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Patient-Perceived Long-Term Communication and Swallow Function Following Cerebellopontine Angle Surgery

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Objectives/Hypothesis: Evaluation of long-term patient-perceived functional outcomes and quality of life (QOL) related to communication and eating with an emphasis on voice, speech production, and swallowing after cerebello-pontine angle (CPA) surgery.

Study Design: Prospective cross-sectional study.

Methods: The MD Anderson Dysphagia Inventory (MDADI), Voice Handicap Index (VHI), and Facial Clinimetric Evaluation (FaCE) surveys were distributed to patients who underwent CPA surgery between January 2008 and December 2010. Immediate postoperative cranial nerve function extracted from medical records was compared to long-term patient-perceived function and associated QOL.

Results: There was a 61% response rate with a mean postoperative period of 31.6 months (range 15–49). The presence of facial palsy in the postoperative period and the corresponding House-Brackmann (H-B) score were the strongest predictors of patient-perceived long-term function and QOL in all three domains ($P < .005$). Postoperative vagal palsy by comparison was not associated with long-term disturbance of voice or speech function. Postoperative dysphagia had a particularly large association with perceived long-term facial function and related QOL ($P < .0005$), with a smaller but significant impact on perceived swallow outcome ($P < .05$). After adjusting for other variables, the postoperative H-B score remained a significant predictor of perceived long-term facial and voice function and related QOL.

Conclusions: Patients with severe facial dysfunction following surgery to the CPA are at increased risk for long-term self-reported difficulties with communication and eating, even with improvement of vagal function. Speech and swallow therapy should therefore be provided to these patients whether or not they also have pharyngeal dysphagia or voice disturbance.

Key Words: Vestibular schwannoma, acoustic neuroma, quality of life, swallowing, dysphagia, speech, voice, long-term.

Level of Evidence: 2b.

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INTRODUCTION

Cranial nerve deficits are not unexpected following surgical management of vestibular schwannomas. In the immediate postoperative period, facial nerve palsy has been reported to occur in ≈1/3 of patients undergoing surgery for vestibular schwannoma, with a significant improvement in nerve function noted in the first postoperative year for the majority of patients.[1–3] Although vagal nerve palsy is uncommonly reported, the proximity of the tenth cranial nerve complex to the internal auditory canal (IAC) may lead to temporary or permanent dysfunction after surgery to this region. Best et al. documented unilateral vagus nerve palsy in 10% of patients in the postoperative period following surgery to the cerebellopontine angle (CPA).[4] Vagus nerve palsy was associated with tumor size (>30 mm) as well as prolonged hospitalization. Aspiration was common in individuals with vagal palsy. Both facial nerve and vagal palsies may impact speech, voice, and swallowing postoperatively, with potential for long-term impact on health status and quality of life (QOL).

Several factors including hearing loss, facial nerve weakness, and headaches have been reported to negatively impact overall QOL.[5–7] The largest report was based on a survey of patients in the Acoustic Neuroma Association database.[5] In this report, hearing loss, facial nerve weakness, eye dysfunction, and headaches were cited as the most troubling symptoms following surgery. Additionally in this sample, 31% of participants reported some postoperative swallowing difficulties. The nature of these swallowing difficulties was not, however, defined by the survey utilized. Starmer et al. reported oral and/or pharyngeal swallowing abnormalities in the immediate postoperative period in ≈1/3 of patients.[8] Of those individuals with dysphagia, 51% were found to have purely oral stage deficits, 12% were found to have purely pharyngeal deficits, and 37% had both oral and pharyngeal deficits. Diet alterations at discharge were

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TABLE I.
Patient Characteristics (n = 111).

Age	
<40 years	19 (17%)
40–60 years	72 (65%)
61–80 years	19 (17%)
>80 years	1 (1%)
Sex	
Male	44 (40%)
Female	67 (60%)
Race	
White	99 (89%)
Black	6 (5%)
Hispanic	2 (2%)
Asian	4 (4%)
Side of tumor	
Left	62 (56%)
Right	49 (44%)
Postoperative House-Brackmann Score	
Score 1–3	123 (68%)
Score 4–6	58 (32%)
Pathology	
Vestibular schwannoma	107 (96%)
Other	4 (4%)
Approach	
Suboccipital craniotomy	102 (92%)
Translabyrinthine	9 (8%)
Tumor size (n = 109, 2 unknown)	
<10mm	8 (7%)
10–20mm	49 (45%)
21–30mm	33 (30%)
31–40mm	14 (13%)
>40mm	5 (5%)

documented in 65% of individuals with dysphagia. Information regarding long-term swallowing ability was not available at that time.

Limited data regarding the long-term impact of cranial nerve deficits, particularly those relevant to voice and swallowing, led us to evaluate long-term patient-perceived outcomes and QOL related to these functions after the resection of CPA tumors. Given the prominent role of oral stage deficits in patients with dysphagia, we aimed to further understand the relationship between facial dysfunction and long-term swallow and voice outcomes.

MATERIALS AND METHODS

Consecutive patients undergoing surgical excision of CPA pathology from January 1, 2008, to December 31, 2010, at the Johns Hopkins Hospital comprised the study population (n = 181). Clinical variables were extracted from the electronic medical record as part of earlier investigations regarding vagal palsy and dysphagia. All patients maintained nothing by mouth status until completion of a bedside swallow screen performed by the neurotology team on the second postoperative day. Patients with dysphonia or clinical evidence of aspiration (coughing/wet vocal quality) also underwent fiberoptic laryngoscopy to assess vocal fold mobility and glottic closure. Patients with findings suspicious for dysphagia were referred for evaluation by a speech-language pathologist (SLP). SLP bedside clinical evaluation typically occurred 1 day following the failed swallow screen. SLP clinical evaluations suggestive of significant dysfunction resulted in referral for videofluoroscopic swallowing studies (VFSS). Presence and characteristics of dysphagia were determined through review of SLP reports. Types of dysphagia were defined as oral, pharyngeal, combined oropharyngeal, or other; and these categories were mutually exclusive. Alteration of diet, the need for VFSS, and impairment of the facial and vagus nerves were recorded. House-Brackmann (H-B) scores at the time of discharge were extracted from neurosurgical and/or neurotological reports.[9]

The MD Anderson Dysphagia Inventory (MDADI), Voice Handicap Index (VHI), and Facial Clinimetric Evaluation (FaCE) were distributed to our patient cohort. The MDADI is a 20-item survey that includes questions regarding swallowing function and its impact on functional, physical, and emotional domains.[10] The highest possible score is 100, and higher scores indicate better function. The VHI is a 30-item survey that assesses functional, physical, and emotional impact of voice difficulties.[11] The highest possible score is 120 points, and higher scores indicate poorer voice-related QOL. The FaCE is a 16-question survey used to assess facial nerve function and its impact on patient-reported QOL.[12] The highest number of points possible on this instrument is 75, and higher scores are indicative of better function and QOL. Questionnaires were distributed through direct mailing, with one repeat mailing completed when surveys were not returned. Data regarding immediate postoperative cranial nerve function, as described above, was extracted from our existing database, and comparisons were performed between postoperative function and long-term patient perception of function.

Data were analyzed using Stata 10 (StataCorp, College Station, TX). Unpaired t test was used to assess between-group differences in QOL measures for postoperative dysphagia, facial nerve palsy, or vagal palsy. Univariate analysis was performed to assess prognostic factors of long-term postoperative QOL. Variables that were significant by univariate analysis were considered as potential predictors for multivariate analysis. A stepwise multiple linear regression analysis was performed. If two predictor variables were identified as highly correlated (Spearman's rho >0.60), only one was chosen to be included in the final model. Significance was attributed to a $P < 0.05$. This protocol was reviewed and approved by the Johns Hopkins Medical Institutions Review Board.

RESULTS

Surveys were returned by 111/181 patients, with a return rate of 61% (Table I). The mean time from surgery to survey completion was 31.6 months (range 15–49). The mean age of subjects was 51 years (range 20–81). The majority of patients were female (60%) and white (89%). The majority of CPA tumors were on the left side (56%) and were vestibular schwannomas (96%). The retrosigmoid approach was most commonly used (92%). Half of the subjects had tumors larger than 20-mm diameter in the cisternal portion. Dysphagia was documented in the immediate postoperative period for 35% of those who returned surveys. Postoperative vocal fold motion impairment was documented for 7% of those returning surveys. Postoperative facial nerve palsy was documented for 41% of those returning surveys; 32%

TABLE II.
Long-Term Quality of Life by Presence of Postoperative Dysphagia.

	Dysphagia Present	Dysphagia Absent	*P* Value
MDADI			0.021
Mean	80.43	86.53	
SD	13.72	11.4	
VHI			0.758
Mean	17.02	8.01	
SD	23.67	17	
FaCE			0.0001
Mean	51.88	64.44	
SD	16.72	11.3	

FaCE = facial clinimetric evaluation; MDADI = MD Anderson dysphagia inventory; SD = standard deviation; VHI = voice handicap index.

TABLE IV.
Long-Term Quality of Life by Presence of Postoperative Vagal Palsy.

	Vagal Palsy Present	Vagal Palsy Absent	*P* value
MDADI			0.195
Mean	89.08	84.02	
SD	9.57	12.72	
VHI			0.757
Mean	13.88	21.03	
SD	12.03	20.28	
FaCE			0.963
Mean	59.85	60.68	
SD	13.66	13.89	

FaCE = facial clinimetric evaluation; MDADI = MD Anderson dysphagia inventory; SD = standard deviation; VHI = voice handicap index.

had HB score of 4 or worse. This distribution was reflective of patients in the original database in regards to dysphagia, vagal palsy, and facial nerve palsy, which were 31%, 10%, and 38%, respectively.

Significant differences in long-term QOL measures were found between patients with and without dysfunction in the immediate postoperative period. Patients with postoperative dysphagia scored poorer on the MDADI and FaCE instruments (Table II). Individuals with postoperative facial nerve palsy had significantly poorer scores on all three surveys (Table III). Individuals with postoperative vagal palsy, however, did not report any perceived long-term decrements in facial, swallowing, or voice function, or associated QOL (Table IV).

A number of variables were associated with MDADI, VHI, and FaCE scores on univariate analysis (Table V). Tumor size, postoperative facial nerve palsy, H-B score, presence of dysphagia, type of dysphagia, speech language pathologist (SLP) care, and length of hospitalization were all associated with poorer scores on QOL measures. Using stepwise regression, the tumor size, postoperative H-B score of 4 or greater, presence of dysphagia, and length of hospitalization were included in the final model. A postoperative H-B score of 4 or greater was the only significant variable associated with QOL scores associated with communication and facial function, after controlling for all other factors (Table VI). Further analysis of H-B scores revealed that those with scores ≥ 4 had significantly worse scores on QOL measures in contrast to those with scores ≤ 3 at discharge (Fig. 1). Specifically, H-B scores of 4 to 6 at discharge were associated with worse VHI total (23, SD 4.2 vs. 5.2, SD 1.5, $P < 0.0001$), MDADI (80, SD 2.2 vs. 87, SD 1.3, $P < 0.01$), and FaCE scores (45.6, SD 2 vs. 67.5, SD 1.1, $P < 0.001$).

TABLE III.
Long-Term Quality of Life by Presence of Postoperative Facial Palsy.

	Facial Palsy Present	Facial Palsy Absent	*P* Value
MDADI			0.0005
Mean	81.17	89.1	
SD	13.08	10.02	
VHI			0.0025
Mean	16.75	4.22	
SD	22.91	12.6	
FaCE			<0.0001
Mean	42.5	70.13	
SD	15.88	6.83	

FaCE = facial clinimetric evaluation; MDADI = MD Anderson dysphagia inventory; SD = standard deviation; VHI = voice handicap index.

DISCUSSION

This is the first report of long-term voice- and swallowing-related QOL outcomes in patients undergoing surgery for tumors of the CPA. These data suggest that patients with postoperative cranial neuropathies,

TABLE V.
Univariate Regression of Factors Associated With QOL Measures (*P* Values).

	MDADI	VHI	FaCE
Age	0.602	0.953	0.716
Sex	0.245	0.689	0.839
Race	0.199	0.241	0.572
Tumor side	0.909	0.879	0.062
Surgical approach	0.206	0.676	0.355
Tumor size	0.016	0.013	<0.0001
Vagal palsy	0.274	0.896	0.723
Facial nerve palsy	0.001	0.001	<0.0001
House-Brackmann Score	0.001	<0.0001	<0.0001
Presence of dysphagia	0.014	0.019	<0.0001
Type of dysphagia	0.011	0.003	<0.0001
Length of hospitalization	0.029	0.012	0.018
SLP care	0.024	0.026	<0.0001
Months postoperative	0.368	0.820	0.248

FaCE = facial clinimetric evaluation; MDADI = MD Anderson dysphagia inventory; QOL = quality of life; SLP = speech-language pathologist; VHI = voice handicap index.

TABLE VI.
Multiple Linear Regression Results.

	MDADI		VHI		FaCE	
	Standardized β	P Value	Standardized β	P Value	Standardized β	*P* Value
Intercept	90.890	0.026	15.611	<0.001	68.466	<0.001
Tumor size	−0.139	0.325	0.105	0.490	−0.071	0.561
House-Brackmann Score 4–6	−4.122	0.159	16.040	<0.001	−20.407	<0.001
Presence of dysphagia	−1.981	0.495	0.066	0.988	−3.393	0.180
Length of hospitalization	−0.280	0.414	0.475	0.366	0.219	0.458
R^2	0.100		0.194		0.518	
F	2.880		6.27		27.64	

FaCE = facial clinimetric evaluation; MDADI = MD Anderson dysphagia inventory; VHI = voice handicap index.

even if limited to the facial nerve, are at increased risk for long-term difficulty eating and speaking, with associated decrements in QOL. Postoperative H-B score of 4 or greater is a particularly strong predictor of diminished long-term QOL measured in the context of facial, swallowing, and voice functions. Previous studies of our patient population have reported high rates of facial nerve recovery over the first postoperative year.[2,3] The current study suggests, however, that residual dysfunction in the most impaired cases has implications in other functional domains.

In addition to cosmetic repercussions,[13–15] decreased QOL in patients with facial nerve palsy is also mediated by impaired speech and swallowing functions. From the perspective of speech function, the ability to maintain lip closure is important for speech precision, particularly for the production of bilabial plosives /p, b/. Facial nerve palsy may therefore impact a patient's comfort and willingness to speak in social settings. Patients with facial nerve palsy had poorer VHI scores than those without facial nerve deficits. Although the VHI is designed to capture patient perception of voice function, multiple items may be interpreted by patients to reflect speech (e.g., "People have difficulty understanding me in a noisy room "; "I use the phone less often than I would like to "; and "I use a great deal of effort to speak."). The strong influence of labial dysfunction in the response to these items likely accounts for the higher than anticipated VHI scores in the group with facial palsy.

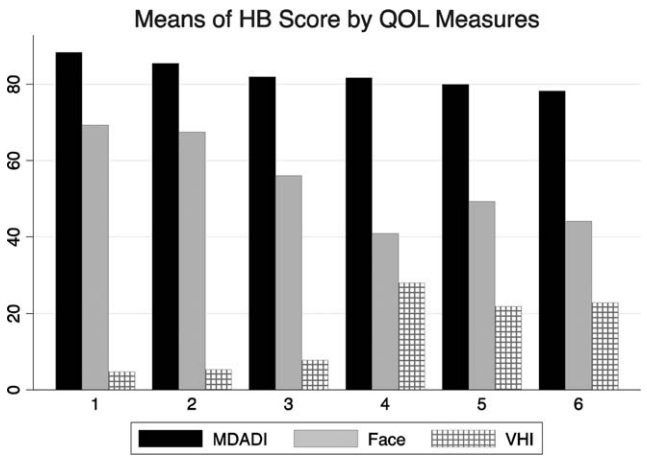

Fig. 1. Means of HB (House-Brackmann) scores by QOL (quality of life) measures.
HB = House-Brackmann; FaCE = Facial Clinimetric Evaluation; MDADI = MD Anderson Dysphagia Inventory; VHI = Voice Handicap Index; X Axis = H–B scores; Y Axis = total QOL scores.

Normal facial nerve function allows individuals to maintain lip closure and buccal tone during swallowing to retain foodstuffs in the oral cavity without anterior or lateral bolus loss. Facial nerve palsy may make eating challenging, particularly in social settings, and it may lead to poorer QOL as reflected in the lower MDADI scores. These findings are in agreement with the prominent role of oral phase dysfunction in patients with dysphagia following CPA surgery.[8] Presumably these deficits persist with residual facial palsy even following the resolution of pharyngeal dysfunction.

These data suggest the importance of early identification of speech and swallowing difficulties to allow for the application of compensatory strategies, postures, diet modifications, and speech and swallowing therapy by a speech and language pathologist (SLP) and/or physical therapist to lessen the functional impact of the speech and swallowing disorder. Although there is limited data regarding the efficacy of treatment in this population, there is data to support the role of rehabilitative therapy in overcoming issues related to facial palsy.[16,17] Similarly, there are data to support the efficacy of speech and swallowing intervention in other populations with oral issues impacting communication and swallowing.[18–20]

Surprisingly, most patients with postoperative vagal palsy apparently recovered nerve function as they were no more likely to have long-term difficulties related to voice and swallowing than patients without vagal palsy. Careful review of these patients suggests several factors that may account for their favorable long-term outcomes. Voice and swallowing intervention was delivered by a SLP during and/or after hospitalization in 71% of these individuals. All had documented improvement in voice and swallowing function following this intervention. Vocal fold medialization injections were performed in 29% of those with vagal palsy, resulting in improvements in voice and swallowing. Finally, of those with

vagal palsy, 71% had documented recovery of vagal function. These findings suggest that vagal palsy is transient in a large number of cases, and that patients receive benefit from SLP interventions and injection laryngoplasty, with favorable QOL in the long term.

SLP care was only administered to 35% of those returning surveys. Those patients receiving SLP care appear, appropriately, to have been the most impaired given their poorer long-term QOL scores (Table V). Of interest, few of those receiving SLP care in the hospital ever received outpatient care for speech and swallowing concerns, despite the long-term impact on function and QOL. This suggests room for improvement in the supportive care provided to these after discharge.

Limitations of this study include the use of patient-reported QOL measures as a proxy for persisting nerve dysfunction in the absence of follow-up clinical assessment. Patient factors such as depression and anxiety have been associated with QOL scores,[21,22] and we are unable to account for their contribution in this series. It is possible that patients with other issues following surgery such as chronic headaches and hearing loss might experience depression or anxiety, which may lead to poorer QOL reporting. In the absence of data regarding long-term nerve function in this sample, we are unable to determine definitively whether nerve dysfunction was responsible for QOL scores. Nevertheless, postoperative functional status was related to long-term patient perception of QOL in this sample, supporting the need to provide supportive care following surgery to maximize QOL potential.

An increasing trend to operate on growing and larger tumors requires the coordination of more complex care across specialties and disciplines.[23,24] Further investigations are needed to define the role of SLP and physical therapy interventions in mitigating long-term functional and QOL consequences of cranial neuropathy, including facial nerve palsy following CPA surgery. The use of minimally invasive options for early facial reanimation may also provide improved outcomes[25] and warrant further investigation.

CONCLUSION

Postoperative dysphagia and advanced facial dysfunction after CPA surgery are associated with long-term decrements in voice, swallowing, and facial function, with associated decline in QOL. This study reveals a larger than expected effect of facial palsy on long-term speech production and eating as perceived by patients, even as vagal function recovers. These persistent deficits and their impact on long-term QOL may be mitigated by early SLP intervention that is sustained after discharge from the hospital.

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