Clinics of Oncology

Research Article ISSN: 2640-1037 | Volume 4

Analyzing Speech Outcomes in Hemiglossectomy Patients Using Telecare Platform

Kim C[1], Ouyoung LM[2], Capobres Villegas B[2], Ipek C[3], Hagedorn C[4] and Sinha UK[2*]

[1]Keck School of Medicine of the University of Southern California, CA

[2]Caruso Department of Otolaryngology - Head and Neck Surgery, Keck School of Medicine of the University of Southern California, CA

[3]Department of Psychology, University of Southern California, CA

[4]Department of Linguistics, City University of New York, New York

[*]Corresponding author:

Uttam K Sinha,
Caruso Department of Otolaryngology – Head and Neck Surgery, Keck School of Medicine,
University of Southern California,
1540 Alcazar Street, Suite 204M,
Los Angeles, CA 90033,
Phone: 323-442-5790;
Fax: 323-442-5820;
E-mail: sinha@med.usc.edu

Received: 01 Mar 2021
Accepted: 15 Mar 2021
Published: 20 Mar 2021

Keywords:

Glossectomy; Dysarthria; Speech; Telemedicine

Citation:

Sinha UK, Analyzing Speech Outcomes in Hemiglossectomy Patients Using Telecare Platform.
Clin Onco. 2021; 4(3): 1-9

1. Abstract

1.1. Background: Dysarthria is a common postoperative sequela of glossectomy and can greatly impact daily function and Quality of Life (QOL). It is important to study the anatomic and physiological factors that influence speech function, even with the challenges of conducting clinical research during the COVID pandemic. Therefore, our study aims to 1) display the feasibility of using a telecare platform to conduct clinical research; 2) analyze speech outcomes of patients who underwent hemiglossectomy with radial forearm free flap (RFFF) tongue reconstruction.

1.2. Methods: This is a prospective cohort study of 20 tongue cancer patients who underwent hemiglossectomy and RFFF reconstruction and received postoperative SLP evaluation via telemedicine. Speech outcome measures included tongue range of motion (ROM), speech clarity, diadochokinetic (DDK) rate, and Speech Handicap Index (SHI). Statistical analyses consisted of Mann-Whitney U-test, Kruskall-Wallis test, and Spearman's rank correlation.

1.3. Results: Early tumor stage (vs late) had significant relationships with improved objective and subjective speech outcomes, particularly lateral ROM and total SHI. Those who did not receive Radiation Therapy (XRT) also performed better than those who underwent XRT, most notably for DDK rate. Oral tongue cancer patients generally had worse ROM than base of tongue patients. Furthermore, SHI speech and psychosocial domains were significantly correlated.

1.4. Conclusion: Postoperative dysarthria experienced by glossectomy patients can vary based on multiple factors, particularly tumor stage and radiation therapy. Our results suggest that during speech rehabilitation in this population, a biopsychosocial approach is important for optimal outcomes. Telecare is an effective platform to conduct such clinical research.

2. Introduction

Since the World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020, various precautionary measures have been implemented in order to help mitigate the spread of the virus. Its rapid transmission and high hospitalization rate have forced health professionals to drastically alter their practices in order to slow its proliferation. Technology can be adopted to mitigate extreme exogeneous shocks, such as natural disasters and diseases [1, 2]. Telemedicine represents the use of technology in healthcare to enable 'healing at a distance' [3]. Within otolaryngology specifically, certain telehealth assessments have been shown to allow for quicker examinations without compromising the communication of crucial information from the patient to the physician, or vice versa [4]. Otolaryngologists and speech-language pathologists have rapidly adopted telemedicine to provide adequate care to their patients.

Patients with advanced tongue cancer undergo glossectomy with free flap reconstruction, with or without post-operative radiation therapy [5-8]. One of the most common postoperative sequelae of treatment of tongue cancer is dysarthria. Though reduced post-surgical speech intelligibility has long been observed using clinical assessments relying on impressionistic phonetic transcription and acoustic measures, no study has systematically identified the anatomical and physiological patterns that underlie the impairment of lingual function that reduces speech intelligibility due to anatomic disruption of the tongue [6, 9]. Because such patterns have not been identified, the anatomical and physiological changes that give rise to improved speech intelligibility over the course of rehabilitation also remain unknown. Speech plays a primary role in daily communication, and dysarthria greatly impacts Quality of Life (QOL). Despite the prevalence of dysarthria in this patient population, there are limited studies that evaluate their postoperative speech outcomes using both objective and subjective measures [10, 11]. Conducting such clinical research is more challenging during the COVID pandemic due to limited in-person visits. The goals of the current study are 1) to determine the feasibility of conducting clinical research using telecare platform; 2) to analyze speech outcomes in hemiglossectomy patients who underwent Radial Forearm Free Flap (RFFF) tongue reconstruction.

3. Materials and Methods

This is a prospective cohort study, with a total of 20 patients who all underwent hemiglossectomy with primary tongue reconstruction using Radial Forearm Free Flap (RFFF). We implemented this careful method of patient selection in order to minimize the variability in speech outcomes that may be introduced with different types of glossectomy and/or flaps. Surgery was the primary method of treatment for all participants, and each patient received postoperative Speech-Language Pathologist (SLP) evaluation. All participants, as well as respective family members (except one), completed the Speech Handicap Index (SHI). Cohorts were based on site of tongue resection (oral tongue, base of tongue, overlapping sites), early versus late tumor stage (T1/2 vs T3/4), and presence of nodal spread (N0 or N+). All participants interacted with two experienced speech-language pathologists (BV, MO). This study was approved by the University of Southern California Institutional Review Board.

3.1. Telemedicine SLP Evaluations

All patients received formal Speech-Language Pathologist (SLP) evaluation through telemedicine appointments via the video-call application Zoom, because in-person evaluations have been severely limited during the COVID-19 pandemic. These SLP evaluations consisted of objective measures of speech, including tongue range of motion, speech clarity, and diadochokinetic rate, as detailed below.

3.2. Tongue Range of Motion (ROM) Assessment Scale

Tongue ROM was assessed using the Tongue ROM Severity Rating Scale by Lazarus et al [12]. There are four sub-categories for ROM: protrusion, left lateralization, right lateralization, and elevation. The scores for protrusion and lateralization (left and right) are as follows: 100 - normal, 50 - mild to moderately impaired, 25 - severely impaired, and 0 - totally impaired. The scores for elevation are: 100 - normal, 50 - moderately impaired, and 0 - severely impaired. Total tongue ROM score was subsequently obtained by calculating the mean of the four sub-category scores. Possible total tongue ROM scores ranged from 0 to 100, with lower scores indicating a greater degree of impairment to tongue range of motion.

3.3. Speech Clarity

Level of speech clarity was evaluated, both during conversation and reading, based on ASHA National Outcomes Measurement System (NOMS) guidelines for Spoken Language Expression and for Reading, respectively [13]. Reading and conversation clarity were graded from level 1 to 7, with increasing clarity. Please refer to Supplementary Table S1 for detailed descriptions of each level.

Supplementary Table S1: ASHA National Outcomes Measurement System (NOMS) guidelines for Reading and for Spoken Language Expression [13].

Level	Reading Clarity
1	Attends to printed material, but does not recognize even single letters or common words
2	Reads single letters and common words with consistent maximal cueing
3	Reads single letters and common words, with consistent moderate cueing, and can read some words that are less familiar, longer, and more complex
4	Reads words and phrases related to routine daily activities, and words that are less familiar, longer, and more complex; requires moderate cueing to read sentences of approximately 5-7 words
5	Reads sentence-level material containing some complex words; occasionally requires minimal cueing to read more complex sentences and paragraph-level material; occasionally uses compensatory strategies
6	Successfully able to read most material but some limitations are apparent in vocational, avocational, and social activities; rarely requires minimal cueing to read complex material; reading is successful, but may take longer to read the material; usually uses compensatory strategies when encountering difficulty

Level	Conversation Clarity
7	Successfully and independently participates in vocational, avocational, and social activities and is not limited by reading skills; independent functioning may occasionally include compensatory strategies
Level	**Conversation Clarity**
1	Attempts to speak, but verbalizations are not meaningful to familiar or unfamiliar communication partners at any time
2	Attempts to speak, although few attempts are accurate or appropriate; partner must assume responsibility for structuring communication exchange; with consistent and maximal cueing, the individual can only occasionally produce automatic and/or imitative words and phrases that are rarely meaningful in context
3	Communication partner must assume responsibility for structuring communication exchange; with consistent and moderate cueing, individual can produce words and phrases that are appropriate and meaningful in context
4	Successfully able to initiate communication using spoken language in simple, structured conversations in routine daily activities with familiar partners; usually requires moderate cueing, but able to demonstrate simple sentences and rarely uses complex sentences/messages
5	Successfully able to initiate communication using spoken language in structured conversations with both familiar and unfamiliar partners; occasionally requires minimal cueing to frame more complex sentences; occasionally self-cues when encountering difficulty;
6	Successfully able to communicate in most activities, but some limitations in spoken language are apparent in vocational, avocational, and social activities; rarely requires minimal cueing to frame complex sentences; usually self-cues when encountering difficulty;
7	Successfully and independently participate in vocational, avocational, and social activities; not limited by spoken language skills; independent functioning may occasionally include use of self-cueing

3.4. Diadochokinetic Rate

Diadochokinetic (DDK) rate measures the repetition rate of a set of syllables. In our study, it was calculated by counting the number of times the participant was able to repeat the syllables "/p/ /t/ /k/" within a 15 second interval. DDK rate is considered a stable measurement of maximum performance in speech evaluations [14].

3.5. Speech Handicap Index (SHI)

The SHI is a survey specifically designed to analyze speech in patients with oral or oropharyngeal cancer [15]. It is composed of thirty questions that address patient speech function and how their speech is perceived. Each question may be answered as never (0), almost never (1), sometimes (2), almost always (3), and always (4). The responses are added for a total score that ranges from 0 to 120. Total scores are categorized as follows: 0-29 excellent, 30-69 good, 70-99 average, and 100-120 bad [10]. There are also 2 SHI subcategories: speech domain and psychosocial domain [10]. 14 statements focused on the patients' speech itself, and 14 other statements primarily assessed psychosocial problems related to speech impairments.

Participants were asked to personally complete the SHI, sent to them via email. They were also asked to distribute a separate SHI to a close family member or friend in order to assess how others perceive the participant's speech function.

3.6. Statistical Analysis

Data analysis was performed using statistical software R v.3.6.3. Because the data did not follow a normal distribution, non-parametric tests were used to compare patient subgroups as well as patient and family SHI scores. Patient data on tongue range of motion and speech clarity were analyzed using the Mann-Whitney U-test (for comparison between two patient subgroups) and the Kruskall-Wallis test (for comparing three or more subgroups). In addition, the correlation between patients' SHI speech domain and psychosocial domain, and the correlation between patient total SHI score and family total SHI score were assessed using Spearman's rank correlation coefficient.

4. Results

4.1. Patient Population

There was a total of 20 participants included in this study, with a mean (SD) age of 60 (+14) years (Table 1). The male to female ratio was 1.5:1 and a majority was Caucasian (55%). The rest of the patients were Hispanic (10%), Asian (5%), or Other (30%). All patients grew up in Southern California and spoke English as their primary language. Though all patients underwent hemiglossectomy, varying anatomical sites of tongue were resected: 20% of participants had only their Oral Tongue Cancer (OTC) resected, 30% had their Base of Tongue (BOT) resected, and 50% had Overlapping Sites (OLS) resected. More than half (55%) had radiation therapy in the past and/or as part of their current cancer treatment. A majority (65%) had T1/T2 disease, and the remainder (35%) had T3/T4 disease. Most participants (60%) had no nodal spread. All patients completed their cancer treatment 1-5 years ago.

Table 1: Patient Characteristics

Category	No. (%)
Ethnicity	
Caucasian	11 (55%)
African-American	0 (0%)
Hispanic/Latino	2 (10%)
Asian	1 (5%)
Other	6 (30%)
Age	
Mean (SD)	60 (14) years
T stage	
T1	8 (40%)
T2	5 (25%)
T3	6 (30%)
T4	1 (5%)
N stage	
N0	12 (60%)
N1	3 (15%)
N2	4 (20%)
N3	1 (5%)
Site of Tongue Resection	
Oral tongue	4 (20%)
Base of tongue	6 (30%)
Overlapping sites	10 (50%)
Radiation therapy (XRT)	
Yes	11 (55%)
No	9 (45%)

4.2. Participation in Telecare Platform

All patients used the Zoom platform to communicate and be evaluated by SLPs.

4.3. Range of Motion

All 20 patients scored between 25 and 100 for each subcategory of tongue range of motion (Table 2). Each subcategory had a varied distribution of scores, except for tongue elevation, for which all 20 patients were able to elevate their tongue tip but without contact with the upper alveolar ridge.

When analyzing ROM based on site of resection, OTC patients experienced the most difficulty. When protruding the tongue, a higher percentage of OTC patients (25%) could not reach past the upper lip margin, compared to BOT (15%) and OLS (20%) patients. When lateralizing the tongue, half of the OTC and BOT participants had >50% reduction; but there was one BOT patent who was able to reach the corner of the mouth, a task that none of the OTC participants were able to achieve.

Table 2: Results of Objective and Subjective Speech Outcome Measures
*statistically significant relationship

Speech Measure	Patient Characteristic		
	Oral Tongue	**Base of Tongue**	**Overlapping Sites of Tongue**
Range of Motion			
Protrusion	43.8 (12.5)	45.8 (10.2)	45.0 (10.5)
Lateralization	37.5 (14.4)	45.8 (29.2)	42.5 (12.1)
Elevation	50.0 (0.0)	50.0 (0.0)	50 (0.0)
Total	42.2 (9.4)	46.9 (15.7)	45.0 (8.2)
Clarity			
Reading	6.5 (0.6)	6.2 (0.8)	5.9 (1.1)
Conversation	6.5 (0.6)	5.8 (1.0)	6.0 (1.1)
Diadochokinetic			
Rate	26.8 (8.5)	24.2 (5.5)	22.9 (6.4)
Speech Handicap Index			
Total	20.0 (8.04)	24.8 (20.9)	28.5 (19.7)
Speech Domain	11.8 (17.0)	13.0 (10.1)	15.3 (8.8)
Psychosocial Domain	7.0 (6.1)	9.1 (9.2)	11.2 (9.8)
	T1/T2		**T3/T4**
Range of Motion			
Protrusion	46.2 (9.4)		42.9 (12.2)
Lateralization*	48.1 (19.0)		32.1 (12.2)
Elevation	50.0 (0.0)		50.0 (0.0)
Total	48.1 (10.9)		39.3 (7.8)
Clarity			
Reading	6.2 (1.0)		6.0 (0.8)
Conversation	6.2 (0.9)		5.9 (1.1)
Diadochokinetic			
Rate	24.8 (6.4)		22.7 (6.7)
Speech Handicap Index			
Total*	20.9 (18.1)		34.5 (14.7)
Speech Domain	11.7 (8.3)		18.0 (6.5)
Psychosocial Domain	7.8 (8.9)		13.2 (8.0)
	N0		**N-positive**
Range of Motion			
Protrusion	43.8 (11.3)		46.9 (8.8)
Lateralization	45.8 (20.9)		37.5 (13.4)
Elevation	50.0 (0.0)		50.0 (0.0)
Total	46.4 (12.3)		43.0 (7.8)
Clarity			
Reading	5.9 (1.0)		6.4 (0.7)
Conversation	5.9 (0.9)		6.3 (1.0)
Diadochokinetic			
Rate	24.4 (6.2)		23.5 (7.0)
Speech Handicap Index			
Total	25.2 (20.4)		26.4 (14.6)
Speech Domain	13.6 (9.5)		14.3 (6.2)
Psychosocial Domain	7.8 (8.9)		13.2 (8.0)

	No XRT	XRT
Range of Motion		
Protrusion	44.4 (11.0)	45.5 (10.1)
Lateralization	50.0 (21.7)	36.4 (13.1)
Elevation	50.0 (0.0)	50.0 (0.0)
Total	48.6 (12.8)	42.0 (8.0)
Clarity		
Reading	6.3 (0.9)	5.9 (0.9)
Conversation	6.4 (0.7)	5.7 (1.0)
Diadochokinetic		
Rate*	26.9 (5.9)	21.7 (6.0)
Speech Handicap Index		
Total	23.2 (20.5)	27.7 (16.3)
Speech Domain	12.8 (9.3)	14.7 (7.4)
Psychosocial Domain	8.4 (9.7)	10.8 (8.2)

Patients with early T stage performed better than those with late T stage across all range of motion subcategories, particularly during tongue lateralization. Most (77%) early T stage participants were able to lateralize their tongue to the corner of their mouths or had <50% reduction in movement, whereas most (71%) late T stage participants had >50% reduction in movement (p=0.03). Furthermore, those with no nodal spread performed better than those with nodal spread during lateralization, though the association was not as strong.

Patients who did not undergo XRT generally performed better than those who received XRT. A larger percentage (55%) of patients who received XRT had >50% reduction in lateralization, compared to those who did not undergo XRT (22%).

4.4. Total ROM

OTC patients had the lowest mean total ROM score (42.2) compared to BOT (46.9) and OLS patients (45.0) (p=0.87). Early T stage and lack of nodal spread had a higher mean total ROM score than those with late T stage (p=0.06) and nodal spread (p=0.6), respectively. Additionally, participants who underwent XRT had a lower mean total tongue ROM score (42.0) than those who did not receive XRT (48.6) (p=0.22).

4.5. Diadochokinetic (DDK) Rate

OTC patients had slightly higher mean DDK rates (26.8) than BOT (24.2) and OLS (22.9) patients (p=0.7). Those with early T stage and no nodal invasion had higher DDK rates than those with late T stage (p=0.5) and nodal invasion (p=0.6), respectively. XRT had a significantly negative relationship with DDK rate, with XRT patients having a mean rate of 21.7 and non-XRT patients a mean rate of 26.9 (p=0.04).

4.6. Speech Clarity

All 20 patients scored between 4 and 7 in reading clarity, meaning they were able to read without consistent cueing. They also scored between 4 and 7 in conversation clarity, with all patients being able to at least successfully initiate communication (Figure 1 and 2). OTC patients performed best and were able to read and converse at the highest level (7), when compared to BOT and OLS patients, though the differences in mean levels were minimal. Similarly, a higher percentage of participants with early T stage and no nodal spread were able to achieve the level 7 clarity during reading and conversation, compared to those with late T stage and nodal spread, respectively. Additionally, more XRT patients had lower clarity levels than patients who did not receive XRT.

4.7. Speech Handicap Index (SHI)

4.7.1. Patient SHI: Those with early T stage had a mean (SD) total SHI score of 20.9 (18.12) whereas late T stage patients had a mean score of 34.5 (14.7), indicating better subjective outcomes for the former. Even when speech (p=0.05) and psychosocial (p=0.06) SHI domains were evaluated separately, the early T stage cohort had better scores than the late T stage cohort. Site of resection, nodal stage, and exposure to radiation did not show similar associations with total, speech, or psychosocial SHI scores [Table 2]. Overall, patients' respective speech domain and psychosocial domain scores were highly correlated with each other (p<0.001) (Figure 3).

4.7.2. Patient vs Family SHI: All 20 patients submitted a complete SHI, but one patient was unable to have a family member or close friend complete an SHI. On average, patients gave themselves higher SHI scores (25.7) than their family counterparts (21), with higher scores indicating greater impairment (p=0.39). There is a similar trend when analyzing the speech domain (p=0.53) and psychosocial domain (p=0.64) SHI scores separately. There appears to be greater agreement between patient and family when patient SHI scores are low, with larger discrepancies between the two respective parties as patient SHI scores increase (Figure 4).

5. Discussion

5.1. Anatomic Site of Tongue Resection

Our results showed identifiable patterns in postoperative tongue range of motion based on site of tongue resection. Oral tongue participants had larger impairments in each tongue ROM sub-category (except elevation) (Table 2). These trends are in line with other findings in existing literature. Studies have shown that those with oral cavity tumors have worse speech intelligibility than those with oropharyngeal tumors [11, 16]. The greater severity of dysarthria in oral glossectomy patients is likely due to the alteration of oral cavity articulators that work to produce intelligible speech, including the anterior tongue and its direct role in consonant articulation (i.e. plosives, fricatives) [10, 17]. The pliability and complex mobility of the anterior tongue are difficult to restore, even with flap reconstruction, so oral tongue resection often leads to greater speech impairment [17]. Resection of base of tongue (oropharyngeal) can lead to altered resonance, but reconstruction can restore adequate function [17].

5.2. Tumor Stage

In our study, late T stage was significantly correlated with decreased tongue lateralization (Table 2). This is likely explained by the fact that treatment of advanced disease requires larger area of resection and reconstruction, though the heavier tumor burden may be affecting adjacent sites and not primarily the tongue [18]. The resulting decrease in range of motion may lead to greater difficulty producing intelligible speech. Additionally, the discrepancy in tongue range of motion may have been more prominent during lateralization, due to the multidimensional (anterior and lateral) movements required to successfully lateralize the tongue. Participants with advanced T stage did not have notably lower speech clarity ratings during SLP evaluation, but their significantly worse SHI scores suggest dysarthria that is severe enough to be detected in their daily lives. Our findings align with previous studies that have also emphasized the relationship between tumor stage and speech outcomes [10, 11, 16, 18].

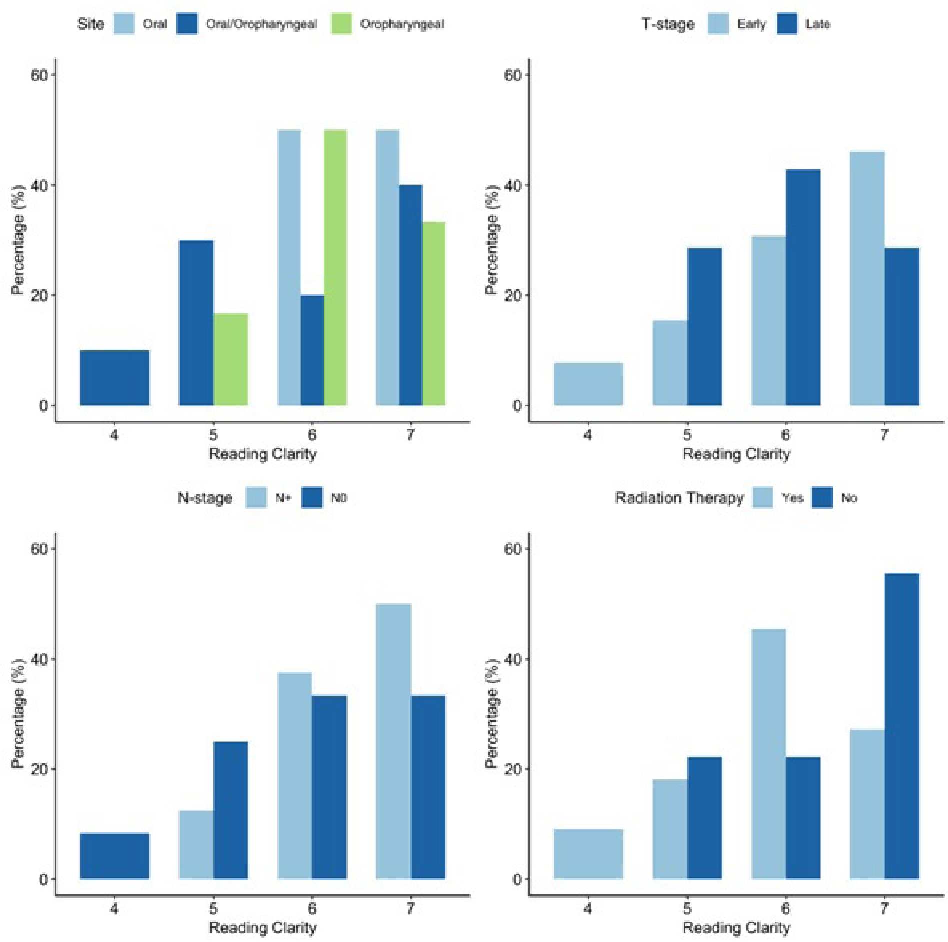

Figure 1: The distribution of reading clarity levels based on site of tongue resection (top left), tumor stage (top right), nodal stage (bottom left), and radiation therapy (bottom right).

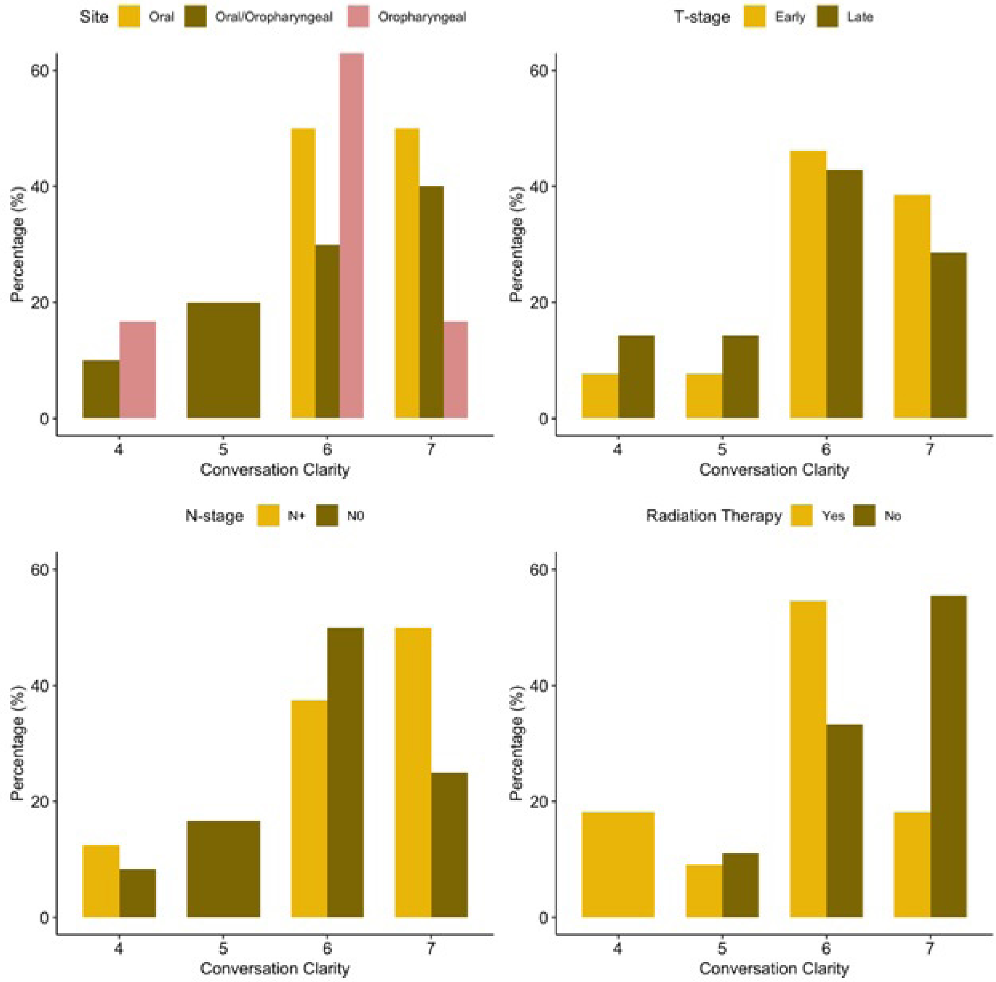

Figure 2: The distribution of conversation clarity levels based on site of tongue resection (top left), tumor stage (top right), nodal stage (bottom left), and radiation therapy (bottom right)

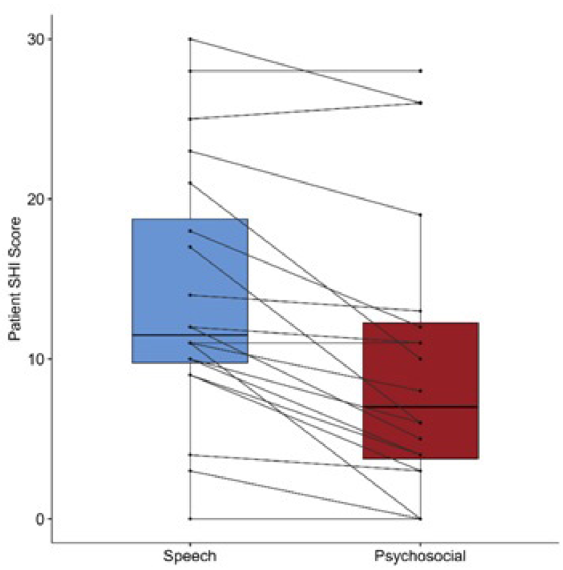

Figure 3: Comparison between patient speech and psychosocial domain scores from the Speech Handicap Index (SHI)

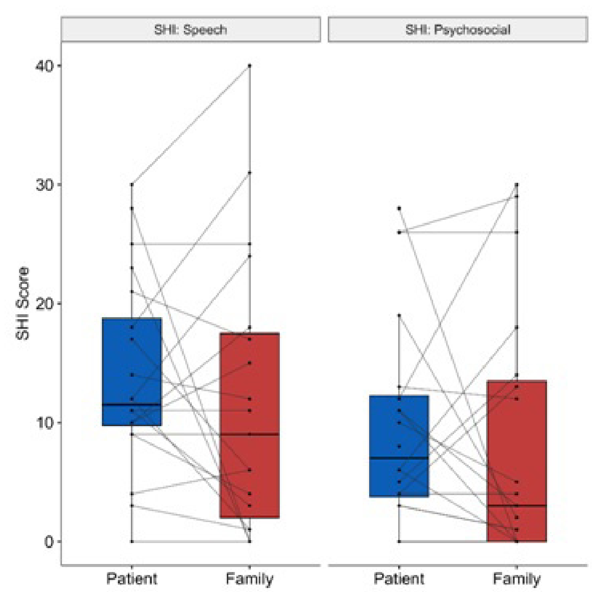

Figure 4: Comparisons between respective patient and family scores for speech domain (left) and psychosocial domain (right) scores from the Speech Handicap Index (SHI)

5.3. Radiation Therapy

Our results show that DDK rate is significantly lower for those who underwent radiation therapy, though tongue range of motion and clarity levels are not significantly related (Table 2). These results suggest that XRT has a greater impact on tongue control and coordination than on tongue ROM. This would lead to greater speech impairments during rapid and repetitive tasks that require high levels of tongue coordination (i.e. DDK), more so than during slower tasks such as regular reading and conversation. Shin et al also suggested a similar theory when they found that radiotherapy patients had significantly higher DDK rates than those who only underwent surgery, with no large differences in tongue mobility [19]. The significantly diminished functional outcomes in XRT therapy patients are likely due to greater tissue fibrosis induced by radiation exposure [9, 19]. Thus, it is imperative to consider which treatment modalities a patient will undergo when managing expectations and planning for functional rehabilitation.

5.4. Speech vs Psychosocial SHI Domains

Our results show that there is a strong correlation between the speech and psychosocial domains of SHI ($p<0.001$). Though it is difficult to determine the direction of this relationship, it is apparent that the two are closely intertwined. Patients who self-perceive more dysarthria may feel a greater psychosocial burden as a result of their impairments. Conversely, patients with less psychosocial support may achieve lower levels of functional rehabilitation. Our results are in line with other studies that have also emphasized the importance of a biopsychosocial approach to rehabilitation of patients with dysarthria and other speech impairments [20, 21]. Further research is required in order to better understand the relationship between speech and psychosocial outcomes, in order to better guide the functional rehabilitation process of post-glossectomy patients.

5.5. Patient Versus Family SHI

To our knowledge, this is the first study to compare patient and family SHI scores in glossectomy patients. Overall, patient and family scores are similar, but patients with greater impairments (higher SHI) appear to have larger discrepancies between their own scores and their families' scores. Further research is required in order to ascertain the reasons for this trend. It is important to consider both the patient and family's understanding of the patient's dysarthria during speech rehabilitation, since family members are often the primary communication partners and support network [22]. Previous studies on rehabilitation of aphasia patients have shown that SLPs are in favor of family involvement, and results support some degree of family participation [22, 23].

Future direction of telemedicine for speech therapy research

With the onset of the pandemic, the use of telemedicine in clinical research has become a highly relevant topic. More specifically, one of the concerns that have arisen is the practicality of conducting speech and swallow evaluations through telemedicine. There are limited studies on the role of telemedicine in research, but our study is the first to analyze the feasibility of conducting clinical research entirely through video speech evaluation [24, 25]. It is also the first to use telemedicine to analyze speech outcomes in hemiglossectomy patients who have undergone RFFF tongue reconstruction. Our project design and results suggest that telemedicine platforms can be used effectively for SLP evaluations and prospective studies. The authors who collected data stated that all twenty patients were assessed to the same caliber as they would have been through an in-person evaluation. Additionally, all our participants endorsed feeling well-supported throughout the duration of these evaluations. During a pandemic, when in-person assessments have been severely limited, it is important to consider the future directions of clinical research via telecare platforms. There will likely continue to be increased involvement of telemedicine in future clinical and research settings.

5.6. Limitations

One of the limitations of our study was our small sample size. This was largely due to the fact that we are conducting research during a pandemic, and patients are less inclined to enroll in research studies, whether or not they are performed through a virtual medium. Additionally, it is possible that participants' responses to the Speech Handicap Index were influenced by the pandemic. COVID precautions have led to fewer social interactions for many, so this may have affected both the participant and family's perceptions of patient speech.

6. Conclusion

Dysarthria is a common sequela of glossectomy that can have large impacts on patients' daily functioning and quality of life. Our data has shown that the degree of speech impairment, as measured by both objective and subjective speech measures, can be affected by a variety of factors, particularly tumor stage and inclusion of radiation therapy. Speech function is also closely correlated with psychosocial factors, underlining the importance of a more biopsychosocial approach to rehabilitation. Future projects with larger sample sizes are required in order to further analyze the factors that influence dysarthria in glossectomy patients, a population that is frequently afflicted by speech dysfunction. Furthermore, our study highlights the fact that telecare is an effective platform to conduct such clinical research.

References

1. Hollander JE, Carr BG. Virtually Perfect? Telemedicine for Covid-19. N Engl J Med. 2020; 382(18): 1679-81.
2. Lurie N, Carr BG. The Role of Telehealth in the Medical Response to Disasters. JAMA Intern Med. 2018; 178(6): 745-6.
3. Strehle EM, Shabde N. One hundred years of telemedicine: does this

new technology have a place in paediatrics? Arch Dis Child. 2006; 91(12): 956-9.

4. Alemi AS, Seth R, Heaton C, Wang SJ, Knott PD. Comparison of Video and In-person Free Flap Assessment following Head and Neck Free Tissue Transfer. Otolaryngol Head Neck Surg. 2017; 156(6): 1035-40.
5. Ji YB, Cho YH, Song CM, et al. Long-term functional outcomes after resection of tongue cancer: determining the optimal reconstruction method. Eur Arch Otorhinolaryngol. 2017; 274(10): 3751-6.
6. Takatsu J, Hanai N, Suzuki H, et al. Phonologic and Acoustic Analysis of Speech Following Glossectomy and the Effect of Rehabilitation on Speech Outcomes. J Oral Maxillofac Surg. 2017; 75(7): 1530-41.
7. Acher A, Perrier P, Savariaux C, Fougeron C. Speech production after glossectomy: methodological aspects. Clin Linguist Phon. 2014; 28(4): 241-56.
8. Urken ML, Moscoso JF, Lawson W, Biller HF. A systematic approach to functional reconstruction of the oral cavity following partial and total glossectomy. Arch Otolaryngol Head Neck Surg. 1994; 120(6): 589-601.
9. Matsui Y, Ohno K, Yamashita Y, Takahashi K. Factors influencing postoperative speech function of tongue cancer patients following reconstruction with fasciocutaneous/myocutaneous flaps--a multicenter study. Int J Oral Maxillofac Surg. 2007; 36(7): 601-9.
10. Dwivedi RC, St Rose S, Chisholm EJ, et al. Evaluation of speech outcomes using English version of the Speech Handicap Index in a cohort of head and neck cancer patients. Oral Oncol. 2012; 48(6): 547-53.
11. Borggreven PA, Verdonck-de Leeuw IM, Muller MJ, et al. Quality of life and functional status in patients with cancer of the oral cavity and oropharynx: pretreatment values of a prospective study. Eur Arch Otorhinolaryngol. 2007; 264(6): 651-7.
12. Lazarus CL, Husaini H, Jacobson AS, et al. Development of a new lingual range-of-motion assessment scale: normative data in surgically treated oral cancer patients. Dysphagia. 2014; 29(4): 489-99.
13. National Outcomes Measurement System (NOMS): Adults Speech-Language Pathology User's Guide. American Speech-Language-Hearing Association; 2002, 2013.
14. Kent RD, Kent JF, Rosenbek JC. Maximum performance tests of speech production. J Speech Hear Disord. 1987; 52(4): 367-87.
15. Rinkel RN, Verdonck-de Leeuw IM, van Reij EJ, Aaronson NK, Leemans CR. Speech Handicap Index in patients with oral and pharyngeal cancer: better understanding of patients' complaints. Head Neck. 2008; 30(7): 868-74.
16. Balaguer M, Boisguérin A, Galtier A, Gaillard N, Puech M, Woisard V. Assessment of impairment of intelligibility and of speech signal after oral cavity and oropharynx cancer. Eur Ann Otorhinolaryngol Head Neck Dis. 2019; 136(5): 355-9.
17. Sun J, Weng Y, Li J, Wang G, Zhang Z. Analysis of determinants on speech function after glossectomy. J Oral Maxillofac Surg. 2007; 65(10): 1944-50.
18. Balaguer M, Boisguerin A, Galtier A, Gaillard N, Puech M, Woisard V. Factors influencing intelligibility and severity of chronic speech disorders of patients treated for oral or oropharyngeal cancer. Eur Arch Otorhinolaryngol. 2019; 276(6): 1767-74.
19. Shin YS, Koh YW, Kim SH, et al. Radiotherapy deteriorates postoperative functional outcome after partial glossectomy with free flap reconstruction. J Oral Maxillofac Surg. 2012; 70(1): 216-20.
20. Wray F, Clarke D. Longer-term needs of stroke survivors with communication difficulties living in the community: a systematic review and thematic synthesis of qualitative studies. BMJ Open. 2017; 7(10): e017944.
21. Atkinson-Clement C, Letanneux A, Baille G, et al. Psychosocial Impact of Dysarthria: The Patient-Reported Outcome as Part of the Clinical Management. Neurodegener Dis. 2019; 19(1): 12-21.
22. Johansson MB, Carlsson M, Sonnander K. Working with families of persons with aphasia: a survey of Swedish speech and language pathologists. Disabil Rehabil. 2011; 33(1): 51-62.
23. Johansson MB, Carlsson M, Östberg P, Sonnander K. A multiple-case study of a family-oriented intervention practice in the early rehabilitation phase of persons with aphasia. Aphasiology. 2013; 201-26.
24. McConnell MV, Shcherbina A, Pavlovic A, et al. Feasibility of Obtaining Measures of Lifestyle From a Smartphone App: The MyHeart Counts Cardiovascular Health Study. JAMA Cardiol. 2017; 2(1): 67-76.
25. Sharma A, Harrington RA, McClellan MB, et al. Using Digital Health Technology to Better Generate Evidence and Deliver Evidence-Based Care. J Am Coll Cardiol. 2018; 71(23): 2680-90.