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Original Research Article

Audiological assessment in children with autism spectrum disorder: a tertiary care centre experience

Vikas Mahajan[1], Priyanka Khar[2], Neha Saraf[3], Aditiya Saraf[2]*, Gopika Kalsotra[2]

[1]Department of Paediatrics, ASCOMS. Jammu, Jammu and Kashmir, India
[2]Department of ENT and HNS, SMGS Hospital, GMC Jammu, Jammu and Kashmir, India
[3]Department of Anatomy, HBT Medical College and Dr. RN Cooper Municipal General Hospital, Mumbai, Maharashtra, India

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***Correspondence:**
Dr. Aditiya Saraf,
E-mail: rksaraf56@gmail.com

ABSTRACT

Background: Aim was to assess the audiological function in children with autism spectrum disorder (ASD).
Methods: A prospective study conducted over one year at a tertiary care center involved 55 children: 30 with ASD (Group A) and 25 healthy children (Group B). Tympanometry, transient evoked otoacoustic emissions (TEOAE), and brainstem evoked response audiometry (BERA) tests were performed on both groups and compared.
Results: The study involved 55 children divided in 2 groups-ASD (Group A) and healthy children (Group B). Tympanometry showed Type 'A' curves in all group B children and in 26 out of 30 group A children; 4 children in group A with type 'B' or 'C' curves were excluded. In group A, 16.6% of children had TEOAE response in one ear, and 20% had no responses. All children in group B had TEOAE responses in both ears. BERA results showed significant differences between both groups in terms of inter-peak latencies between waves I and III and III and V ($p<0.05$), though the inter peak latency between waves I and V was not significant ($p>0.05$).
Conclusions: According to our study, patients with ASD in addition to neurological and behavioral assessment need regular auditory function testing as well.

Keywords: TEOEA, BERA, ASD

INTRODUCTION

According to the diagnostic and statistical manual of disorders, 5th edition (DSM-5), ASD is an early onset, typically lifelong condition characterised by enduring deficit in social communication skills and restricted, repetitive behaviours. DSM-5 has replaced 4 of these subtypes (autistic disorder, Asperger's disorder, childhood disintegrative disorder and PDD-NOS) with one central diagnosis, ASD to encompass a range of conditions that were classified under development disorder in the DSM-4.

Autism is thought to have an early onset, with symptoms appearing before 30 months of age in majority of cases. However, a definitive diagnosis of autism is not made until age of 4-4.5 years of age.[1] According to WHO, it is estimated that worldwide about 1 in 100 children have autism. The prevalence of autism in India has been steadily rising. According to a study published in Indian journal of paediatrics in 2021, the estimated occurrence of autism in India is approximately 1 in 68 children.

Children with autism often show unresponsiveness to their environment and are often difficult to test with standard behavioural audiometric procedures. As a result, children who are eventually diagnosed as having autism are often initially suspected of having hearing impairment by their parents.[2]

On an average, a child who is deaf will be diagnosed with autism later in life than a hearing child with autism. According to a study the deaf children were diagnosed an average of one year later. The reason for it is speculated to be the difficulty encountered in distinguishing characteristics of deafness and autism. Also, deaf children are diagnosed later because there are relatively few psychological tests that have been made for, or even include, considerations for children who are deaf.[3]

Studies have shown that people with autism may have impaired brain stem functions. Various imaging, embryologic, genetic, and neurobiological studies have shown brain stem involvement in these children. According to these findings, involvement at different levels of the brain stem can affect auditory sensory input and cause difficulties in understanding and integrating auditory information at a higher level.[4] This leads to delay in speech learning and language development along with abnormal responses to sensory input in these children.

The ABR test is a reliable method for detecting hearing loss in children with autism.[5-7] Also, an abnormal increase in ABR waves latency and abnormal increase in wave I latency has been reported due to cross olivocochlear bundle (COCB) involvement in children with autism. Evoked otoacoustic emission, discovered by Kemp in 1978, reflects the cochlea's active response to sound stimulation.[8] The test is objective, accurate, non-invasive, and easy and rapid to administer, and specifically reflects the function of the cochlea.[9] Moreover, a study by Khalfa et al using otoacoustic emission reported a decreased inhibitory effect of COCB in children.

Due to the above reasons, a need erupts to evaluate the hearing of children with ASD. Therefore, the present study was conducted to evaluate the hearing objectively using TEOAE and ABR in children with ASD.

METHODS

Present prospective study was conducted in department of paediatrics at GMC, Jammu on 55 children over a period of 1 year (from March 2023-February 2024). Present study was conducted after approval by institutional ethics committee and written informed consent taken from attending care takers of all children.

Inclusion criteria

Children between the age group of 2-8 years and caretakers who gave consent for participation in study were included.

Exclusion criteria

Children with CSOM, children with external canal atresia, chromosomal abnormalities, neurodegenerative disorder and caretaker not giving consent for participation were excluded.

Out of 55 children, 30 children were diagnosed as ASD (based on DSM-V) (Group A) and 25 children were healthy children who came to OPD for complaints than audiological or neurological (Group B). After relevant clinical history and general/systemic examination both the groups were subjected to tympanometry. TEOAE and BERA test were performed and compared between both the groups.

The TEOAE test was performed by using click stimulus of 80s rectangular pulses with a peak intensity of 80±5 dB. Sound pressure level (SPL)and stability was more than 80%. The test was applied in a quiet environment, the rejection threshold was under 50 dB and the quiet/ noise ratio was over 50%. Transient responses were averaged 260 times and analysed during first 2.5-20 ms interval after the stimulus onset. We assumed the reproducibility of 50% or greater as a 'positive' result. If this ratio of reproducibility was not obtained after the acquisition of 260 subsets, this constituted the negative result.

Auditory brainstem response (ABR) testing was carried out using neurosoft neuro-audio device. Silver-silver chloride button electrodes were used. The following parameters were selected for recording: The filter bandwidth was adjusted to 100-3000 Hz; The stimulus was click; The stimulus rate was 19.3/second and its duration was 100 microsecond/click; a minimum of 2000 clicks were presented at each recording (responses will be repeated at each intensity level to ensure reproducibility) and Wave forms were recorded at a sound intensity of 70-90 dBnHL, in both ears separately.

The site of electrode placement was cleaned thoroughly with a spirit swab to reduce the skin- electrode impedance to less than 5 kΩ. The non-inverting electrode was placed at the vertex, the inverting electrode on either mastoid and the ground electrode on the forehead, using conduction gel. The surface impedance was adjusted below 5kΩ to facilitate optimal recording.

The following parameters were studied: Absolute latencies of wave I, III and V and interpeak latencies (IPLs) of waves I-III, III-V and I-V.

All data was entered in MS excel spreadsheet and appropriate statistical analysis were applied as advised by statistician.

RESULTS

A total of 55 children were enrolled in our study.

Mean age of presentation (Table 1) was 3.2±1.1 years in group A and 3.6±1.6 years in B, difference being statistically insignificant ($p>0.05$). There was male preponderance in both groups (Table 2) (M:F ratio being 1.4:1 and 1.2:1 in group A and B respectively; p>0.05). Thus, both the groups comparable in terms of age and sex.

Table 1: Mean age of presentation in both groups.

Group A	Group B	P value
3.2±1.1	3.6±1.6	>0.05

Table 2: Male to female ratio in both groups.

Group A	Group B	P value
1.4:1	1.2:1	>0.05

Tympanometry revealed type ‘A' curve in all children in group B and type ‘A' curve in 26 children in group A. Three children had type ‘B' and one child had type ‘C' curve. These 4 children were excluded from further study.

In group A, out of 26 children, 15 children had TEOAE responses present in both ears, 5 had TEOAE responses present in one ear and 6 had absent response in both ears. In group B, TEOAE was present in all children in both ears (Table 3).

Table 3: TEOAE results.

Variables	Present in both ear	Absent in one ear	Absent in both ears
Group A, (n=26)	15	5	6
Group B, (n=25)	25	-	-

*P<0.0001.

Table 4: Interpeak latency in BERA.

Wave latency	Group A, (n=26)		Group B, (n=25)		P value
	Right (m sec)	Left (m sec)	Right (m sec)	Left (m sec)	
I	2.04±0.28	2.05±0.18	2.09±0.37	2.05±0.22	>0.05
III	4.13±0.51	4.11±0.24	4.09±0.66	4.1±0.25	>0.05
V	6.18±0.33	6.15±0.11	6.03±0.18	6.04±0.21	>0.05

Table 5: Mean latencies of waves I, III and V in both groups on ABR.

Inter peak latency	Group A, (n=26)		Group B, (n=25)		P value
	Right (m sec)	Left (m sec)	Right (m sec)	Left (m sec)	
I-III	2.24±0.11	2.22±0.14	2.08±0.09	2.08±0.12	<0.05
III-V	1.99±0.14	1.98±0.11	1.810.1±1	1.81±0.18	<0.05
I-V	4.11±0.18	4.11±0.16	4.16±0.12	4.09±0.11	>0.05

There was no significant difference in mean latencies of wave I, III and V between group A and B (p>0.05) on ABR, as shown in Table 2. There was significant difference between I and III and III and V inter peak latency among group A and group B (p<0.05). However, latency between wave I and V among both groups was statistically insignificant (p>0.05), as shown in Table 3.

DISCUSSION

ASD is a lifelong condition affecting social communication and behaviour, now unified under DSM-5. Symptoms typically appear early, but diagnosis is confirmed around four years of age. Globally, ASD affects about 1 in 100 children, with higher rates in India. Children with ASD may initially be mistaken for having hearing issues due to their unresponsiveness to surroundings. Deaf children are diagnosed with ASD later due to challenges distinguishing symptoms. ASD involves impaired brain stem functions affecting auditory processing and speech development. ABR tests effectively detect hearing impairment in ASD children, showing specific abnormalities. Evaluating hearing using TEOAE and ABR in ASD children is crucial based on these findings.

In our study of 55 children, the mean age of presentation was 3.2±1.1 years in group A and 3.6±1.6 years in group B, with no significant difference (p>0.05). Both groups showed a male predominance (M:F ratio 1.4:1 in group A and 1.2:1 in group B; p>0.05), making them comparable in age and sex distribution.

Tympanometry revealed a type ‘A' curve in all children in group B and in 26 children in group A; four children with type ‘B' or ‘C' curves were excluded. In group A, out of 26 children 15 had TEOAE responses in both ears, 5 in one ear, and 6 had absent responses. Group B showed TEOAE present in all children in both ears.

Comparing ABR latencies, there were no significant differences in mean latencies of wave I, III, and V between groups A and B (p>0.05). However, IPLs between wave I and III and III and V differed significantly between the groups (p<0.05). The latency between wave I and V was statistically insignificant (p>0.05) across both groups.

A study showed similar findings.[2] TEOAE showed 83% children with autism had bilateral TEOAE responses. 10% had absent TEOAE in both ears, and 7% had TEOAE in only one ear. Control group had TEOAE present in all ears. Significant difference ($p<0.05$) in TEOAE responses between groups. ABR showed mean III-V IPLs were longer in autistic children compared to controls ($p<0.05$). No significant differences in latencies of waves I, III, V, and in I-V and I-III IPLs between groups.

A study conducted by Noorazar showed that the III-V and I-V interweave latency time were longer in the autism group ($p<0.001$).[4] In the autism group, 11 children had a positive OAE test, and 9 children had a negative OAE test. Our findings were also consistent with the findings by Wong and Wong, and Rosenhall.[6,7]

However, a study conducted by Rumsey showed prolonged transmission times in only one PDD subject and in one normal control, while shortened transmission times were seen in four PDD subjects.[10] The majority of PDD subjects showed normal ABRs.

The main limitation of our study was that the sample size was small, study duration short and we did not examine higher auditory processing skill which could differentiate between behavioural response to hearing loss, from behavioural response to autism.

CONCLUSION

Thus, we can conclude that, patients with ASD in addition to neurological and behavioral assessment need regular auditory function testing as well. It is important to detect any hearing impairment at an early stage in these children for the prevention of a possible failure to respond to behavioural therapy.

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