Abstract

Objective: Review the literature regarding Auditory Brainstem Implant (ABI) indications, surgical techniques, activation methods, and post-surgery follow-up in children.

Materials and Methods: A search was performed in LILACS, MEDLINE, SciELO, and PubMed databases in June 2014, and the key words used in the search were (“auditory brain stem implant” OR “auditory brainstem implants”) OR (“auditory” AND “brainstem” AND (“implants” OR “implant”)). Additional filters were used: Portuguese, English or Spanish languages, subjects younger than 18 years old, and the period of publication was set to 2000-2014. Duplicates were excluded at this point. The abstract of all the resulting studies were read, and after removing studies that did not comply with the inclusion/exclusion criteria, the remaining studies were read in full.

Methods and Materials

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Results

Two hundred and thirty two studies were found and, after reading the abstracts of these manuscripts, 42 studies were read in full. Finally, twenty-four studies were selected for appraisal. The studies shows results on 120 patients fitted with an ABI.

Most of the studies considered the indication of ABIs for patients with bilateral severe sensorineural hearing loss caused by issues in the cochlear nerve (aplasia or avulsion after a head trauma with bilateral temporal bone fracture, tumours like sporadic schwannoma of the cochlear nerve or bilateral tumours caused by neurofibromatosis type 2 (NF2)), severe abnormalities of the cochlea (malformations or ossification), or auditory neuropathy. It is not possible to estimate the average age of the patients in the studies, since most of them showed results involving patients older than 18 years old. Twelve (10.0%) of the patients had associated anatomic deformities, and 15 (12.5%) had other associated deficiencies or disabilities, as presented in Tables 1 and 2.

Thirteen patients were fitted with the Pulsar CI100 ABI® (Med-EI Co., Innsbruck, Austria), 5 patients were fitted with a Concerto ABI® (Med-EI Co., Innsbruck, Austria), 1 patient received a Nucleus 22 Auditory Brainstem Implant System® (Cochlear Co., Lane Cove, Australia), and the other 48 were fitted with the Nucleus 24 Auditory Brainstem Implant System® (Cochlear Co., Lane Cove, Australia). Regarding the surgical procedure, four patients were fitted with ABIs with the retro labyrinthine approach, eight with the suboccipital approach, 49 with the retrosigmoid approach and 2 with the translabyrinthine approach. Both patients with bilateral schwannomas and tumours caused by NF2 received the retrosigmoid and transmeatal combined approaches for tumour removal.

Introduction

The auditory brainstem implant (ABI) indications are bilateral lesions in the auditory nerve and cochlear malformations or ossification that prevents the surgical placement of the arrays of the cochlear implant, as the ABI may be placed directly at the cochlear nucleus on the IV ventricle.

The U.S. Food And Drug Administration (FDA) has allowed, since December 2000, the Nucleus 24 Auditory Brainstem Implant System® (Cochlear Co., Lane Cove, Australia) for patients above 12 years old. However, some authors like Colletti et al. have successfully fitted ABIs in patients younger than this age, with the authorisation of the research ethics committees. Only in January 2013 the FDA has given authorization to begin clinical trials for ABI in children younger than 12 years old.

The objective of this paper is to review the literature about the results obtained by different authors regarding ABI, as well as the indications, surgical techniques, activation of the device, long-term results, and factors that may influence the outcomes.

Deformity Number of patients

<table>
<thead>
<tr>
<th>Internal auditory canal open</th>
<th>67.61%</th>
<th>Normal size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced auditory canal</td>
<td>35.17%</td>
<td>75%: diameter of 1 mm or less</td>
</tr>
<tr>
<td>Reduces auditory canal</td>
<td>25%:</td>
<td>75%: diameter of 2 mm or more</td>
</tr>
<tr>
<td>Labyrinthine malformations</td>
<td>15%:</td>
<td>46.14%: reduced internal auditory canal</td>
</tr>
<tr>
<td>Nonsensory size internal auditory canal</td>
<td>20%:</td>
<td>75.56%: normal size</td>
</tr>
</tbody>
</table>

Table 1. Associated disabilities on children fitted with ABIs.

Methodology and Materials

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Discussion

Hearing loss is one of the most common deficiencies in humans. The number of Americans with hearing loss has evidently doubled during the past 30 years, and in the USA, 5 per 10,000 children younger than 2 yearsold have profound hearing impairment.

Colletti et al. proposed the following criteria to indicate ABIs in patients of all ages: (1) cochlear implant not indicated; (2) no contraindications; (3) the absence of neurological deficits capable of making rehabilitation difficult or even impossible; (4) strong motivation in adults; (4) motivated family and social environment for children; (5) extensive experience in posterior fossa surgery of the surgical team; (6) Extensive experience in auditory rehabilitation of the rehabilitation team; and (7) the possibility of prolonged, intensive rehabilitation.

Tan et al. considered that despite the better results of the ABI compared to cochlear implant in patients with ossified cochlea, there is a higher risk of complications, such as meningitis, hydrocephalus (transient or permanent), balance problems, cerebrospinal fluid leakage, wound seroma, minor infections, transient facial palsy, temporary dysphonia and dysphagia, and headache.

The first step of the ABI activation is to define the threshold (T) and the maximum comfort levels (C). There are no tonotopic relationships between the ABI array and the human cochlear nucleus, so ‘place-pitch scaling’ and ‘ranking’ are performed to determine the pitch perception and define the tonotopic array order. The programming process in children should follow the same steps as in adults; nevertheless, it requires different strategies, like behavioural observations to the stimulus given and responses with a pictures loudness scale.

Even though Colletti et al. consider the retrosigmoid surgical technique as the preferred technique, the translabyrinthine approach is the only one allowed by the FDA. Bento et al. showed the feasibility of exposing of the jugular bulb without complications when using the retrolabyrinthine approach, stating that the distance to the bulb nerves is short, allowing a good manipulation of the cerebellar floculus and choroid plexus, as well as excellent visualization of the foramen of Luschka.

Colletti et al. observed that patients with non-tumoral scored much better than patients with cochlear acoustic neuroma and with type 2 neurofibromatosis.

Colletti et al. considered the global performance of children fitted with ABIs to be very satisfactory. The children had increased communication skills and an improvement in lip reading and environmental sound perception was observed as soon as the ABI was activated.

There are only a few studies that referred to ABI in children younger than 18 years old. That fact may have occurred because of the age limitations imposed by the FDA in the past years. Since FDA has given authorization to clinical trials to be performed, the number of papers in this specific area might bring more valuable information in this subject in the next years.

Conclusions

The results obtained in 120 children fitted with an ABI showed that the patients globally improved in their ability to detect sounds and communication skills.

References

10. Rapoport LA, Kornreich E, Birk D, M. The results obtained in 120 children fitted with an ABI showed that the patients globally improved in their ability to detect sounds and communication skills.

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