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Does cerebellar flocculus size affect subjective outcomes in pediatric auditory brainstem implantation

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A R T I C L E I N F O

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A B S T R A C T

Objectives: The objectives of study was to 1) Describe relevant surgical anatomy in defining and accessing the lateral recess for placement of electrode, 2) Propose a working classification for grades of Flocculus; 3) To determine if different grades of cerebellar flocculus effects placement of ABI electrode and subjective outcomes in implantees.
Methods: Our study was a prospective study, and comprised of cohort of 12 patients who underwent ABI surgery via retrosigmoid approach between 1 Jan 2012 to 31 Dec 2014. All children with congenital profound sensorineural hearing loss with either absent cochlea or cochlear nerve were included in the study. Relevant anatomy was noted. We also noted down the difficulty encountered during the placement of ABI electrode. Auditory perception and speech intelligibility was scored post operatively for 1 year.
Results: Cerebellar flocculus was divided into 4 grades depending on the morphology of cerebellar flocculus. It was noted that Grade 3 & 4 flocculus (Group B) had difficult ABI electrode placement in comparison to Grade 1 & 2 flocculus (Group A). The subjective outcomes of Group A was better than Group B. However the p value was not statistically significant.
Conclusion: Cerebellar flocculus can be graded depending on morphology and size. Flocculus of higher grades can make the placement of ABI electrodes difficult and adversely effects the postoperative subjective outcomes.

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1. Introduction

The concept of auditory prosthesis has undergone a revolutionary evolution which began with Djourno and Eyries on 25 February 1957 [1,2].

Auditory Brainstem Implant (ABI) is an auditory prosthesis directly stimulating second order auditory neurons present in cochlear nucleus in brainstem bypassing cochlea and cochlear nerve. Since first successful ABI surgery performed in 1979 for a woman with Neurofibromatosis type 2 (NF2), by William E. Hitselberger and William F. House at House Ear Institute [3], there has been increasing interest to provide auditory sensations to non NF2 patients with either cochlear or cochlear nerve pathology or both over last couple of decades [4].

In 2001, Colletti performed first pediatric ABI surgery for a case of auditory nerve aplasia [5]. Since then Colletti group from Italy and Sennaroglu group from Turkey have has performed nearly 200 non NF2 pediatric ABI surgeries, including surgery on an 8 month old infant by Colletti [4,6–10]. Today ABI surgery is accepted as a safe surgery and an effective option for auditory stimulation in profound retrocochlear deafness in children.

The site for placement of ABI electrode is Cochlear nucleus

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complex, comprising of the ventral cochlear nuclei (VCN) and dorsal cochlear nuclei (DCN). The VCN is main nucleus for transmission of neural impulses from cochlear nerve as its axons form the main ascending tract of the cochlear nerve [11]. Both VCN and DCN are not visible during ABI surgery and hence, locating nucleus depends on identification of adjacent anatomical structures.

An important question which still remains unanswered is whether patients who are unfit for or who are likely to have poor outcomes following Cochlear Implant (CI) surgery might still be good enough candidates for ABI surgery. Proper electrode positioning is one of the most important predictive factor determining ABI outcomes. Looking for anatomically preserved regions during ABI surgery, either distally or proximally, and intraoperative electrophysiological tests are presently the most useful parameters available for the proper placement of electrode [11].

2. Aims and objectives

The aim of the study was to 1) Describe relevant surgical anatomy in defining and accessing lateral recess for placement of electrode via a retrosigmoid approach, 2) Propose a working classification of grades of Cerebellar Flocculus; 3) To determine if different grades of cerebellar flocculus affects placement of ABI electrode intraoperatively and subjective outcomes in implantees post operatively.

3. Study methodology

Our study was a prospective study, conducted at a tertiary care centre in southern India, and comprised of cohort of 12 pediatric patients who underwent ABI surgery from 1 Jan 2012 to 31 Dec 2014 (3 years). Institutional research ethics board approval was obtained. All children with congenital profound sensori-neural hearing loss (SNHL) with either absent cochlea or cochlear nerve or both, who underwent ABI surgery at our centre were included in the study. Children more than 10 years of age, those with subnormal IQ and children with syndromic associations and multiple disability were excluded from the study in order to reduce bias while comparing outcomes in ABI implantee.

Children brought with complaints of speech delay and not responding to sounds, after noting down relevant history and complete examination, underwent complete electrophysiological hearing evaluation and imaging (HRCT of the temporal bone and MRI brain and inner ear), to determine the severity of hearing loss and anatomical site of lesion. All those patients who were diagnosed to have profound retrocochlear SNHL with either absent cochlea or cochlear nerve were advised to undergo ABI surgery. Parents and family members were counselled regarding diagnosis, need for ABI surgery, surgery and likely complications, cost, prolonged habilitation process and expected outcomes. An informed written consent of parents for surgery was taken. All relevant investigations were undertaken. Comprehensive evaluation and opinions from neurosurgeon, pediatrician, ophthalmologist, cardiologist, clinical psychologist and occupational therapist were obtained.

Our surgical team comprised of an ENT surgeon, Neurosurgeon, Anesthesiologist and Audiologist. Surgery was performed under intensive neuroanesthesia with intraoperative cranial nerve monitoring.

A standard retromastoid suboccipital approach was used to reach the cerebellopontine angle (CPA). The 7th/8th cranial nerve complex and the 9th/10th/11th cranial nerve complex were visualized. The 9th cranial nerve was followed medially onto the foramen of Luschka, where choroid plexus was identified. When in doubt location of lateral recess was further confirmed by noting for the egress of CSF during Valsalva maneuver. Further dissection was done to reach the floor of IV ventricle where a constant vein, **the straight vein** (Fig. 1), was identified leading to cochlear nucleus.

ABI receiver stimulator coil bed was drilled with tie-down holes positioned atleast about 10 mm behind the edge of pinna and above canthomeatal line and angled between 30 and 45° posterosuperiorly. Initially a test electrode was placed in region of cochlear nucleus to check optimal positioning of electrodes (Fig. 1). Once satisfactory it was replaced by permanent electrodes (Med El OPUS 2 ABI electrode) after fixing receiver stimulator coil with 3-0 prolene sutures over the previously drilled bed. Prior to placement of electrode (Fig. 1) its polyethylene terephthalate mesh was trimmed in all our pediatric ABI candidates. This was done because of smaller dimensions of lateral recess in children and theoretical advantage of ease in removing electrode for any revision surgery if required.

During dissection we made note of presence or absence of cerebellar flocculus and tried to grade it based on its size and in relation to visualization of choroid plexus, 7th/8th cranial nerve complex and 9th/10th/11th cranial nerve complex. The problems associated with each variant of cerebellar flocculus in defining the foramen of Luschka and in placement of brainstem implant was elucidated. The other anatomical variations defining foramen of Luschka were also noted.

Electrodes were tested under bipolar conditions. EABR in ABI lacks waves I and II. Positive auditory response are multi-peak waveforms generated in first 2–4 ms of onset of stimulus, while larger waves with longer amplitude are generally non-auditory responses. After optimal placement, electrodes was secured with surgicel. The ground electrode was placed underneath temporalis

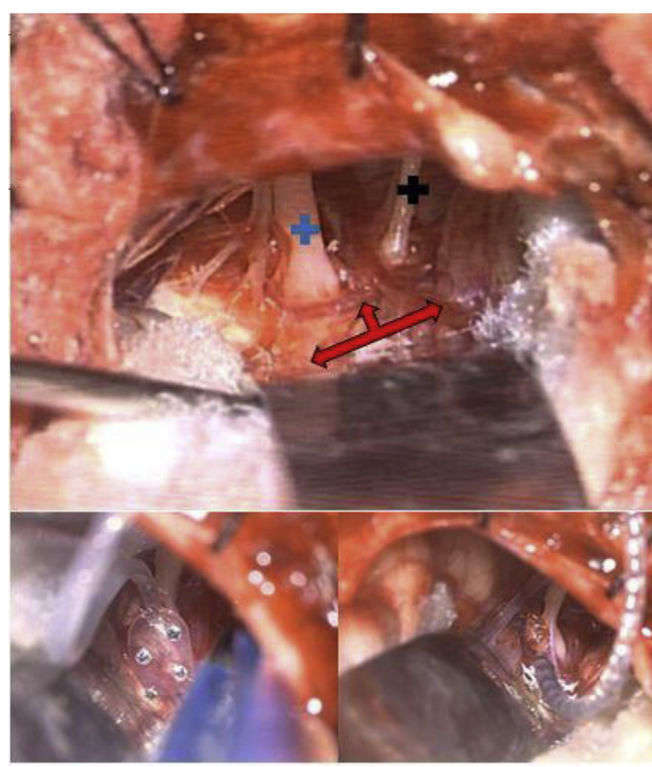

Fig. 1. Demonstrating the anatomical relationship of **straight vein** (Red arrow) and 7–8 Cranial nerve complex (black cross) and 9 cranial nerve (blue cross). Left lower figure shows the ABI template being placed superficial to the straight vein. Right lower figure shows the trimmed ABI electrode in its final position superficial to **straight vein**. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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