regions of the tongue. Since there were only a small number of paired comparisons, no Bonferroni-adjustment was made. Due to the small sample size, an alpha level of $p<0.1$ was set as the criterion for statistical significance. The results suggest that tongue velocity decreased after the surgery in all tongue regions (anterior, centre, and posterior). The decrease in tongue velocity was only significant for the posterior tongue (t = 2.871, df=5, $p<0.05$). All patients showed a postoperative deceleration.

There was an increase in the postoperative tongue movement range in the anterior region of the tongue. However, this increase was not significant. The preoperative and postoperative movement range were almost the same in the centre tongue region. The movement range in the posterior region decreased significantly after the surgery ($t=2.158$, df=5, $p<0.1$).

The preliminary results from the MRI data confirm the findings from the videofluoroscopic data. Qualitatively, patients showed a decrease in postoperative tongue velocity in all three functional tongue segments (see Figure 3). Also, there was a reduction in tongue movement range in the anterior and posterior tongue segments, following the partial glossectomy. There was a slight increase in the centre tongue region (see Figure 4).

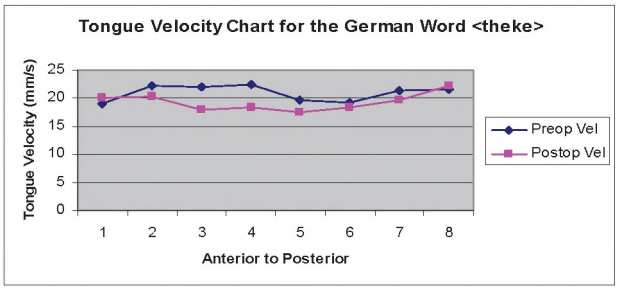

Figure 3: Preoperative and postoperative tongue velocity at various points along the surface of the tongue for patient 6.

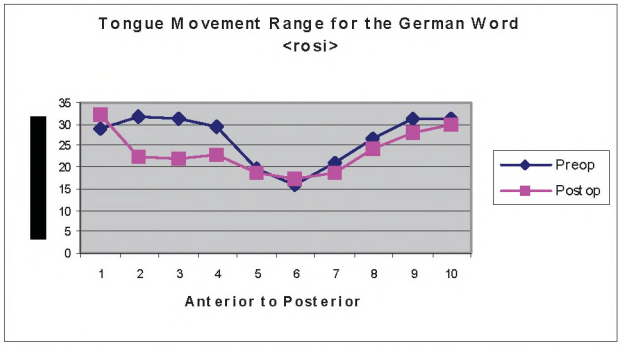

Figure 4: Preoperative and postoperative tongue movement range at various points along the surface of the tongue for patient 3.

5. DISCUSSION

The preliminary results suggest that tongue velocity and tongue movement range decreased after a partial glossectomy surgery. These findings confirm previous assumptions (Korpijaako-Huuhka et al. 1999) that a loss of lingual tissue results in reduced tongue movement and speed. A reduction in tongue speed and movement range could be the cause of the observed speech distortions.

The results from this study contradict the findings by Rastadmehr et al. (2008), who found an increase in post-surgical tongue height and velocity. Further analysis will demonstrate whether the patients in the present study use fundamentally different compensatory strategies. There was also an obvious difference in the speech tasks: Rastadmehr et al. (2008) used a complex reading passage, while the current study investigated the articulation of single words. Finally, the different findings may also be attributable to the differences in patients and glossectomy surgeries.

REFERENCES

Bressmann, T., Sader, R., Whitehill, T., & Samman, N. (2004). Consonant Intelligibility and Tongue Motility in Patients with Partial Glossectomy. *Journal of Maxillofacial Surgery, 62*, 298-303.

Korpijaako-Huuhka, A.M., Söderholm, A.L., & Lehtihalmes, M. (1999). Long-lasting speech and oral-motor deficiencies following oral cancer surgery: a retrospective study. *Logopaedics, Phoniatrics, and Vocology*, *24*, 3, 97-106.

Rastadmehr, O., Bressmann, T., Smyth, R., & Irish, J. (2008). Increased midsagittal tongue velocity as indication of articulatory compensation in patients with lateral partial glossectomies. *Otolaryngology-Head and Neck Surgery, 30*, 718-726.

ACKNOWLEDGEMENTS

Janette Quintero would like to acknowledge the valuable support and advice of Dr. Catriona Steele and Dr. Alexei Kochetov.