The role of neuromonitoring in vestibular schwannoma resection and its impact on facial nerve outcomes

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Background

Multi-modal neuromonitoring such as SSEPs, ABR, CN7 EMG[1] in lateral skull base surgery could improve safety[2] but also adds cost[3]. The true utility of multi-modal neuromonitoring in VS surgery has not been comprehensively evaluated.

Objective

To analyze the clinical effectiveness of somatosensory evoked potentials (SSEPs), auditory brainstem response (ABR), and cranial nerve 7 electromyography (CN7 EMG) (**multimodal monitoring**) vs. CN7 EMG (**single modality**) only monitoring and compare outcomes in VS surgery.

Methods

- N=20 sporadic VS
  - **Multimodality:** n = 13; mean age = 48.6 years
  - **Single modality:** n = 7; mean age = 49.9 years
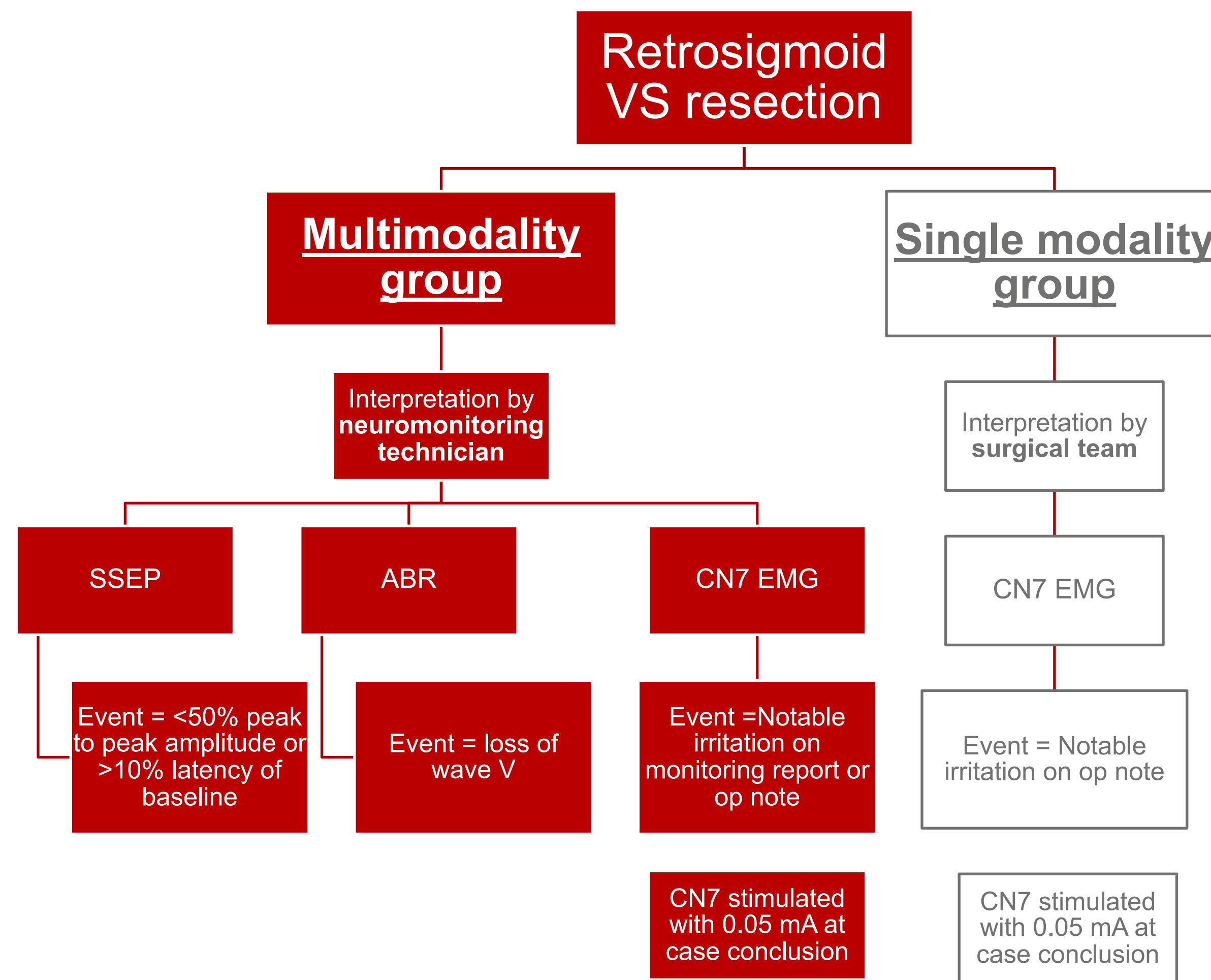
- CN7 EMG by the NIM Response 3.0 (Medtronic, Xomed, Jacksonville, FL, USA); SSEPs and ABR from NuVasive Clinical Services™ (San Diego)
- Outcomes:
  - Facial nerve – House-Brackmann
  - Hearing – 1995 AAO-HNS classification system[4]
    - Preservation - >50% WRS on pre- and post-operative audiogram
  - Surgeon behavior – coded from operative report
- Independent samples t-test, Chi square test, and Fischer's exact tests were used for statistical analysis.

Abbreviation Legend:
VS = vestibular schwannoma; SSEP = somatosensory evoked potentials; CN7 EMG = cranial nerve 7 electromyography; ABR = auditory brainstem response; miV = microVolts; mA = milliAmps; HB = House-Brackmann; WRS = word recognition score

Table 1. Demonstrates relationship between post-operative HB change and EMG output in miV after CN7 stimulation with 0.05 mA. Nerve simulation under 200 miV significantly more likely to have new post-operative HB deficits ($\chi^2 = 5.43$, $p < 0.05$).

EMG stimulation at 0.05 mA and CN7 outcomes

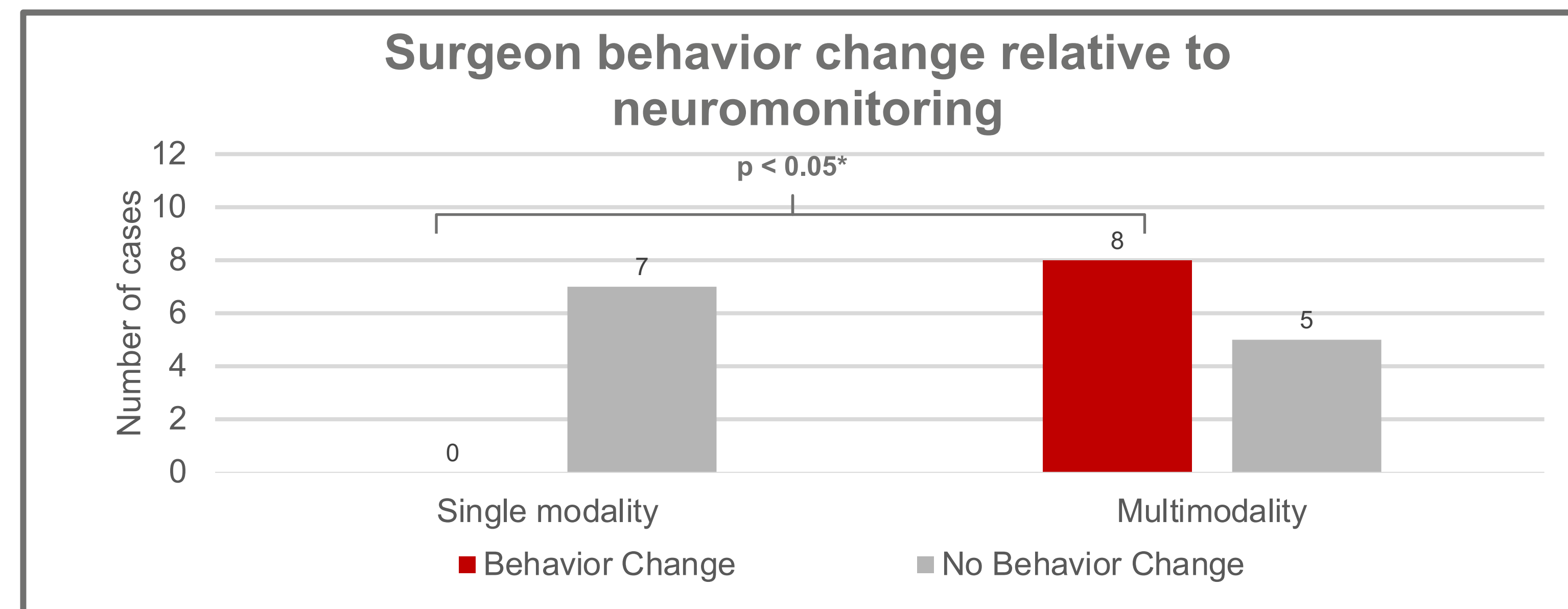|	EMG < 200 miV	EMG ≥ 200 miV	Total
HB change	4	1	5
No HB change	3	12	15
Total	7	13	20
$\chi^2 = 5.43$, $p < 0.05$			

Figure 1. Significantly more episodes of surgeon behavior change in the multimodality group vs single modality ($\chi^2 = 7.18$, $p = .015$). ABR and EMG influenced behavior change in 4 cases each.

Table 2. Describes hearing outcomes and ABR monitoring course for study cohort. Pre- and post-operative hearing class and hearing preservation rates are noted for each group. Tumors in multimodality group larger on average in largest dimension with near significance ($p = 0.073$)

Patient ID	Tumor size (cm)	Hearing Class Pre	Hearing Class Post	Loss of ABR wave V	Surgeon behavior change from ABR?	CN VIII Sacrifice	Hearing preservation
Multimodality							
1	1.6	B	unknown	Intraoperative	yes - Paperivine use	no	16.70%
2	1.0	A	D	Intraoperative	yes - approach changed	no	
3	1.7	B	B	None	no	no	
4	3.6	D	D	n/a - no ABR	n/a	no	
5	1.6	A	D	Intraoperative	yes - dissection change	no	
6	2.6	A	unknown	None	no	no	
7	2.7	A	D	None	no	no	
8	1.4	A	C	Baseline loss	no	no	
9	2.8	B	D	Baseline loss	no	no	
10	3.7	A	D	Baseline loss	no	**yes**	
11	2.4	A	D	Intraoperative	no - presumed artifact	no	
12	1.4	C	D	Intraoperative	yes - retraction change	no	
13	2.4	B	D	Baseline loss	no	no	
Total	2.22*						
Single Modality							
14	2.1	C	D	n/a	n/a	**yes**	14.30%
15	2.5	B	D	n/a	n/a	**yes**	
16	1.3	B	D	n/a	n/a	**yes**	
17	1.2	B	D	n/a	n/a	no	
18	1.5	C	D	n/a	n/a	no	
19	1.7	A	A	n/a	n/a	no	
20	1.3	A	D	n/a	n/a	no	
Total	1.66*						

* $p < 0.05$

Results

- CN 7 stimulation at 0.05 mA <200 miV had significantly worse facial nerve outcomes than >200 miV ($\chi^2 = 5.43$, $p < 0.05$) (Table 1).
- Single modality vs. Multimodality tumor size (Table 2)
  - Volume: (**1.95 vs 4.91 cm³, $p < 0.05$**)
  - Largest dimension: (1.66 cm vs. 2.22 cm, $p = 0.073$)
- No difference between hearing preservation or new HB deficits between groups ($\chi^2 = 0.014$, $p = 0.91$; $\chi^2 = 1.56$, $p = .212$).
- Hearing outcomes predicted by wave V status in 9/10 applicable cases (Table 2).
- 8 cases with surgeon behavior change due to a monitoring event (4 EMG and 4 ABR) in multimodality group vs. 0 in single modality group ($\chi^2 = 7.18$, $p = .015$) (Figure 2).
  - Behavior change in response to EMG was near total resection as opposed to gross total resection.
  - ABR behavior change in Table 2.
- 3/13 patients with SSEP changes, however all were artifact without clinical correlation.

Discussion

- SSEP useful during cases that directly contact somatosensory pathways or major intracranial vasculature,[5] however questionable use for positional peripheral nerve injury which can be prevented by liberal use of joint padding.[6]
- Discontinued use of SSEP during routine VS surgery is an opportunity for cost saving from equipment, anesthesia time, and OR time.[7]
- Hearing outcomes consistent with those described by Bozhkov et al:[8]
  - For tumors with a largest dimension between 12mm and 25mm the hearing preservation rate is 30.3%, and only 5.3% for tumors > 25mm at the time of operation.[8]
- CN7 stimulation <200 mAmps with 73% specificity and sensitivity for predicting long term facial nerve outcomes.[9]

Conclusions

ABR and CN7 EMG provide useful information during VS resection that impacts surgeon behavior, but **SSEPs are a low utility monitoring modality in VS resection**. Discontinuing SSEPs in routine VS resections may be an opportunity for safe, cost-effective care.

References

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