Surgical Reconstruction Versus Prosthetic Obturation of Extensive Soft Palate Defects: A Comparison of Speech Outcomes

Jana Rieger, PhD[a]/George Bohle III, DDS[b]/Joseph Huryn, DDS[c]/Judith Lam Tang, MSc[d]/Jeffrey Harris, MD, FRCSC[e]/Hadi Seikaly, MD, FRCSC[f]

Purpose: The restoration of speech after an extensive resection of the soft palate has been a challenge faced by both prosthodontists and surgeons. Few comparisons between prosthetic rehabilitations and surgical reconstructions of large soft palate defects exist in equally matched groups of patients. The purpose of this study was to evaluate speech outcomes in patients with soft palate defects that were rehabilitated with either a pharyngeal obturator or surgical reconstruction. ***Materials and Methods****:* Nine patients who were treated via prosthetic obturation were compared to nine patients who underwent surgical reconstruction of the oropharynx with a radial forearm free flap and a soft palate insufficiency repair modification. Speech intelligibility data, perceptual ratings of resonance, and aeromechanical measurements of velopharyngeal function were collected. ***Results****:* There were no differences in any of the speech outcome measures between the two groups of patients. ***Conclusion****:* Future studies should focus on the patient's perspective on rehabilitative options and potential quality of life issues. *Int J Prosthodont 2009;22:566–572.*

Acquired defects of the soft palate pose a technical and functional treatment challenge for the surgeon, prosthodontist, speech and language pathologist, and the patient. The velopharyngeal complex is an intricate arrangement of muscles simultaneously moving the soft palate superiorly and posteriorly, the lateral pharyngeal walls medially, and the posterior wall anteriorly to various degrees during phonation and swallowing. Acquired anatomical defects from tumor ablation result in a physical void in this sphincter. This allows for the escape of acoustic energy, resulting in hypernasality during speech and incompetence during swallowing, resulting in liquids expressed from the nose. Debates discussing the advantages and disadvantages of various surgical and prosthetic approaches to correct these defects and improve overall patient outcomes continue today.

Several surgical approaches utilizing various flap designs to repair a defect of this nature have been proposed throughout the years.[1–9] These approaches have accomplished the goal of physically closing the defect and possibly eliminating the need for a prosthesis. Advocates for surgical intervention claim that a prosthetic rehabilitation is bulky and cumbersome. This is a particularly important point when rehabilitating a patient with trismus, since the prosthesis may not be fully extended due to the physical limitations in opening. Additionally, edentulous patients may have a difficult time retaining prostheses without the aid of adhesive or osseointegrated implants.

[a]*Associate Professor, Faculty of Rehabilitation Medicine, University of Alberta, Edmonton, Alberta, Canada; Program Director for Functional Outcomes, Institute for Reconstructive Sciences in Medicine, Misericordia Hospital, Edmonton, Alberta, Canada.*
[b]*Director, Maxillofacial Prosthetics Training Program, Memorial Sloan Kettering Cancer Center, New York, New York, USA.*
[c]*Chief of Dental Service, Memorial Sloan Kettering Cancer Center, New York, New York, USA.*
[d]*Research Associate, University of Alberta, Edmonton, Alberta, Canada; Research Associate, Institute for Reconstructive Sciences in Medicine, Misericordia Hospital, Edmonton, Alberta, Canada.*
[e]*Director, Advanced Head and Neck Oncology and Microvascular Reconstruction Program, University of Alberta, Edmonton, Alberta, Canada.*
[f]*Associate Professor, Faculty of Medicine, University of Alberta, Edmonton, Alberta, Canada; Director, Division of Otolaryngology–Head and Neck Surgery, University of Alberta Hospital, Edmonton, Alberta, Canada.*

Correspondence to: *Dr Jana Rieger, Institute for Reconstructive Sciences in Medicine, Misericordia Hospital, 16940-87 Avenue, Edmonton, Alberta, Canada T5R 4H5. Fax: 780-735-2658. Email: jana.rieger@ualberta.ca*

Table 1 Patient Characteristics

Patient	Age (y)	Sex	History of RT	Lesion	BOT resected (%)	SP resected (%)	Days between Sx and Ax
iRSM 1	64	M	Yes	T3N2M0	25	100	26
MSKCC 1	80	F	Yes	NA	0	75	609
iRSM 2	45	M	No	T3N2BM0	25	75	365
MSKCC 2	54	F	No	NA	0	75	427
iRSM 3	68	F	Yes	T4N2BM0	50	75	395
MSKCC 3	47	M	Yes	T4N2M0	50	50	1,014
iRSM 4	55	M	Yes	T3N0M0	25	100	357
MSKCC 4	70	M	Yes	NA	0	75	2,049
iRSM 5	46	M	Yes	T4N2M0	50	100	339
MSKCC 5	30	F	No	NA	0	100	1,354
iRSM 6	74	M	Yes	T3N2BM0	25	75	159
MSKCC 6	46	F	Yes	T3N0M0	0	75	5,560
iRSM 7	55	F	Yes	T3N1M0	0	100	191
MSKCC 7	62	M	Yes	NA	0	100	193
iRSM 8	49	F	Yes	T2N2BM0	25	75	531
MSKCC 8	52	M	Yes	T2N1M0	0	75	477
iRSM 9	59	M	Yes	T4N0M0	50	100	419
MSKCC 9	56	F	Yes	T3N0M0	0	100	500

RT = radiation therapy; BOT = base of tongue; SP = soft palate; Sx = surgery; Ax = speech assessment; M = male; F = female; NA = not available.

Prosthodontic rehabilitation through the fabrication of a speech and feeding aid has been long advocated and used as treatment for patients with hard and soft palate defects. Acrylic resin prostheses are custom-molded using normal sphincter functions to replace the missing musculature of the soft palate and improve speech and swallowing. These prostheses are removable and able to be reshaped as needed, especially throughout radiation therapy, during which fibrotic scaring and necrosis may occur. Typically, once the area has healed, the need for adjustments diminishes and the patient requires a replacement prosthesis only if damaged. Furthermore, although medical imaging and fiber-optic examination allow for monitoring of the reconstructed area, medical professionals have the luxury of a direct visualization of the area for follow-up in patients wearing prostheses.

The purpose of this article is to compare the prospective speech analysis data of patients who have undergone soft palate resection with the soft palate insufficiency repair (SPIR) modification to the data collected retrospectively on matched patients having undergone ablative surgery and prosthodontic rehabilitation.

Materials and Methods

Patients

Medical records from two institutions were reviewed for two groups of patients who underwent a soft palate resection as part of ablative cancer therapy. The first group was composed of 9 patients out of a sample of 19 consecutive patients who were treated via prosthetic obturation at the Memorial Sloan Kettering Cancer Center Dental Service (MSKCC), New York, New York, over the course of 10 years (from 1990 to 2000). The data for these patients were collected and reported on as part of a previous study participated in by the two primary co-authors of the present study.[10] To be included in the present study, all patients in this group were required to have defects of the soft palate that extended across the midline and included the levator sling. The use of microvascular free flaps in this group of patients was only for protection and lining of the lateral and posterior pharyngeal walls, thereby allowing access into the nasopharynx for prosthetic rehabilitation with a pharyngeal obturator.

Data from 10 patients who participated in the 2005 study[10] were excluded from the present study because of one of the following: in addition to a soft palate defect, there was *(1)* a unilateral maxillary resection that extended anteriorly to the right or left first molar, *(2)* a bilateral maxillary resection, or *(3)* resection of any portion of the anterior two-thirds of the tongue. For this group, informed consent was given for evaluation of the medical and surgical data and the speech evaluation prior to involvement in the original study.

The second group was composed of nine consecutive patients who were treated at the Institute for Reconstructive Sciences in Medicine (iRSM), Edmonton, Alberta, Canada, between 2003 and 2006. A portion of the data for these patients is also reported elsewhere.[11] All patients in this group had defects that crossed the midline and included the levator sling. These defects were reconstructed at the time of resection using a radial forearm free flap with an SPIR modification.[1] An SPIR modification includes incising the dermis along the free edge of the folded radial forearm flap, followed by the elevation of small subdermal and submucosal flaps on either side of this incision. A superior pharyngeal flap is sutured to the posterior free edges of the folded flap, effectively closing off the nasopharyngeal side of the defect. The anterior subdermal flap is then approximated to the inferior posterior pharyngeal flap. This results in complete closure of the nasopharyngeal defect, leaving only a small nasopharyngeal port on one side just large enough to provide passage of a feeding tube.

From the original group of 10 patients, 1 individual was excluded due to cognitive deficits that prevented him from completing the speech assessments necessary for the present comparison. As with the prosthetic group, no patient in the reconstructive group had involvement of the anterior two-thirds of the tongue or maxilla. Ethical approval was obtained through the Health Research Ethics Board at the University of Alberta, Edmonton, Alberta, Canada.

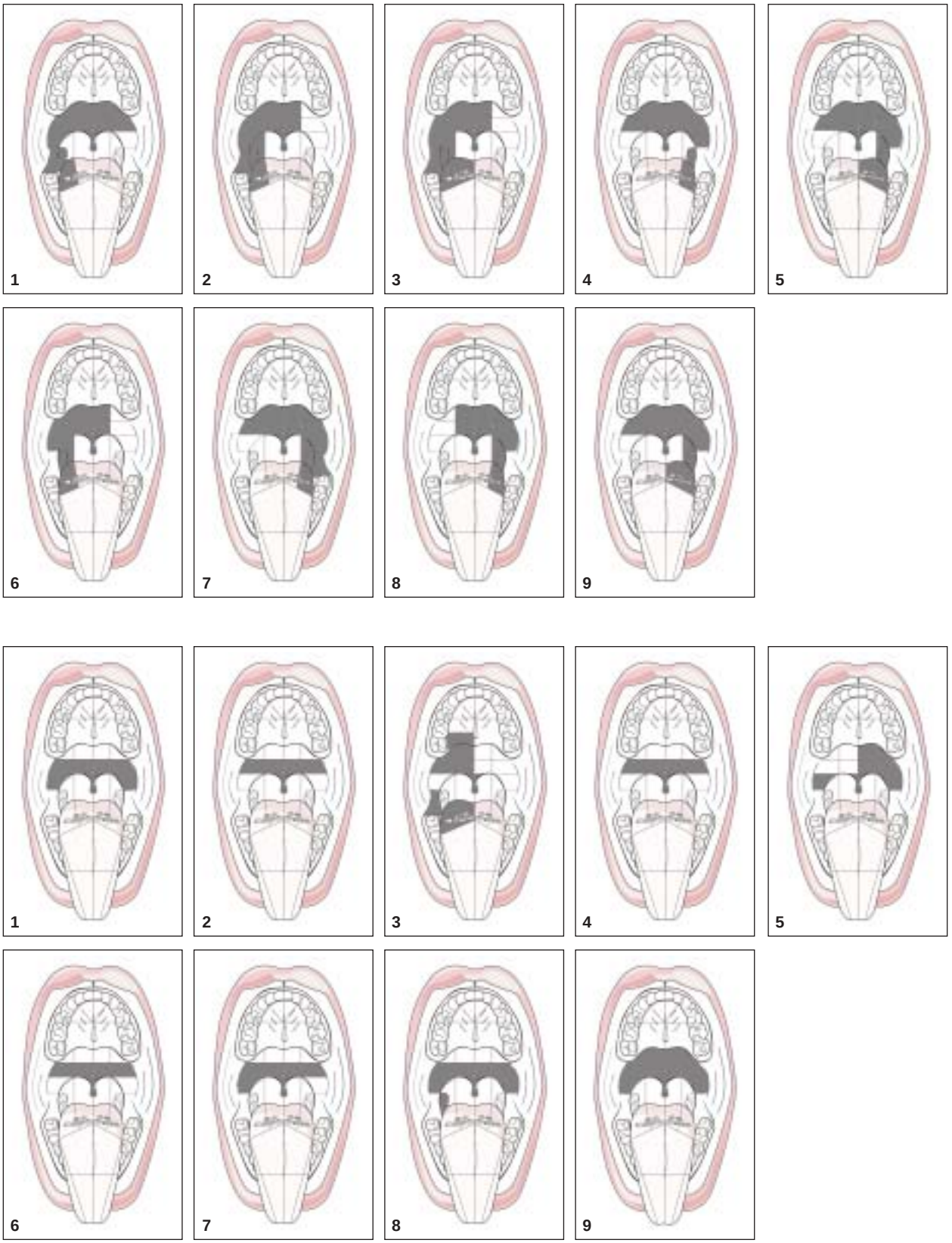

Fig 1 Anatomical areas involved in the ablative surgery for patients one through nine in both groups: SPIR *(top)*, obturator *(bottom)*.

Table 2 Descriptive Data

	VPO "papa" (mm^2)		VPO "hamper" (mm^2)		Word intelligibility (%)		Sentence intelligibility (%)		Perceptual rating				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	1	2	3	4	5
Prosthetic rehabilitation	3.00	5.14	4.97	4.39	79.78	12.37	92.34	8.67	n = 0	n = 2	n = 6	n = 1	n = 0
Surgical reconstruction	1.14	1.71	5.06	3.67	74.11	19.03	91.75	10.99	n = 0	n = 5	n = 2	n = 2	n = 0
Normal values[14,15]	0–5				> 90				3				

SD = standard deviation; n = number of patients; 1 = markedly hyponasal; 2 = mildly hyponasal; 3 = normal; 4 = mild hypernasality; 5 = markedly hypernasal.

The medical and surgical data collected for each patient included: age, sex, diagnosis, TNM staging, date of surgical procedure, anatomical regions resected, and radiation dosage. Patient characteristics are presented in Table 1. The anatomical areas involved in the ablative surgery for both groups are presented in Fig 1.

Functional Speech Measures

Speech evaluations included both aeromechanical and perceptual assessments and were carried out by a speech-language pathologist using a standard protocol. As previously described, the PERCI-SARS software (Microtronics) was used to estimate velopharyngeal orifice area (VPO) during speech.[10,11] The patients' data included repeated utterances of two stimulus words (papa and hamper) used in routine clinical practice for the collection of aeromechanical data.

Perceptual evaluations of speech included the evaluation of intelligibility, as well as a subjective rating of the presence of hypernasality and nasal air emission. Speech samples for intelligibility measures and perceptual evaluations were collected in a quiet but nonsoundproof room using a portable analog cassette recorder (TCM-5000EV, Sony) at MSKCC and a portable digital tape recorder (TCD-D10 Pro II, Sony) at iRSM with an external microphone. For the evaluation of intelligibility, speech stimuli included 50 words and 22 sentences that were randomly generated (Computerized Assessment of Intelligibility of Dysarthric Speech, Pro-Ed).[12] To calculate percent intelligibility, four listeners at each institution transcribed what they perceived each patient to be saying. At MSKCC, two attending maxillofacial prosthodontists, a maxillofacial prosthodontic fellow, and an untrained layperson who had no prior patient contact transcribed the speech samples. At iRSM, one speech-language pathologist, two graduate students in speech pathology, and an untrained layperson who had no prior patient contact transcribed the speech samples. The transcriptions were compared to a key that was stored in each patient's file to calculate the percentage of correctly identified words.

For the perceptual analysis of hypernasality and nasal air emission, each patient was asked to read the Zoo Passage—a nonnasal reading passage that has been used routinely for the assessment of nasality in North America.[13] One speech language pathologist, who was blinded to each patient's identity, rated the hypernasality of each sample of speech from both MSKCC and iRSM subjects using the following scale:

- Markedly hyponasal: the patient's resonance is characterized by pervasive hyponasality such that speech becomes unintelligible out of context and the patient is often asked to repeat.
- Mildly hyponasal: the patient's resonance is characterized by hyponasality but speech remains intelligible out of context.
- Normal: resonance balance is appropriate for everyday communication and is not characterized by hypo- or hypernasality.
- Mildly hypernasal: the patient's resonance is characterized by hypernasality but speech remains intelligible out of context.
- Markedly hypernasal: the patient's resonance is characterized by pervasive hypernasality such that speech becomes unintelligible out of context and the patient is often asked to repeat.

The presence or absence of nasal air emission was also noted by this listener.

Statistical Methods

A one-way multiple analysis of variance (MANOVA) was used to analyze group differences for the speech variables that involved continuous data (ie, VPO for the words "papa" and "hamper" and word and sentence intelligibility). A Mann-Whitney test was used to analyze differences between groups for the perceptual ratings of hypernasality and nasal air emission. Intraclass correlations (ICC[2,1]) were used to assess interrater reliability between the four raters at each institution. All tests used a significance level of .05.

Results

Descriptive data for the speech results across the two groups are shown in Table 2. A preliminary analysis of the background patient characteristics revealed that there was only one variable, percent base of tongue resected, that differed significantly between the two groups. The group of patients from iRSM had significantly more base of the tongue resected than those from MSKCC. However, a two-tailed Pearson correlation did not show any significant relationship between the percent of base of the tongue resected and any of the dependent speech variables. Thus, this factor was not considered in the main between-group statistical analysis. Neither the MANOVA nor the Mann-Whitney test revealed statistically significant differences between the groups for any of the speech variables. ICCs revealed an acceptable level of interrater reliability for both words and sentences at MSKCC (0.81 and 0.70, respectively) and at iRSM (0.92 and 0.83, respectively).

Discussion

The question of what is the best way to provide the most functional speech post–ablative cancer resection involving the soft palate continues to be an open-ended discussion, with options involving prosthetic rehabilitation and surgical reconstruction. When attempting to discuss functional speech outcomes via the use of free flap reconstruction as opposed to prosthetic rehabilitation, the literature is sparse with direct comparisons. Yoshida et al[16] directly compared obturators to flaps of acquired defects in their investigation. These patients were recorded speaking 100 Japanese syllables with 10 listeners transcribing the recordings who had no prior patient contact. The obturator group averaged 68% intelligibility with the obturator and the flap group averaged 58% postoperatively, with 4 of the flap patients improving an average of 9.3% (median: 4.2%) when later treated with prostheses. Comparisons of these results with the present study and other studies that investigated word intelligibility reveals similar results for the prosthetically treated patients. For example, in Kipfmueller and Lang's study[17] involving acquired defects following cancer surgery, intelligibility percents for words ranged from 71% to 99% with an obturator. In the present study, word intelligibility in the group of patients treated with prostheses was similar, ranging between 52% and 90% with a mean score of 79.8%. On the contrary, however, results of the current study reveal better word intelligibility scores (74.1%) for patients who were treated with surgical reconstruction than those reported by Yoshida et al (58%).[16]

Because there are so few direct comparisons between the two treatments under discussion in the present study, it is necessary to look to reports of each method of treatment individually for some insight into this debate. With respect to surgical reconstruction, Brown et al[2] reported speech outcomes for flap reconstruction with and without an additional pharyngeal flap for acquired defects and found greater success when a pharyngeal flap was added to the reconstructive procedure. Their findings revealed that 94% of the connected speech sample was intelligible to a trained listener for patients who had a pharyngeal flap. These findings compare favorably with the results from the present study. Moerman et al[3] reported on 4 patients who underwent surgical reconstruction with a radial forearm free flap after resection for extensive lesions that involved the soft palate. Although specific percentages of speech intelligibility were not reported, their perceptual and acoustic speech results indicated that all 4 patients had normal postoperative speech outcomes. Other studies that appear to use perceptual assessment of speech report good outcomes after surgical reconstruction. For example, Sinha et al[4] reported on 16 patients who underwent soft palate reconstruction with a radial forearm free flap. Of these patients, 2 required a palatal prosthesis to restore function. The authors report that 2 patients were hypernasal and 3 were hyponasal.

Hashikawa et al[5] compared five patients who were reconstructed with an adhesion to those who were not. Out of the five patients with an adhesion, four were reported to have excellent speech. Those who did not have an adhesion had poor to moderate speech. Likewise, speech outcomes in patients who underwent soft palate reconstruction were variable, ranging from normal to markedly impaired in a study reported by McCombe et al.[6] The surgical reconstruction in the McCombe study did not include a procedure to reduce the velopharyngeal aperture.

Comparison of the present study's findings to those reporting speech outcomes for soft palate obturation is much more limited, since there are few studies that have reported solely on prosthetic intervention with this subset of patients. One study that has reported speech outcomes on a small group of patients who had lesions that involved both the maxilla and the soft palate revealed that word and sentence intelligibility scores compared favorably with the results for both groups reported on in the present study (77% and 95%, respectively).[18]

Historically, surgical reconstruction of the velopharynx has resulted in poor speech outcomes, especially when no modifications are made to reduce the size of the velopharyngeal orifice. On the other hand, pharyngeal obturators have been considered a conventional form of treatment that has been successful in restoring the intelligibility of speech. However, removable prostheses have been criticized for being rigid in

nature and therefore ineffective as a substitute for the pliable and dynamic soft palate.[7,8] They also have been criticized for their effect on the surrounding musculature, obstructing its movement[9] and being cumbersome to wear, causing discomfort and irritation.[4,8,9] Regardless of these criticisms that may or may not be well-founded, the functional results in this study reveal clinically acceptable speech outcomes for patients who are rehabilitated with an obturator. Furthermore, we are now at a point where the surgical results from the present study would suggest that surgical reconstruction is also a viable technique, especially when a modification such as the SPIR is undertaken to reduce the velopharyngeal aperture. Eight of the nine surgically reconstructed patients in this study were assessed after radiation therapy (mean date of assessment was 345 days postsurgery; range: 159 to 531 days). One patient who had a history of failed primary radiation therapy was assessed 25 days after salvage surgery. The potential for poor functional outcomes after radiation therapy due to fibrotic scaring and necrosis, which was a problem previously reported in a group of patients reconstructed without an SPIR modification,[19] was not an issue for the surgically reconstructed patients in the present study. While the sample size within this study was small and power was limited, the results suggest that from a functional perspective, both surgical and prosthetic intervention are effective at restoring speech after large soft palate ablations. Future investigations with larger sample sizes will be required to confirm the findings from the present study.

One final consideration that has not been mentioned is the patients' perspectives on the outcomes. While the present study did not collect this information, an indication of comparative quality of life outcomes associated with both forms of treatment can be gained from one study in the literature.[20] Although the outcomes of that study are related to maxillary obturation versus surgical reconstruction of the maxilla and are based on a small population, the results point to a potential disparity between the approaches in terms of psychosocial adjustment in the patients. For example, those who received a prosthesis reported more difficulty speaking in public and a general fear of being misunderstood during conversation. Extrapolation of these results to soft palate resection may be flawed and thus, a future study on the quality of life in patients with soft palate defects is required.

Conclusion

This study evaluated and compared speech outcomes between two groups of patients with 50% or more of their soft palate resected—those rehabilitated with a pharyngeal obturator and those reconstructed for function via a radial forearm free flap with an SPIR modification. The results revealed no differences between the two groups of patients. To render a fair and well-informed decision regarding which treatment modality to use, the overall well-being of the patient should be considered. The overriding goal of cancer treatment should be patient survival with an adjunct goal of restoring and returning the patient to as near presurgical level of function as possible. In addition, the patient's perspective on rehabilitative options and potential quality of life outcomes must be considered in the future.

Acknowledgments

This work was supported by the Memorial Sloan Kettering Cancer Center Dental Service Research Fund and the Alberta Heritage Foundation for Medical Research.

References

1. Seikaly H, Rieger JM, Zalmanowitz JG, et al. Functional soft palate reconstruction: A comprehensive surgical approach. Head Neck 2008;30:1615–1623.
2. Brown JS, Zuydam AC, Jones DC, Rogers SN, Vaughan ED. Functional outcome in soft palate reconstruction using a radial forearm free flap in conjunction with a superiorly based pharyngeal flap. Head Neck 1997;19:524–534.
3. Moerman M, Vermeersch H, Van Lierde K, Fahimi H, Van Cauwenberge P. Refinement of the free radial forearm flap reconstructive technique after resection of large oropharyngeal malignancies with excellent functional results. Head Neck 2003;25:772–777.
4. Sinha UK, Young P, Hurvitz K, Crockett DM. Functional outcomes following palatal reconstruction with a folded radial forearm free flap. Ear Nose Throat J 2004;83:45–48.
5. Hashikawa K, Tahara S, Terashi H, et al. Positive narrowing pharyngoplasty with forearm flap for functional restoration after extensive soft palate resection. Plas Reconstr Surg 2005;115:388–393.
6. McCombe D, Lyons B, Winkler R, Morrison W. Speech and swallowing following radial forearm flap reconstruction of major soft palate defects. Br J Plast Surg 2005;58:306–311.
7. Zohar Y, Buler N, Shvilli Y, Sabo R. Reconstruction of the soft palate by uvulopalatal flap. Laryngoscope 1998;108:47–50.
8. Zeitels SM, Kim J. Soft-palate reconstruction with a "SCARF" superior-constrictor advancement-rotation flap. Laryngoscope 1998;108:1136–1140
9. Gillespie MB, Eisele DW. The uvulopalatal flap for reconstruction of the soft palate. Laryngoscope 2000;110:612–615.
10. Bohle G, Rieger J, Huryn J, Verbel D, Hwang F, Zlotolow I. Efficacy of speech aid prostheses for acquired defects of the soft palate and velopharyngeal inadequacy—Clinical assessments and cephalometric analysis: A Memorial Sloan-Kettering Study. Head Neck 2005;27:195–207.
11. Rieger JM, Zalmanowitz JG, Li SY, et al. Speech outcomes after soft palate reconstruction with the soft palate insufficiency repair procedure. Head Neck 2008;30:1439–1444.

12. Yorkston K, Beukelman D. Assessment of Intelligibility of Dysarthric Speech. Portland, Oregon: CC Publications, 1981.
13. Fletcher SG. Contingencies for bioelectronic modification of nasality. J Speech Hear Disord 1972;37:329–346
14. Warren DW, Dubois AB. A pressure-flow technique for measuring velopharyngeal orifice area during continuous speech. Cleft Palate J 1964;16:52–71.
15. Strong MJ, Grace GM, Orange JB, Leeper HA, Menon RS, Aere C. A prospective study of cognitive impairment in ALS. Neurology 1999;53:1665–1670.
16. Yoshida H, Michi K, Yamashita Y, Ohno K. A comparison of surgical and prosthetic treatment for speech disorders attributable to surgically acquired soft palate defects. J Oral Maxillofac Surg 1993;51:361–365.
17. Kipfmueller LJ, Lang BR. Presurgical maxillary prosthesis: An analysis of speech intelligibility. J Prosthet Dent 1972;28:620–625.
18. Rieger J, Wolfaardt J, Seikaly H, Jha N. Speech outcomes in patients rehabilitated with maxillary obturator prostheses after maxillectomy: A prospective study. Int J Prosthodont 2002;15:139–144.
19. Seikaly H, Rieger J, Wolfaardt J, Moysa G, Harris J, Jha N. Functional outcomes after primary oropharyngeal cancer resection and reconstruction with the radial forearm free flap. Laryngoscope 2003;113:897–904.
20. Genden EM, Okay D, Stepp MT, et al. Comparison of functional and quality-of-life outcomes in patients with and without palatomaxillary reconstruction: A preliminary report. Arch Otolaryngol Head Neck Surg 2003;129:775–780.