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Long-term Dysphagia following Acoustic Neuroma Surgery: Prevalence, Severity, and Predictive Factors

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Abstract

Background Acoustic neuroma (AN) may compress the cerebellum and brainstem and may cause dysfunction of bulbar cranial nerves.
Objective To describe swallowing function outcomes in the late postoperative period after AN surgery.
Methods This cohort study included patients operated on between 1999–2014, with a mean follow up of 6.4 ± 4.5 years. The swallowing function was assessed through the functional oral intake scale (FOIS). The primary outcome was defined by scores 5 to 1, which implied oral feeding restriction or adaptation. Risks factors were identified through multivariate logistic regression.
Results 101 patients were evaluated. As many as 46 (45.5%) presented dysphagia on the late postoperative period. Women comprised 77.2%, and the mean age was 47.1 ± 16.0 years (range 19–80). Dysphagic patients presented more type II neurofibromatosis (NF II) (32.6% vs. 10.9%, $p = 0.007$), larger tumors (3.8 ± 1.1 vs. 3.1 ± 1.0 cm, $p < 0.001$), partial resection (50.0% vs. 85.5%, $p < 0.001$) and needed more surgeries (≥2, 39.1% vs. 18.2%, $p = 0.019$). Important peripheral facial palsy (PFP) (House–Brackmann [HB] grade ≥3) was present before the surgery on 47.5% and worsened on 55.4%. Postoperative PFP ($p < 0.001$), but not preoperative PFP, was predictive of postoperative dysphagia. On multivariate analysis, the following factors were risk factors for dysphagia: NF II (OR 5.54, $p = 0.034$), tumor size (each 1 cm, OR 2.13, $p = 0.009$), partial resection (OR 5.23, $p = 0.022$) and postoperative HB grade ≥3 (OR 12.99, $p = 0.002$).
Conclusions Dysphagia after AN surgery is highly correlated to postoperative facial motor function. NF II, tumor size, and extent of resection were also predictive of this morbidity in the late postoperative period.

Keywords
► neurologic disorders
► dysphagia
► speech-language disorders and swallowing

Introduction

Swallowing function is controlled at the early oral and pharyngeal stages by the cranial nerves trigeminal (V), facial and intermedius (VII), glossopharyngeal (IX), and vagus (X), which provide afferent sensorial information and gustation. Cerebellopontine angle tumors, mainly acoustic neuroma (AN), may compress the cerebellum and brainstem and displace bulbar cranial nerves that are responsible for swallowing and speech functions.[1,2]

One survey of 1671 patients from the Acoustic Neuroma Association database revealed that 31% had swallowing problems during the postoperative period compared with 6.5% before the surgery.[3] The prevalence of dysphagia after AN

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surgery suggests that it may significantly impact patients' quality of life.[4] Dysphagia management requires different strategies, such as speech therapy and diet modifications, to reduce its functional impact. Peripheral facial paralysis (PFP) is well-studied as a common neurologic impairment after AN surgery. However, few studies have adequately investigated the occurrence of long-term dysphagia.[5,6] Therefore, this issue has been systematically neglected.

The present study aims to describe the swallowing function outcomes and identify its prognostic factors in the late postoperative period of patients submitted to AN surgery.

Methods

Study Design and Population

A cohort study was performed at the outpatient clinic. Adults patients (> 18 years old) operated between 1999 and 2014 were consecutively included, if they met the following criteria: absence of previous disabilities due to other neurological morbidities and clinical follow-up longer than 2 years.

Dysphagia Assessment

Dysphagia assessment was performed in two steps. The first was a structural evaluation, which consisted of analyses of the oral motor and sensory systems. The second step consisted of functional assessment of oral food intake assessed through the American Speech-Language-Hearing Association (ASHA) clinical bedside swallowing assessment protocol,[7] and speech-language disorder protocol for introduction and transition of oral feeding.[8] Functional oral intake was assessed, as described in ►**Table 1**. Food consistency was evaluated according to the protocol described in ►**Table 2**.

Additionally, patients were evaluated both clinically (►**Table 3**) and using the functional oral intake scale (FOIS) (►**Table 4**).[9] Scores 6 and 7 were considered as favorable, without interference on the daily food ingestion, whereas scores from 5 to 1 were deemed unfavorable.

Data Collection and Variables

Retrospective data collection was performed for the following variables: age, gender, type II neurofibromatosis (NF II) diagnosis, tumor size (measured from the auditory internal canal), PFP presence and House–Brackman (HB)[10] grade (preoperative and postoperative), surgical approach, extent of resection, and number of surgeries. Dysphagia was the primary outcome, as defined by the FOIS, which was prospectively evaluated. Data about preoperative dysphagia were not available for all patients.

Data Analysis

Categorical variables are presented as relative and absolute frequencies. Normally distributed continuous data are presented as mean and standard deviations and, otherwise, by median and quartiles. Categorical variables were compared between the groups through the Chi-square test. Continuous variables were evaluated through the student *t*-test or the Mann–Whitney U test, as appropriate.

Potential predictors of the primary outcome of dysphagia identified at the univariate analysis with a *p* value under 0.10 were included in a multivariate logistic regression model, as well as age, independently of its significance. The model assumptions were assessed and were not violated.

All tests were bicaudal and final *p*-values under 0.05 were considered statistically significant. All analyses were conducted with the software Statistical Package for Social Sciences (IBM SPSS Statistics for Windows; IBM Corp., version 24.0, Armonk, NY, USA).

Table 1 Intake textures–speech and language pathology protocol for introduction and transition from oral feeding

Level 01	Homogenous pasty (no residue/pieces), very cohesive, not requiring chewing skills. (e.g., yogurt test)
Level 02	Heterogeneous pasty (pasty with pieces), cohesive, mixed, requiring minimum chewing. This level excludes bread, biscuits and other solid food not mixed with creams or purees. (e.g., yogurt with pieces)
Level 03	Soft semisolid foods that require greater chewing ability, excluding loose grains, hard bread, green leaves and other foods that are difficult to chew or that tend to disperse into the oral cavity. (e.g., soft bread).
Level 04	Regular diet that includes all foods, including any solid texture. (e.g., toast)
Thin liquid:	Liquid with water consistency in its natural state.
Thin pasty liquid:	Liquid in the nectar consistency (**0**1 thicker measure).
Thick pasty liquid:	Liquid in honey consistency (02 thicker measures).

Table 2 Intake modes–speech and language pathology protocol for introduction and transition from oral feeding

Half tablespoon:	Equivalent to 3 mL.
Tablespoon:	Equivalent to 5 mL.
Full tablespoon:	Equivalent to 10 mL
Controlled sip:	Control of volume and rhythm by offering liquid to the patient.
Straw:	Supply of liquids with a straw
Free sip:	Supply of liquid is not controlled by the speech therapist and the patient himself conducts the volume and rhythm of the intake of the liquid food.
Dried pieces:	Specific the supply of foods that do not use utensils for holding, such as bread and biscuits, which are offered without modification in their current consistency.
Moisty Pieces:	Specifies the supply of foods that do not use a holding utensil such as bread and cookies, which are offered with a change in their initial consistency, such as bread dampened in milk.

Table 3 Clinical factors–speech and language pathology protocol for introduction and transition from oral feeding

Level of alert, collaboration, and/or attention
Impossibility to follow commands or simple orders
Alteration of postural control
Impaired food retention. In this item, it was scored if the patient had the inability to drink liquid from a glass, capture food from a fork or spoon, and remove a piece of food through a bite; inability to maintain food or liquid in the oral cavity, without any extra oral escape between the labial commissures.
Impaired oral preparatory phase. In this item, the patient's inability to form, contain and/or prepare the bolus for propulsion was punctuated.
Delayed oral transit time. Determined by the triggering of the swallowing reflex, it was considered slowed when oral transit exceeded 4 seconds for liquid foods and 20 seconds for other food consistencies.
Residues in the oral cavity. Residues of up to ~25% of the cake offered in the oral cavity were considered as normal.
Loss of food through the nose.
Odynophagia.
Wet voice.
Premature spillage of food
Decrease hyolaryngeal elevation and anteriorization
Multiple swallowing. Swallowing liquids, two for pastes and four for solids, were considered adequate.
Coughing before, during or after swallowing.
Cough weak and ineffective.
Spontaneous cloying.
Choking.
Alteration of cervical auscultation.
Need for laryngeal cleaning under command.
Oxygen saturation drop.
Respiratory distress.
Signs of general discomfort or clinical instability.

Table 4 FOIS

Level	Description
01	No oral intake
02	Tube dependent with minimal/inconsistent oral intake
03	Tube supplements with consistent oral intake
04	Total oral intake of a single consistency
05	Total oral intake of multiple consistencies requiring special preparation
06	Total oral intake with no special preparation, but must avoid specific foods or liquid items
07	Total oral intake with no restrictions

Abbreviation: FOIS, functional oral intake scale.

Compliance with Ethical Standards

The authors declare no conflict of interest. All participants participated voluntarily and signed an informed consent form. This research was submitted and approved by the local Ethics Committee.

Results

A total of 101 individuals were included. As many as 46 patients (45.5%) presented with dysphagia in the late postoperative period. Men comprised 22.8% of the total sample, with a tendency to be more frequent on the dysphagic group (29.1% vs. 15.2%, $p = 0.098$). Mean age was 47.1 ± 16.0 years (range 19–80), without differences between the groups. NF II was diagnosed in 20.8% of the patients. NF II was present in 32.6% of the dysphagic patients versus 10.9% of the nondysphagic ones ($p = 0.007$). The mean tumor size was 3.4 ± 1.1 cm (range 0.7–6.2). Large tumors were more prone to cause dysphagia (3.8 ± 1.1 cm vs. 3.1 ± 1.0 cm; $p < 0.001$). Retrosigmoid approach was chosen on 92.1%, and total resection was achieved on 69.3%. Half of the dysphagic patients underwent complete resection (versus 85.5%, $p < 0.001$). Multiple surgeries were statistically associated with dysphagia (39.1% vs. 18.2%; $p = 0.019$). Mean follow-up interval was 6.4 ± 4.5 years, similar for the two groups (►**Table 5**).

Facial motor function before the surgery was compromised (HB grade ≥3) on 47.5%, and this percentage reached 75.2% on the follow-up. After the surgery, facial motor function worsened in 55.4%. Postoperative PFP ($p < 0.001$), but not preoperative PFP, was predictive of postoperative dysphagia (►**Tables 6** and **7** and ►**Fig. 1A**). As shown in ►**Fig. 1B** the more severe the postoperative PFP, the more frequent the clinical signs reflect in oral dysfunction, oropharyngeal and pharyngeal phases of swallowing ($p < 0.001$).

In multivariate analysis, the following factors were predictive of dysphagia: NF II (OR 5.54, 95% CI 1.13–27.07; $p = 0.034$), tumor size (each 1 cm, OR 2.13, 95% CI 1.21–3.73; $p = 0.009$), partial resection (OR 5.23, 95% CI 1.27–21.46; $p = 0.022$), and postoperative HB grade ≥3 (OR 12.99, 95%, CI 2.61–64.75; $p = 0.002$).

Discussion

AN is an important and a well-recognized cause of neurological morbidity, with PFP being one of the most prevalent. Although a related disorder, the study of dysphagia in the late follow-up has been neglected and few data are available in the medical literature.

Almost half of our patients evolved with dysphagia after surgery and maintained it in the late postoperative period. Our sample had tumors (mean 3.4 cm) slightly larger than to those reported in most studies (< 3 cm).[1,2] This fact may lead to more significant compression of adjacent cranial nerves. Additionally, longer surgeries increase the risk of neuropathy in the postoperative period.[1,11,12] These facts may have influenced our results.

In addition to the dysfunctions found in the oral phase of swallowing caused by PFP, 80% of the sample showed deficits related to the pharyngeal and oropharyngeal phases. In these phases, there is integration between the musculatures of the pharynges and phonoarticulatory organs.[8] To the best of our

Table 5 Patient characteristics according to FOIS

Variable	Total	FOIS		*p*-Value
		Nondysphagic (6–7)(*n* = 55)	Dysphagic (1–5)(*n* = 46)	
Age (y) (mean ± SD)	47.1 ± 6.0	48.0 ± 15.5	45.9 ± 16.7	0.514
Male gender	23 (22.8)	16 (29.1)	7 (15.2)	0.098
Neurofibromatosis II	21 (20.8)	6 (10.9)	15 (32.6)	0.007
Tumor size (cm) (mean ± SD)	3.4 ± 1.1	3.1 ± 1.0	3.8 ± 1.1	< 0.001
Surgical approach				0.725
Retrosigmoid	93 (92.1)	50 (90.9)	43 (93.5)	
Other[a]	8 (7.9)	5 (9.1)	3 (6.5)	
Total resection	70 (69.3)	47 (85.5)	23 (50.0)	< 0.001
Number of surgeries (median and quartiles)	1 (1–2)	1 (1–1)	1 (1–3)	0.017
Two or more surgeries	28 (27.7)	10 (18.2)	18 (39.1)	0.019
Follow-up (y) (mean ± SD)	6.4 ± 4.5	6.2 ± 4.7	6.5 ± 4.5	0.806

Abbreviation: FOIS, functional oral intake scale.
[a]Combined surgery or translabirintic approach.

Table 6 Association between preoperative and postoperative HB PFP grade and FOIS

Variable	Total	FOIS		*p*-Value
		Nondysphagic (6–7) (*n* = 55)	Dysphagic (1–5) (*n* = 46)	
Preoperative HB grade				0.834
1	33 (32.7)	16 (29.1)	17 (37.0)	
2	20 (19.8)	14 (25.5)	6 (13.0)	
3	18 (17.8)	5 (9.1)	13 (28.3)	
4	10 (9.9)	10 (18.2)	0 (0.0)	
5	4 (4.0)	2 (3.6)	2 (4.3)	
6	16 (15.8)	8 (14.5)	8 (17.4)	
Postoperative HB grade				< 0.001
1	12 (11.9)	12 (21.8)	0 (0.0)	
2	13 (12.9)	10 (18.2)	3 (6.5)	
3	17 (16.8)	13 (23.6)	4 (8.7)	
4	21 (20.8)	11 (20.0)	10 (21.7)	
5	13 (12.9)	3 (5.5)	10 (21.7)	
6	25 (24.8)	6 (10.9)	19 (41.3)	
Dichotomized				< 0.001
Grades 1 or 2	25 (24.8)	22 (40.0)	3 (6.5)	
Grade 3 or worse	76 (75.2)	33 (60.0)	43 (93.5)	
Variation				< 0.001
Better or maintained	45 (44.6)	35 (63.6)	10 (21.7)	
Worse	56 (55.4)	20 (36.4)	36 (78.3)	

Abbreviations: FOIS, functional oral intake scale; HB, House–Brackman; PFP, peripheral facial palsy.
Note: Data are presented as *n* (%).

Table 7 Multivariate analysis for predictors of dysphagia according to the FOIS

Variables	Coefficient	SE	Wald	OR	95% CI	*p*-Value
Age (each 10 years)	0.01	0.02	0.31	1.01	0.98–1.04	0.577
Male gender	− 1.09	0.66	2.72	0.34	0.09–1.23	0.099
Neurofibromatosis II	1.71	0.81	4.47	5.54	1.13–27.07	0.034
Tumor size (each 1 cm)	0.75	0.29	6.92	2.13	1.21–3.73	0.009
Partial resection	1.65	0.72	5.27	5.23	1.27–21.46	0.022
Two or more surgeries	0.30	0.72	0.17	1.35	0.33–5.52	0.680
Postoperative HB grade ≥3	2.56	0.82	9.80	12.99	2.61–64.75	0.002

Abbreviations: CI, confidence interval; FOIS, functional oral intake scale; HB, House–Brackmann; OR, odds ratio; SE, standard error.

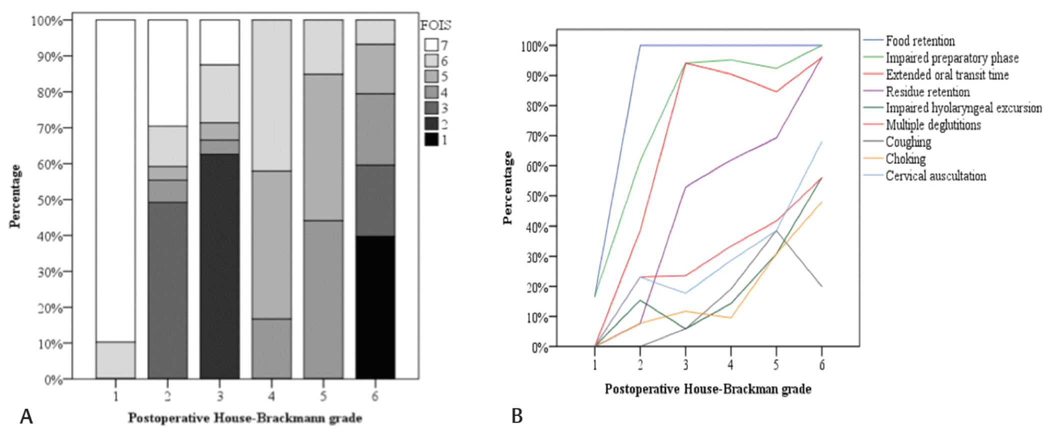

Fig. 1 (**A**) Association between dysphagia (FOIS) and postoperative peripheral facial palsy (PFP) (House–Brackmann [HB] grade). (**B**) Association of each clinical sign of laryngeal penetration/aspiration with PFP (HB grade).

knowledge, the association between PFP and oropharyngeal dysphagia in the late postoperative period (over 2 years) had not been described thus far, raising a new demand for rehabilitation.[13] These findings may be due to the muscular dysfunction and the difficulty in maintaining their synergism, which is caused by facial nerve lesion. Pharyngeal phase impairments may also indicate that lower bulbar nerves have suffered some degree of injury.[14]

Regarding the clinical signs of swallowing abnormalities, we found that 80% of patients presented difficulties with thin liquid intake, demonstrating a direct association between the integration of phonoarticulatory organs and the induction of the pharyngeal phase of swallowing. Furthermore, patients reported a significant decrease in quality of life with adaptation for dry solid intake and the postural maneuvers for thin liquid intake. These findings are congruent with the literature, as deglutition disorders have a high impact in AN patients in the long-term follow-up.[15] All dysphagic individuals reported that this is an impairment that profoundly interferes with daily life activities.

In a previous study,[16] dysphagia was diagnosed immediately after surgery in 31% of the cases, 51% of whom had oral, 37% of oropharyngeal and 12% of pharyngeal involvement. PFP was observed in the immediate postoperative period in 91% of dysphagic patients. Our findings in the chronic phase are similar to that of the literature regarding the postoperative incidence and swallowing characteristics, which suggest that early postoperative deficits may persist and impact late outcomes. Additionally, we found a high-correlation between PFP and disabilities in oral, oropharyngeal and pharyngeal phases of swallowing. These findings emphasize that the follow-up by the speech-language pathologist, mainly in patients who evolve with cranial nerve dysfunction and evidence of PFP, may prevent or minimize persistent neurological morbidity. In this subset of patients, the assistance of speech-language pathologists may optimize oral intake, reduce health risks and costs, and increase the quality of life of these patients through specific rehabilitation programs.

Limitations of the Study

Although the dysphagia evaluation was prospective, this was mostly a retrospective cohort study and all inherent limitations may apply. The dysphagia diagnosis was made by clinical assessment, as is routine in clinical practice. Imaging examinations, including a functional endoscopic test of the swallowing function (functional endoscopic sinus surgery [FESS]), whose sensitivity is higher than that of clinical assessment alone, are reserved for dubious cases, so we cannot exclude that the incidence of dysphagia is higher.

Some patients were operated without intraoperative physiological monitoring. It is not clear how the absence of monitoring could have impacted the dysphagia incidence.

Conclusion

Dysphagia is common after AN surgery and is highly correlated to postoperative facial motor function. NF II, tumor size, and extent of resection were also predictive of dysphagia in the late postoperative period.

Highlights

- AN may compress the cerebellum and brainstem and displace the bulbar cranial nerves.
- Dysphagia is common after AN surgery and is highly correlated to postoperative facial motor function.
- NF II, tumor size, and extent of resection were also predictive of morbidity in the late postoperative period.
- The assistance of speech-language pathologists may optimize oral intake, reduce health risks and costs, and increase the quality of life of these patients through specific rehabilitation programs.

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Conflict of Interest
None declared.

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