Fundus Obliteration and Facial Nerve Outcome in Vestibular Schwannoma Surgery

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ABSTRACT

The major objectives in vestibular schwannoma (VS) surgery have evolved from reducing mortality to functional preservation of the facial nerve and hearing. Absence of fluid between the lateral end of the VS and the internal auditory canal fundus on magnetic resonance imaging (MRI) appeared to have a negative influence on hearing outcome. Our goal was to study the prognostic significance of fundus obliteration on facial nerve function after VS surgery in patients with clinically normal facial function. We performed a retrospective review in a tertiary referral neurotology unit of 110 consecutive patients with a surgically removed VS and normal preoperative facial nerve function. Facial nerve function was evaluated at 1 month and 1 year by using the House-Brackmann (HB) scale and correlated to fundus obliteration on MRI. Facial nerve function was intact preoperatively in 114 of 123 patients (92.7%). We noticed a statistically significant difference and worse short-term outcome when the fundus was obliterated: 29.7% had HB 3 or more versus 13.0% if no fundus obliteration was seen. This statistically significant difference disappeared at 1 year. Fundus obliteration has a negative prognostic influence on short-term facial nerve function after VS surgery in patients with clinically normal facial function preoperatively.

KEYWORDS: Vestibular schwannoma, acoustic neuroma, magnetic resonance imaging, facial paralysis

Vestibular schwannomas (VS) are benign tumors of the vestibular nerve with a reported incidence of 1 to 20 cases per million inhabitants per year.^{1,2} The major objectives in VS surgery have evolved from reducing mortality to functional preservation of the facial nerve and hearing in more recent years. Despite technical improvements, the percentage of patients with impaired facial function (i.e., House-Brackmann [HB] grade 3 or more) ranges from 7 to 41%.^{3,4}

Several factors, including tumor size, intraoperative stimulus amplitudes, postoperative function at 1 month, and auditory brainstem responses abnormal-

ities, have been suggested as a prognostic indicator of functional postoperative facial nerve outcome. Also, good preoperative hearing and absence of brain stem compression are indicators of a better prognosis. Abnormalities of auditory brain stem responses on the tumor side appear to have a negative effect on the prognosis of facial nerve function, reflecting tumoral compression and/or infiltration of the cochlear nerve and, most probably, the facial nerve.⁵⁻⁷

The prognostic significance for hearing preservation of fundus obliteration as seen on preoperative magnetic resonance imaging (MRI) has already been

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discussed by Somers et al⁸ in 2001. Involvement of the fundus (i.e., the absence of fluid between the lateral end of the VS and the fundus) appeared to have a negative influence on the hearing outcome. In 2002, Kobayashi et al⁹ had a similar hypothesis for postoperative facial nerve function and tried to establish the prognostic significance of the distance between the VS and the fundus on postoperative facial palsy. However, they did not find a statistically significant difference in their population where a middle fossa approach was used.

This present study focuses on the prognostic significance of fundus obliteration in facial nerve function after VS surgery in patients with clinically normal facial function before surgery.

MATERIALS AND METHODS

We conducted a retrospective study on charts of 123 consecutive patients operated for unilateral VS. One hundred fourteen patients (92.7%) had normal preoperative facial nerve function (HB grade 1). Nine patients already suffered from clinical symptoms of facial nerve deficit preoperatively and were excluded from this study: six had HB grade 2, two had HB grade 3, and one had HB 6. In four cases, data were missing on the presence or absence of fundus obliteration.

The study population had a male:female ratio of 1:1 (58 male versus 52 female patients) and a mean age of 51.7 years (range 25 to 73 years). All patients had a unilateral VS (total lateromedial diameter 4 to 42 mm, mean 18.4 mm). Forty-two patients (38.2%) underwent surgery via a retrosigmoid approach and sixty-eight patients (61.8%) underwent a translabyrinthine approach. In the patients with a normal preoperative facial nerve function, HB grade 3 or more after surgery was considered a complication. Short-term (1 month) and long-term (1 year) clinical facial nerve function, graded by the HB facial grading scale,¹⁰ was correlated to fundus involvement. In one patient, the HB grade was missing at 1 year, although the patient had HB grade 1 at 6 months.

Diagnosis was verified by histological examination of tumor tissue. Mean clinical follow-up was 3.9 years (standard deviation 2.8 years).

The MRI sequences for screening of VSs routinely included 2-mm-thick contiguous unenhanced and gadolinium-enhanced T1-weighted spin-echo images, and 0.7-mm-thick high-resolution gradient-echo images (3DFT-CISS).¹¹ On 3DFT-CISS images, one can assess whether cerebrospinal fluid (CSF) is still present between the lateral end of the tumor and the fundus. If CSF was visible, the tumor was labeled as not involving the fundus. Data on fundus obliteration were missing in four cases.

A *p* value of 0.05 or less was considered statistically significant. All calculations were performed with statistical software (SPSS 16.0, SPSS Inc., Chicago, IL). The Pearson chi-square test was used to evaluate percentages of patients in different HB categories.

RESULTS

The facial nerve outcomes in our population are displayed in Table 1. Looking at the rate of intact facial nerve function (HB grade 1 or 2) at 1 month postoperatively, we did not notice any differences in sex, side, total diameter, or cerebellopontine angle (CPA) diameter of the VS. Older age resulted in a worse outcome (independent samples *t* test, *p* = 0.01). Looking at the rate of intact facial nerve function 1 year postoperatively, we noticed no differences in sex, side, total diameter or CPA diameter of the VS. Older age did not result in a worse outcome at 1 year.

There was no statistically significant difference (SSD) in total and extrameatal size of the tumor, but there was definitely an SSD in intrameatal size when comparing the presence or absence of fundus involvement, which is quite obvious (translabyrinthine group, median 10 versus 7 mm, respectively, *p* < 0.001; retrosigmoid group, median 10 versus 8 mm, respectively, *p* = 0.005). The type of approach was affected by fundus obliteration: if the fundus was obliterated, the translabyrinthine approach was preferred (*n* = 49), and the

Table 1 House-Brackmann Facial Grading at 1 Month and 1 Year in the Total Population, the Group Without Fundus Obliteration, and the Group With Fundus Obliteration

HB	Total Population (<i>n</i> = 110)		Fundus Not Obliterated (<i>n</i> = 46)		Fundus Obliterated (<i>n</i> = 64)	
	1 mo	1 y	1 mo	1 y	1 mo	1 y
I	75 (68.2%)	85 (78%)	38 (82.6%)	38 (82.6%)	37 (57.8%)	47 (73.4%)
II	10 (9.1%)	8 (7.3%)	2 (4.3%)	3 (6.5%)	8 (12.5%)	5 (7.8%)
III	6 (5.5%)	8 (7.3%)	1 (2.2%)	2 (4.3%)	5 (7.8%)	6 (9.4%)
IV	7 (6.4%)	7 (6.4%)	2 (4.3%)	2 (4.3%)	5 (7.8%)	5 (7.8%)
V	9 (8.2%)	0 (0%)	2 (4.3%)	0 (0%)	7 (10.9%)	0 (0%)
VI	3 (2.7%)	1 (0.9%)	1 (2.2%)	0 (0%)	2 (3.1%)	1 (1.5%)

Missing data on fundus obliteration in four cases. HB, House-Brackmann.

Table 2 Binary Classification Testing Using HB Grade 2 as a Cutoff Point

	HB ≥ 2 Postoperative 1 mo			HB ≥ 2 Postoperative 1 y		
	+	–		+	–	
Fundus obliteration						
+	27	37	PPV 42%	17	47	PPV 27%
–	8	38	NPV 83%	7	38	NPV 84%
	Sensitivity 77%	Specificity 51%	LR + 1.6; LR – 0.45	Sensitivity 71%	Specificity 45%	LR + 1.3; LR – 0.64

HB, House-Brackmann; LR +, positive likelihood ratio; LR –, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

retrosigmoid approach was preferred if the fundus was not obliterated by the VS ($n = 27$). We did not observe an SSD in facial nerve outcome comparing presence or absence of fundus obliteration in the retrosigmoid approach group, nor did we find an SSD in the trans-labyrinthine group.

Sensitivity, specificity, positive and negative predictive value, and likelihood ratios are displayed in Tables 2 and 3. We noticed a statistically significant difference and worse short-term outcome when the fundus was involved: 29.7% had HB of 3 or more postoperatively versus 13.0% if no fundus obliteration was seen (Pearson chi-square $p = 0.04$), 36.5% had HB of 2 or more postoperatively versus 17.4% if no fundus obliteration was seen (Pearson chi-square $p = 0.006$). The SSD of fundus involvement disappeared at 1 year (Pearson chi-square $p = 0.14$ and 0.16, respectively, in the HB outcome groups).

DISCUSSION

In our study, involvement of the fundus was defined as the absence of fluid between the lateral end of the tumor and the fundus. The tumor reached the fundus in 58% of the cases, whereas residual CSF was still present between the tumor and the fundus in 42%. The presence of a fluid-filled space between the lateral end of the tumor and the fundus theoretically allows easier dissection and luxation of the lateral end of the tumor in the internal auditory canal (IAC). The facial nerve might be at greater risk because of the smaller diameter of the IAC toward the fundus; more adhesions are present at this level, there is a higher length of contact and potential pressure between the nerve and the tumor, and thus there is less surgical control over the facial nerve at the fundus. Kobayashi et al⁹

had a similar hypothesis and tried to establish the prognostic significance of the distance between the VS and the fundus on postoperative facial palsy. However, they did not find a SSD in their population. This might be related to their use of the middle cranial fossa approach in a limited series of 45 cases, or because they looked for a correlation between distance between the lateral end of the VS and the fundus instead of using a dichotomous variable like fundus obliteration.

In our series, when the tumor did not reach the fundus, intact facial nerve function at 1 month (defined as HB 1 or 2) was achieved in 87% of the cases, whereas when it reached the fundus, it was preserved in 70%. The clinical relevance lies in the positive and negative likelihood ratios. The baseline risk for short-term postoperative HB grade 3 or more decreased by ~50% if the fundus was not involved and increased by 40% when the fundus was involved.

Our major limitation is that fundus involvement, to some extent, influenced the approach type, although the authors were not aware of the impact on facial nerve function. Due to the retrospective nature of the study, we were not able to study the possible bias of decision making on the distribution of approach types. This might explain the absence of a statistically significant difference within the approach type subgroups. Other points of discussion might include the effect of fundus obliteration on facial nerve function in VS patients where a wait-and-scan policy would have been followed and those receiving gamma-knife treatment. The focus of this current study was on the surgically treated patients and did not involve the influence of fundus obliteration on treatment choice. In the future, our goals will be to increase the sample size and to elaborate the current results within the approach types.

Table 3 Binary Classification Testing Using House-Brackmann Grade 3 as a Cut-off Point

	HB ≥ 3 Postoperative 1 mo			HB ≥ 3 Postoperative 1 y		
	+	–		+	–	
Fundus obliteration						
+	19	45	PPV 30%	12	52	PPV 19%
–	6	40	NPV 87%	4	41	NPV 91%
	Sensitivity 76%	Specificity 47%	LR + 1.4; LR – 0.51	Sensitivity 75%	Specificity 44%	LR + 1.39; LR – 0.57

LR +, positive likelihood ratio; LR –, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

CONCLUSION

We found that fundus obliteration has a negative prognostic influence on short-term (1-month) but not on long-term (1-year) facial nerve function after VS surgery in patients with clinically normal preoperative facial function. This prognostic indicator might be an important point to discuss with the VS patient in accurate preoperative counseling to determine the individual risk profile.

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