



Hearing preservation after removal of small vestibular schwannomas: the role of ABR neuromonitoring

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This issue features an article by Mastronardi et al. [7]. The authors evaluated the hearing preservation (HP) after removal of vestibular schwannomas (VS) with a maximum diameter of < 2 cm. Intraoperatively, two case groups were neuromonitored using two different auditory brainstem response (ABR) techniques: classical Click vs LS-CE-Chirp. The authors concluded that Chirp ABR is superior to Click ABR by providing faster feedback, higher wave amplitude, and shorter latency. We commend the authors on their work; however, we would like to shed the light on some points raised by the authors.

Although stereotactic radiosurgery (SRS) might not eliminate the tumor burden and mass effect of VS, several studies have shown promising results related to HP in the management of VS, and various authors suggested that it should not be only considered in recurrent VS cases. Golfinos et al. [5] reported a series of 399 small- and medium-sized VS with a maximum diameter of ≤ 2.8 cm who were treated with either microsurgery or SRS. Postoperative HP for preoperative class A (based on the American Academy of Otolaryngology-Head and Neck Surgery guidelines) patients was achieved in 14.3% of microsurgery cases compared with 42.9% of SRS cases ($p < 0.05$). Serviceable hearing was preserved in 42.8% of microsurgery cases compared with 85.7% of SRS cases ($p < 0.01$). This large difference between the two groups should be considered when deciding the optimal management approach in individualized fashion. Interestingly, SRS for VS within the first 2 years after diagnosis has shown statistically significant superior long-term HP compared with later-onset (> 2 years) treatment [1].

Despite the recommendations for intraoperative eighth cranial nerve monitoring during HP VS resection, several cohort studies reported contradictory results of HP when monitoring was employed compared to unmonitored cases. In 1994, Nedzelski et al. [9] retrospectively compared 56 patients who received intraoperative monitoring with direct continuous cochlear nerve action potentials (CNAP) to 20 unmonitored cases. At 1-year follow-up, the rate of HP was significantly higher in the monitored group ($p < 0.02$) compared to the unmonitored group following VS resection. Conversely, the series of Piccirillo et al. [10] showed no difference between monitored and unmonitored patients in term of HP, and the presence of CNAP at the end of surgery was not a predictive of good hearing outcomes. In fact, more than half of their patients who had intact CNAP after tumor removal ultimately developed poor hearing outcome. Thus, the reliability of CNAP in anticipating HP or hearing loss cannot be generalized.

Mastronardi et al. [7] claimed that the use of LS-CE-Chirp ABR as an intraoperative neuromonitoring technique might be superior to Click ABR by providing faster feedback and shorter latency. In fact, the shorter latency of evoked waves by CE-Chirp in comparison with the classical Click is indeed expected since the onset and offset times of CE-Chirp has been pre-adjusted to give such results [15]. Unlike what the authors implied in their paper, many studies have shown that the enhanced neural synchrony obtained by Chirp would increase ABR amplitude rather than affecting the latency. This has been confirmed by comparing Click to an unmodified Chirp (i.e., without temporal adjustment); the unmodified Chirp produced bigger ABR amplitude but more prolonged ABR latency [4]. Based on this data, it is therefore not justified to compare the latencies between classical Click and CE-Chirp, as the shorter latency does not indicate the superiority of CE-Chirp over other conventional stimuli. Moreover, with the aid of special software systems, the use of combined analog filter and digital filter (WF 25 and WF 50) would enable neurophysiologists to obtain interpretable Click ABR traces in

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5 s with the summation of fewer sweeps [8]. This will alert the surgeon even faster compared to LS-CE-Chirp ABR system based on the results reported by Mastronardi et al. [7].

In our experience of 30 patients with small-sized vestibular schwannomas (overall mean tumor diameter 1.7 ± 0.5 cm) managed surgically via the retrosigmoid approach, 20 patients demonstrated statistically significant constant and reliable click ABR “V” wave associated with postoperative hearing preservation [2].

Furthermore, the utilization of ABR as a far-field monitor entails several limitations. The first limitation is that many VS patients demonstrate significant hearing loss preoperatively, which makes it difficult to monitor the eighth cranial nerve intraoperatively in the setting of an already reduced ABR wave amplitude. Additionally, various systemic factors such as hypothermia or hypocarbia might affect the brainstem conductivity and change the ABR waveform [6, 11]. Therefore, using other neuromonitoring modalities instead or in conjunction with ABR might be more reliable than the utilization of ABR alone.

Among the different intraoperative neuromonitoring techniques, the CNAP monitoring technique seems to be the best modality to reflect the effect of surgical manipulation on hearing as well as predicting postoperative HP/hearing loss [12]. Yamakami et al. [13] utilized CNAP on 44 VS cases with a maximal diameter of ≤ 1.5 cm who underwent surgical resection. The authors concluded that CNAP was more reliable and associated with significantly better rates of HP than ABR (66% vs 32%, $p < 0.01$) as an intraoperative neuromonitoring technique. Similarly, Danner et al. [3] compared the efficacy of ABR and CNAP monitoring in 66 patients with VS measuring ≤ 2.5 cm. The authors achieved HP in 41% of patients using ABR while 64% of their patients achieved HP with direct monitoring ($p = 0.03$). Furthermore, CNAP is associated with lower rates of intraoperative artifacts compared to ABR. Yamakami et al. [14] reported 22 patients who underwent VS resection via the retrosigmoid approach for HP. They monitored all of their patients intraoperatively with CNAP and ABR simultaneously. During surgery, they noticed that ABR monitoring was disrupted with severe artifacts by various intraoperative maneuvers and surgical instruments, especially when using the microscope, compared to CNAP. As a result, a distinct ABR “V” wave was only obtained in 9/22 patients (41%) while it was missed in the rest. In contrast, no significant artifacts were observed in CNAP monitoring group and, hence, a reliable CNAP monitoring without artifacts was obtained in 20/22 patients (91%).

However, CNAP still carries inherent limitations. The presence of large VS with multiple vessels enclosing the cochlear nerve might make it difficult to safely localize the proximal portion of the nerve for electrode insertion and optimal monitoring. Finally, the risk of damaging the nerve fibers while placing the electrodes should be taken into consideration.

Therefore, future prospective clinical trials are needed to confirm the ideal neuromonitoring modality for HP during VS resection.

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