Intraoperative Facial Nerve Monitoring in Posterior Fossa Surgery: Prognostic Value

Abstract—A retrospective study was done of 43 patients operated on for acoustic neuroma by a translabyrinthine approach with intraoperative facial nerve monitoring. Direct stimulation of the facial nerve at the level of the cerebellopontine angle (CPA) and the internal auditory canal (IAC) permits the calculation of a R ratio that has a predictive value for postoperative facial function: $R = R'/R''$, where R' is the ratio of the minimal intensity (I) of stimulation capable of inducing a response after direct stimulation of the facial nerve at the level of the CPA over the electromyographic response amplitude (A): $R' = I(\text{CPA})/A(\text{CPA})$, R'' being equal to the ratio of these same measurements after stimulation at the IAC: $R'' = I(\text{IAC})/A(\text{IAC})$. Statistical analysis has shown that an R ratio ≤ 2 has a favorable prognostic value on facial mobility whereas an R ratio > 2 permits the supposition of an alteration of facial function. This prognostic value is more precise if the R ratio is co-related to the macroscopic aspect of the facial nerve at the end of surgery. (*Skull Base Surgery*, 3(4):214–216, 1993)

The ability of facial nerve monitoring to localize the facial nerve and the site of the neural lesion is well known. Numerous publications have already shown the superiority of facial function results in patients who underwent posterior fossa surgery with facial nerve monitoring compared with those who underwent the same intervention without facial nerve monitoring.^{1–9} The aim of this study is to demonstrate the ability of facial nerve monitoring to predict postoperative facial function.

This study analyzes 43 patients operated on for acoustic neuromas by a translabyrinthine approach between 1989 and 1991. In each case, the facial nerve was stimulated at the level of the cerebellopontine angle (CPA) as well as at the internal auditory canal (IAC). The value of the minimal stimulation intensity capable of inducing an electromyographic (EMG) response and the amplitude of the EMG response at these two levels were used to calculate an R ratio. We will show that this R ratio has a predictive value on postoperative facial function. This predictive value is more precise if it is correlated with the macroscopic aspect of the facial nerve at the end of surgery.

MATERIALS AND METHODS

Intraoperative facial nerve monitoring was accomplished with the Nerve Integrity Monitor II (NIM II). EMG activity is immediately displayed on an oscilloscope and on an audio signal. EMG activity was monitored with intradermic electrodes at three sites: two in the orbital orbicularis muscle, two in the oral orbicularis muscle, and one ground electrode in the frontal area.

Direct facial nerve stimulation was performed with an isolated monopolar stimulator.¹⁰ The stimulus intensity, at a constant current,¹¹ was between 0.05 and 3 mA. Data collection can be carried out by an IBM computer system for which we have developed three work sequences: an acquisition phase during the intervention for stocking the data, an impression phase for analyzing the recorded data, and a phase for computer treatment of the data.

Tumor sizes for the 43 cases were as follows: Grade 1, intercanalicular, five cases; grade 2, less than 1.0 cm extracanal extension, 24 cases; grade 3, extracanal extension, 4 cases.

sion with brainstem contact, ten cases; and grade 4, brainstem compression, four cases.

All the patients included had a total tumor excision and the facial nerve was anatomically conserved. The macroscopic aspect of the facial nerve at the end of surgery was noted. Facial nerve function was subsequently evaluated on postoperative days 10 and 180, using the classification of House and Brackmann.¹²

After tumor excision, the facial nerve was directly stimulated at its emergence from the brainstem as well as in the IAC. The stimulation intensity used was the weakest deliverable by the apparatus: 0.05 mA. When this minimal stimulation intensity induced no EMG response, the intensity was progressively increased by 0.05 mA at a time. These values were then utilized to calculate the R ratio: $R = R'/R''$. R' is equal to the ratio of the minimal stimulation intensity (I) capable of induce an EMG response at the CPA over the EMG response amplitude (A) obtained after the stimulation at the CPA: $R' = I(\text{CPA})/A(\text{CPA})$. R'' is equal to the ratio of these same measurements after stimulation at the IAC: $R'' = I(\text{IAC})/A(\text{IAC})$.

RESULTS

In this study, we have analyzed the difference in facial function as a function of tumor classification at 10 and 180 postoperative days (Table 1), the prognostic value of the R ratio (electrophysiologic correlation), and the correlation between electrophysiologic and anatomic results.

Regarding the prognostic value of the R ratio (electrophysiologic correlation), a comparative analysis between facial function 10 days after surgery and the value of the R ratio is shown in Table 2. In one case, the R ratio could not be calculated at either the CPA or the IAC due to a hematoma located at the tympanic portion of the facial nerve. These results show that a R ratio of 2 or less is a good prognostic factor for facial function, whereas a ratio

Table 2. Facial Function Compared with R Ratio 10 Days After Surgery

	Facial Function		
	I/II	III/IV	V/VI
R < 2	28/31 (90%)	1/1	2/11 (18%)
R > 2	3/31 (10%)		8/11 (73%)

more than 2 has a more pejorative prognostic significance. The statistical significance was $p < 0.03$.

The electrophysiologic and anatomic correlation in seven of eight cases (87.5%) with a R ratio more than 2 and where the facial nerve appeared stretched, spread out, or partially sectioned, showed the postoperative facial function to be evaluated at grade V/VI. In 28 of 31 cases (90%), with a R ratio 2 or less and where the facial nerve appeared macroscopically normal, the postoperative facial function was found to be grade I/II.

Further results showed: (1) In three cases where the R ratio was more than 2, the facial nerve seemed normal at the end of surgery and the clinical evaluation, 10 days after surgery, showed a facial function grade I/II; (2) in two cases where the R ratio was 2 or less, the facial nerve seemed normal and the facial function was grade V/VI. The patient eventually recovered with severe synkinesis. In each case, the minimal stimulation capable of inducing an EMG response after direct stimulation of the nerve at the CPA and the IAC was higher (0.2 mA) than usual (0.05 mA); and (3), in one case, the R ratio was more than 2, secondary to a compressive hematoma at the level of the IAC. The facial function was grade V/VI 10 days after surgery, and grade I/II, 180 days after surgery. In one case the R ratio could not be calculated because stimulation at the CPA and the IAC induced no modification of EMG tracing, but after decompression of the tympanic segment of the facial nerve, the surgeon found a hematoma at the level of this portion. Direct stimulation of the mastoid segment of the facial nerve induced EMG responses. This patient had a facial function grade V 10 days after surgery and grade II 180 days after.

Table 1. Facial Function in Relation to Tumor Classification at 10 and 180 Days Postoperatively

Tumor Grade	Facial Function (%)					
	I	II	III	IV	V	VI
<i>10 days</i>						
1 (n = 5)	80	20				
2 (n = 24)	29	46	4		21	
3 (n = 10)	20	40			40	
4 (n = 4)		50			50	
All sizes	72%		2			26
<i>180 days</i>						
1 (n = 5)	100					
2 (n = 24)	71	8	13	4	4	
3 (n = 10)	60	10			30	
4 (n = 4)	25	25			50	
All sizes	74%		12%			14%

DISCUSSION AND CONCLUSION

This study shows that electrophysiologic tests analyzing the EMG response amplitude after direct stimulation of the facial nerve at the end of surgery, at the level of the CPA and the IAC, can have a predictive value on postoperative facial function. Statistical analysis proved that a R ratio of 2 or less has a favorable prognostic value on facial motricity. Whereas, a ratio more than 2 permits the supposition of an alteration of facial function. Thus a weaker amplitude of the EMG response at the proximal segment compared with that obtained after distal segment stimulation indicates a more pejorative postoperative facial function.

The sensitivity of the electrophysiologic test is increased if the R ratio value is correlated with the macroscopic aspect of the facial nerve at the end of surgery. Statistically, we can anticipate a satisfactory facial function in cases in which the R ratio is 2 or less and the facial nerve seems macroscopically normal. On the other hand, if the R ratio is more than 2 and the facial nerve appeared spread out or stretched, functional prognosis will be poor even 6 months postoperatively, but if the R ratio is more than 2 and the facial nerve seems macroscopically normal, or surrounded by a hematoma, we can consider that the lesion is just a conduction block. The functional prognosis will improve before 6 months.

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REVIEWER'S COMMENTS

Intraoperative facial nerve monitoring provides a potentially useful adjunct in detecting neural injury during neuro-otologic and neurosurgical procedures. These measures further aid the surgeon in preserving facial nerve function by enhancing visual identification through the detection of mechanically evoked facial muscle activation. Berges and colleagues have employed a mathematical ratio of the intensity required for neural stimulation over the amplitude of the evoked response. These authors have shown prognostic value of this ratio. Sites bracketing the region of the nerve involved with neuroma were assessed. This is an innovative approach to further exploring the potential use of monitored data. In addition to its prognostic utility, such information may ultimately provide the necessary feedback for improving strategies of surgical dissection.

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