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Clinical applications of Speech Evoked Cortical Auditory Potentials (SECAPs) in Pediatric Hearing assessment & Aural habilitation- A case report

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ABSTRACT

Speech evoked cortical auditory potentials (SECAPs) are generated from the primary auditory areas of the brain in responses to an acoustic stimulation. Though, the cortical maturation is incomplete in young children, an exogenous potential recording with a speech stimulus would give a positive peak-P1 with a post stimulus latency of 120-150 ms. The potential clinical application of these evoked potentials are merely reported in scientific community due to its recording limitations and also due to the lack of clinical data. Therefore we report a clinical case, where cortical evoked potential measures are effectively used in paediatric assessment and in aural rehabilitation. Further, it would help in the widespread application of SECAP in clinical practice.

KEYWORDS: Speech Evoked Cortical Auditory Potentials, Hearing Assessment, Aural habilitation, Cortical Maturation

Evoked potentials are defined as the perceptual and cognitive processes which are obtained in response to auditory stimuli resulting from higher brain function (Martin, Tremblay & Korczak, 2008). Cortical auditory potentials (CAEPs) are broadly classified into endogenous and exogenous potentials. Endogenous potentials are those which are more dependent on cognition and attention factors where as Exogenous potentials are those, which are more dependent upon the external stimulus parameters. The exogenous CAEPs are also known as 'Late Latency Responses (LLR).The components of LLRs are termed as P1, N1, P2 and N2 respectively (Sharma, Dorman, & Spahr, 2002). In the recent years, there is an increased interest towards the potential application of CAEPs in children especially in assessment and habilitation. Much of the studies have been done to investigate how the maturational process influences in the formation of cortical responses (Gilley, Sharma & Dorman, 2006).However all the reports are diversified in its opinion on how the maturational process influences the CAEPs.

The increased interest in early identification hearing loss in infancy has paved a path breaking journey for CAEPs and its applications. Sharma et al (2002) reported that the positive peak, 'P1' of LLR can be used as a biological marker for auditory processing in children. Sharma and her associates (2011) also explored the possible application of CAEP in children especially in auditory neuropathy spectrum disorders (ANSD). King, Campell and Sharma (2008) stated that, though cortical structures are not fully developed in children; CAEP can still be used to obtain important cortical processing information in children.

The processing of acoustic information through auditory system is key for the normal development of speech and language in young children. By keeping this in mind, evoked potential studies have been far developed by using speech as a stimulus than non speech stimulus. The use of speech stimulus will also give information more realistically regarding the outcomes in aural habilitation. It is also reported that, speech stimuli, such as consonant-vowel syllables can be used to evaluate the functional integrity of the auditory pathways that are important for normal speech and language development. Similar thought was advocated by Martin et al; (2008) by reporting that the Speech Evoked Cortical Auditory Potentials (SECAPs) can be used to objectively measure the perception of spectrally different speech sounds.

Literature also highlights the use of SECAPs in monitoring aural habilitation outcomes. Gilley et al (2006) reported that P1 can be used to monitor the speech processing ability in post aural habilitation. It is also reported that children who present with good speech processing abilities show a normal P1 latency. Therefore, it is required to hire a more clinical support in accordance with possible use and application of SECAPs in children. Thus, in the present case study we aim to highlight the potential application of SECAPs in hearing assessment and in monitoring aural rehabilitation on a 5years old child.

Method

A 5year old child was brought to our clinic with the complaint of inappropriate speech and language skills. Family history was positive for consanguinity and medical history revealed that the child had congenital heart disease. As the primary complaint was that of hearing loss, an audiological test battery was carried out for the child. Auditory brain stem response (ABR) was recorded by using a dully calibrated Intelligent Hearing System - Evoked Potential (IHS-EP). Transient oto-acoustic emission (TEOAE) was done by using ILO-v6 to assess the integrity of outer hair cell function. SECAP was recorded by using a synthesised consonant vowel stimulus /da/ using IHS-EP. Conditioning play audiometry was tried with the child but could not draw any inferences from it. An immittance evaluation was done to rule out any middle ear pathology.

Hearing aid trial (HAT) was carried after the diagnostic evaluation to select an appropriate amplification device. SECAP are recorded after the hearing aid fitting procedure to ensure about the benefit of amplification. The child was enrolled for aural habilitation following the HAT. To account for the benefit and improvement in aural habilitation, SECAP recording was done before enrolling for the therapy, post therapeutically after 1 month and 6 month respectively. Parents were informed about the potential importance and scientific benefit of reporting these findings and dully signed consent were obtained

Results

Audiological testing revealed: ABR - No identifiable peaks observed at maximum intensity level (Figure 1). TEOAE revealed no responses from OHC and it could be attributed as a predominant cochlear involvement in hearing loss. No middle ear disorders observed in Immittance measurements. From the above test results child was diagnosed to have severe hearing loss in both ears. Hearing aid trail with a digital hearing aid showed a mere benefit with the hearing aid behaviourally. However to ensure the benefit, SECAP testing were done and a distorted positive peak, P1 was emerged at 205-210ms. SECAP recording after 1 month and 6 month of post auditory training reveals a significant improvement in P1 latency of 178ms and 88ms respectively(Figure 2). Interestingly for all the recordings only a positive peak, which is considered as first peak of exogenous potentials are found. The reasons for the positive peaks and its changes in latencies will be discussed later. A review of language skills were also done periodically every 3 months

and found that there is a considerable amount of increase in child's vocabulary after aural rehabilitation.

Discussion

The aim of this case study was to highlight the potential application of SECAP in hearing assessment and aural habilitation in children. Interestingly in the present case it was found that how the P1 of SECAP matures after aural habilitation. Based on the evidences from the literature, the P1 of SECAP is thought to be generated from the auditory thalamic and cortical regions. P1 latency decreases with increase in age (Gilley et al 2006) indicative of normal auditory cortical development and it is useful in assessing the central auditory maturation in children (Sharma et al, 2002, **Purdy &** Berry, 2009). Though a substantial amount of information is reported on the maturation of CAEP in children, how cortical regions mature after acoustic stimulation in hearing impaired is merely reported. In the present case, we recorded an exogenous P1 following the hearing aid trial. Soon after 1 month of aural habilitation aided CAEP was recorded and identifiable but delayed P1 response was obtained at 178ms. Kral, Heid & Tillein, (2005) reported that children with hearing loss have received minimal auditory stimulation which in turn leads to delayed maturation of the central auditory system and results in cortical reorganization. Evidence from the literature also states that delayed auditory stimulation results in delay in the development of the central auditory system in congenitally deaf children who are fitted with bilateral cochlear implants (Eggermont & Ponton, 2003).

After 6 months of aural habilitation, aided SECAP was repeated and it was seen that the latency of P1 (88 ms) was reduced in comparison to the recording done after 1 month of aural habilitation. These decreases in latency could be attributed to the increased synaptic efficiency which results in neural synchronization in the central auditory system in response to aural habilitation. This was noticed in congenitally deaf children who are fitted with hearing aids or cochlear implants (Kral et al, 2005 & Bauer, Sharma & Martin, 2006). These changes in the central auditory system after acoustic stimulation highlights the importance of early identification of hearing loss and aural habilitation in children (Purdy & Berry, 2009).Thus, SECAP can be used as a tool to assess the outcomes in aural habilitation especially in children, where behavioral responses are difficult to obtain. SECAP also provides a wealth of information on how the central auditory system follows the normal maturation pattern after acoustic stimulation through hearing aids.

In the present study authors has also looked into the developmental patterns of N1 in SECAP. It is noticed that that during the course of normal neural development, there is an improvement seen in P1 latency and it matures by adult like response 6 years of age. But what happens to N1 of SECAP during the course of normal development is yet to be answered in the scientific community. However, from the current evidences it is known that the P1 is generated from the primary auditory cortex, whereas, N1 is thought to be generated from the recurrent loop feedback from the cortico-cortical and cortico-thalamic projections. These evidences could be used to postulate the delayed and late negativity seen in children due to the reduced acoustic stimulation and due to auditory deprivation. Further, it leads to the cortical reorganization of auditory areas and its functions are taken over by other sensory areas. During the normal developmental stages, with appropriate acoustic stimulation and with the synaptic pruning, the cortico-cortical connections get strengthened. As a result the broad negativity is reduced in its latency and forms a biphasic waveform approximately at the age of 12 years. Thus, by monitoring the aural habitation through SECAP recordings, one can assess the auditory cortical development and can obtain a wealth of information on how speech sounds are processed through the impaired auditory system after aural habilitation.

Conclusion

To conclude, CAEP can be used as a vital test to assess the integrity of cortical structures as well as monitor the outcomes in aural habilitation in children. Though extensive data is required to make such an implication in clinical population, careful recording and analysis would give accurate results. Thus this case report highlights the usefulness and importance of such techniques in paediatric hearing assessment and aural habilitation.

Figure-1-ABRs in Left ear and Right ear

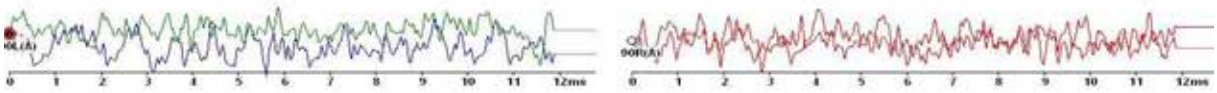
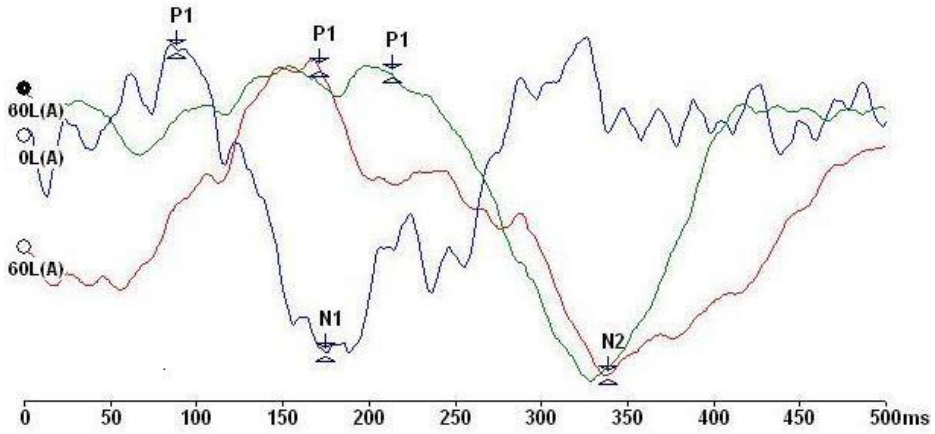


Figure -2-SECAP recording (A):0month, (B):1month and (C):6months



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