Pediatric Auditory Brainstem Implant: Effect of Anesthesia on Electrical Auditory Brainstem Responses

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STUDY PURPOSE

Previous data has shown that anesthesia can affect the auditory brainstem response (ABR) in animals [4]. In humans, specific anesthetic agents such as ketamine/xylazine can also cause prolongation of ABR-peak and interpeak latencies and upwards shift of ABR thresholds;[4] Unfortunately, little data currently exists regarding the impact of the specific anesthetic/sedative agents used during ABI surgery on eABRs especially in children. At our institution, ABIs are implanted in deaf infants under a FDA device exemption. The purpose of our study was to determine whether the anesthetic/sedative agents used intra- or post-operatively the eABR in children.

BACKGROUND

Auditory Brainstem Responses

First described by Jewett in the 1970s, auditory brainstem responses (ABR) have multiple applications today with regards to hearing screening, hearing sensitivity measures in infants and young children and intraoperative monitoring. Traditionally elicited with transient acoustic signals, ABRs can also be evoked with electrical stimulation of the auditory pathway which are usually called eABRs. EABRs are routinely used during auditory brainstem implant (ABI) surgery to guide the placement of the internal electrode array on the the cochlear nucleus. When initial stimulation of the auditory pathway occurs at the level of the cochlear nucleus, the morphology of the eABR differs from its acoustic counterpart (**Figure 1)**. This morphology is dependent on the spatial placement of the ABI and reflect the sensations, auditory and non-auditory, elicited by different electrode pairs.

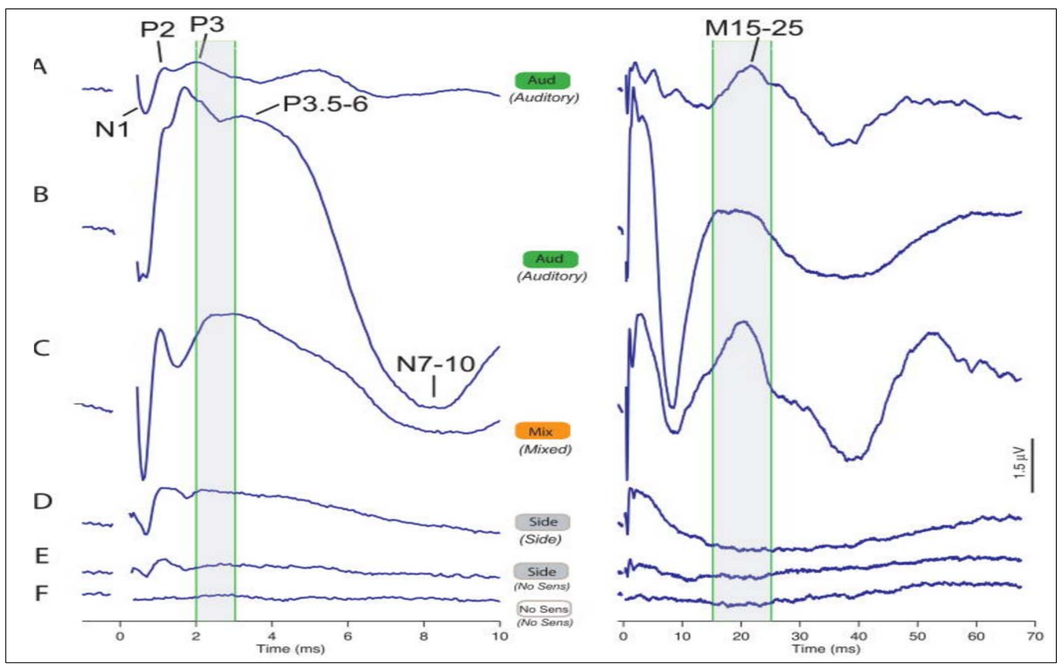

Figure 1. Obtainable eABR waveforms in unanesthetized, post-surgical adult ABI subjects. Adapted from Herrmann et al.[1]

Importance of eABRs

Interoperatively, eABRs are recorded from electrode pairs in the array to help determine if stimulation of the central auditory pathway occurs.[2] This is particularly important given the surgeon's restricted field of view and blind placement of the ABI (**Figure 2**). The utility of intraoperative eABRs is two-fold:

- To maximize the number of electrodes electing auditory sensations.[3]
- To monitor the stability of electrode array position during closing.

Post-operatively, eABRs are valuable for pediatric patients who cannot report non-auditory sensations to confirm device stability, function and potential auditory versus non-auditorysensations prior to the activation of the processor. The post-operative eABR is done under anesthesia or sedation.

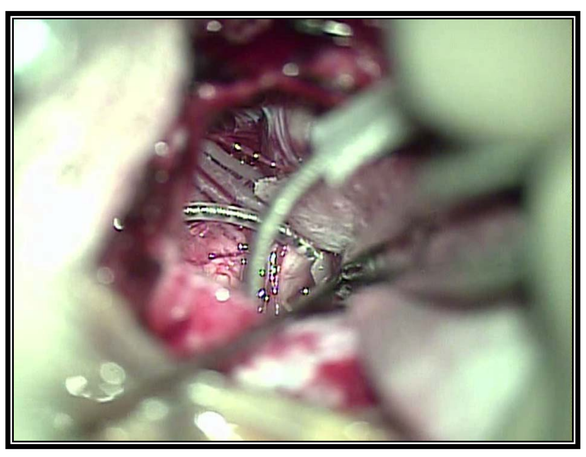

Figure 2. Visualization during ABI electrode implantation

METHODS

All children who underwent ABI surgery using the Nucleus ABI 24M or ABI541 devices from 2013 to 2016 were included. In total, 5 subjects who underwent 7 ABI surgeries (5 primary, 2 revisions) and 7 sedated activation procedures were included for analysis. Anesthetic agent(s) used intraoperatively and before sedated device activations were recorded and compared to respective eABRs (n=14). Patient demographics and operative events were reviewed. eABR waveform morphologies were reviewed and compared to baseline readings.

RESULTS

	Subject 1	Subject 1R*	Subject 2	Subject 2R*	Subject 3	Subject 4	Subject 5
Age at Evaluation	14 months	2 years	8 months	2.5 years	10 months	2 years	5 months
Gender	Male	Male	Female	Female	Female	Male	Female
Birth History	32 week pre-term, oligohydramnios possible PPROM	32 week pre-term, oligohydramnios possible PPROM	Ex-term CHARGE HB I/VI L, HB II/VI R	Ex-term CHARGE HB I/VI L, HB II/VI R	Ex-term, otherwise healthy	Hyperbilirubinemia at birth requiring NICU admission	Ex-term Meconium aspiration requiring 1 month 4 day NICU admission
Family history of hearing loss	None	None	None	None	None	None	None
MRI Workup	Cochlear nerve aplasia bilaterally	Cochlear nerve aplasia bilaterally	Cochlear nerve aplasia bilaterally Possible slightly atrophic pons	Cochlear nerve aplasia bilaterally Possible slightly atrophic pons	Cochlear nerve aplasia bilaterally	Cochlear nerve aplasia bilaterally	Cochlear nerve aplasia bilaterally (R>L)
CT Workup	Cochlear hypoplasia bilaterally	Cochlear hypoplasia bilaterally	IAC / otic capsule hypoplasia bilaterally	IAC / otic capsule hypoplasia bilaterally	Severe cochlear hypoplasia bilaterally, absent R SCC, absent L LCC	Narrow IAC bilaterally	Narrow IAC bilaterally

Table 1. Patient demographics and characteristics. * = Revision

Patient characteristics are reported in **Table 1**. Mean age (±SD) at primary ABI surgery was 20.5 ± 6.7 months. Etiology of deafness was cochlear/cochlear nerve hypoplasia or aplasia. Inhaled sevoflurane induction and propofol maintenance were utilized for all 7 intraoperative recordings. Pre-activation recordings were performed between 6 to 15 weeks post-operatively. Intramuscular dexmedetomidine was used in 6 sedated activations; two sedated activations used sevoflurane and propofol (one sedated activation was converted from dexmedetomidine to sevoflurane originally). Upon review and comparison of eABR waveforms, waveforms were similar across all anesthetic regimens for intraoperative and postoperative recordings (**Table 2**).

	Subject 1	Subject 1R*	Subject 2	Subject 2R*	Subject 3	Subject 4	Subject 5
Intraoperative Anesthesia	Sevoflurane & Propofol	Sevoflurane & Propofol	Sevoflurane & Propofol	Sevoflurane & Propofol	Sevoflurane & Propofol	Sevoflurane & Propofol	Sevoflurane & Propofol
eABR	Present	Present	Present	Present	Present	Present	Present
Postoperative Anesthesia	Dexmedetomidine	Dexmedetomidine	Dexmedetomidine	Dexmedetomidine	Sevoflurane and Propofol	Dexmedetomidine convert to Sevoflurane	Dexmedetomidine
eABR	Present	Present	Present	Present	Present	Present	Present

Table 2. Anesthesia regimens and EABR * = Revision

CONCLUSION

Based on results from a preliminary sample of 5 pediatric ABI subjects who underwent 7 ABI surgeries and sedated activations, sevoflurane, propofol, and dexmedetomidine are viable anesthesia options that do not appear to greatly change eABR waveforms

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