Paediatric Auditory Brainstem Implantation

Surgical Challenges in Anatomical Variations: Our Experience

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INTRODUCTION:

- ABI is indicated for children with profound hearing loss due to congenital cochleo-vestibular malformations, absent/hypoplastic vestibulocochlear nerve, and for whom cochlear implant is not beneficial.
- Locating the nucleus depends on identification of adjacent anatomical structures.
- Site for placement of ABI electrode is Lateral recess of the 4th ventricle close to the foramen of Luschka.
- Knowledge of the anatomical landmarks and variants in anatomy of the brainstem is vital for surgery.

AIMS:

- To study the normal surgical landmarks & Anatomical variants encountered in the CP Angle.
- To grade cerebellar flocculus & determine if different grades of cerebellar flocculus affect placement of the ABI electrode.
- To assess outcomes after ABI.

METHODS:

- Study duration : March 2006 - September 2017 (MedEI ABI)
- Grading of flocculus & electrode insertion difficulty assessed.
- Outcomes measured with Categories of Auditory Performance scores (CAP) / Speech Intelligibility Ratings scores (SIR).

RESULTS:

- Anatomical Landmarks visualized in surgery were :
 - ✓ Choroid plexus marking the entrance of the lateral recess
 - ✓ Flocculus of cerebellum forming an operculum covering the entry to lateral recess of fourth ventricle
 - ✓ Exit of cranial nerves 7, 8 and 9 form a triangle which help in identification of the entrance of the lateral recess of fourth ventricle
 - ✓ Straight vein at the cochlear nucleus heading to the entrance of the foramen of Luschka

Variations as listed below, made the proper positioning of electrode difficult in few cases.

Cerebellar flocculus was graded into 4 categories based on morphology & location.

Majority of our cases had grade 2 flocculus.

Flocculus Grades and its anatomical relationships

Grade	Flocculus Morphology	Location	Covers 7/8 CN Complex	Covers 9/10/11 CN Complex	Choroid plexus	Cases
1	Not Visualized	Not Visualized	No	No	Prominent	6
2	Hypoplastic	Rostral	Yes	No	Prominent	9
3	Small	Central	Yes	Yes	Small	5
4	Large	Central	Yes	Yes	Small	4

OUTCOMES:

- Chi-square test showed $p < 0.05$, suggesting that in group B Cerebellar Flocculus made electrode insertion difficult
- On comparing base line CAP and SIR scores with corresponding 12th month scores of each patient, $p < 0.00001$, showing ABI was helpful in improving Auditory Verbal performance.

	Flocculus Grade	Easy Insertion	Difficult Insertion
Group A (Grade 1 & 2)		13	2
Group B (Grade 3 & 4)		3	6

CAP and SIR Scores in relation to flocculus grade

- Although CAP and SIR scores of grade 1 were higher on comparison to grade 4, it was only a weak correlation
- Grade 4 flocculus was associated with a higher incidence of temporary vestibular imbalance post-operatively
- In general, it was found that difficulties encountered during surgery did not affect the eventual outcomes with ABI.

DISCUSSION:

- Knowledge of anatomical variants in ABI surgery is crucial for successful outcomes.
- The cochlear nucleus complex, composed of the ventral and dorsal nucleus are not under direct vision and their location is determined by lateral recess opening or foramen of Luschka, which lies between root entry zone of facial and glossopharyngeal nerves.
- Colletti et al, 2015 stated that absence or hypoplasia of vestibulocochlear nerve is frequently associated with anomalies of facial nerve. These Authors also described other variants such as variability in choroid plexus dimensions, close proximity of nervus intermedius to the foramen of Luschka and absent abducent nerve.
- Kameswaran M et al, 2017 have graded the anatomical variants based on morphology and insertion difficulty
- Monitoring evoked auditory brainstem response (eABR) during implant positioning is essential in achieving optimal electrode position to obtain maximal auditory verbal outcome.

CONCLUSION:

- ABI can be influenced by frequent anatomical variations surrounding lateral recess.
- Flocculus of the cerebellum is of different grades and higher grades can make the placement of ABI electrodes difficult
- Regardless of the surgical challenges in ABI surgery, intensive post-operative auditory verbal habilitation provides satisfactory outcomes.

FUTURE DIRECTIONS:

- MRI Flocculus studies, Neuro-navigation, CP Angle Endoscopy, Optogenetic stimulation etc may all lead to better understanding of the intricate anatomy of the cochlear nucleus and its surroundings.

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