INTRODUCTION

Neonatal Hearing screening

In India, hearing disability has a higher prevalence in children aged 0–4 years (0.60%) and 5–9 years (0.28%) than all other disabilities (0.32%).[1] Even though two-thirds of all persons with hearing deficits are from developing countries, newborn hearing screening (NHS) programs are not widely adopted. These countries are often burdened with other life-threatening public health concerns so that hearing loss has not received due attention.[2]

Screening for Hearing loss in Asphyxiated neonates: Consequences of perinatal asphyxia range from death to various degrees of neuro-developmental sensory or motor deficits. One of its well-known sequelae is sensorineural hearing impairment. Adequate oxygenation and perfusion are essential for inner ear function and studies showed that neonatal asphyxia can cause inner ear degeneration, disappearance of the outer and inner hair cells, and degeneration of the spiral and vestibular ganglion cells.[15]

Congenital or early childhood onset of deafness or severe-to-profound hearing impairment, as reported by the World Health Organization (WHO), is encountered in approximately 0.5–5 per 1,000 neonates and infants [16]. United States Preventive Services Task Force reported that the prevalence of neonatal hearing loss in the Neonatal Intensive Care Unit (NICU) is 10-20 times greater than the prevalence of hearing loss in a population of normal neonates.[17] Considering the infrastructure limitations in our country and as limited studies are available regarding hearing evaluation and birth asphyxia as a risk factor for hearing impairment including northern part of Karnataka, this study was undertaken to screen the possible burden of hearing impairment among the inborn neonates with birth asphyxia admitted to NICU Niloufer hospital Hyderabad by using OAE and BERA.
Aims & Objectives

Aim
- To study the local incidence of hearing impairment in term neonates with perinatal asphyxia delivered and admitted in Niloufer hospital.

Objectives
- To study the local incidence of hearing impairment in term neonates with perinatal asphyxia delivered and admitted in niloufer hospital.
- To identify associated risk factors in perinatal asphyxia like hypoglycemia, renal and liver dysfunctions, dyselectrolytemias and newborn requiring assisted ventilation.

MATERIALS AND METHODS

Place of Study
The study was conducted in the Department of Pediatrics, Niloufer hospital, affiliated to Osmania Medical College. It is the largest tertiary care center in the state of Telangana, situated in the heart of Hyderabad.

Study Design
A Prospective observational study

Study period
18 months

Study Population
Neonates delivered and admitted in SNCU, Niloufer hospital,

Study Sample Size
211

Methodology
Neonates delivered and admitted in SNCU, Niloufer hospital, satisfying the inclusion criteria were enrolled into the study and admitted after getting informed consent from the parents/guardians.

Inclusion Criteria:
- Term neonates delivered in Niloufer hospital, Hyderabad with perinatal asphyxia
- Moderate perinatal asphyxia-slow or gasping breathing or an apgar score of 4-6 at 1 min.
- Severe perinatal asphyxia -no breathing or low apgar scores 0-3 at 1min of age
- Parents/guardians of children with the above mentioned criteria who are willing to give informed consent.

Exclusion Criteria
The following infants and children were excluded from the study
- Neonates with major congenital anomalies
- Low birth weight and prematurity
- Neonates with torch infections
- Neonates with hyperbilirubinaemia requiring exchange transfusion
- Neonates with family history of hearing loss
- Parents or guardians those who are not willing to give informed consent.

Ethical Clearance
Ethical clearance was obtained from the Institutional Ethical Committee, Department of Paediatrics, Osmania Medical College, Koti, Hyderabad.

RESULTS
The study was conducted in the Department of Pediatrics, Niloufer hospital, affiliated to Osmania Medical College. It is the largest tertiary care center in the state of Telangana, situated in the heart of Hyderabad.

The results of the study are as follows.

Table 1: Table showing the age distribution (age at which baby was screened)

<table>
<thead>
<tr>
<th>Age distribution</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; or equal to 7 days</td>
<td>117</td>
<td>55.45</td>
</tr>
<tr>
<td>8-14 days</td>
<td>72</td>
<td>34.12</td>
</tr>
<tr>
<td>15-21 days</td>
<td>15</td>
<td>7.10</td>
</tr>
<tr>
<td>22-28 days</td>
<td>7</td>
<td>3.31</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100</td>
</tr>
</tbody>
</table>

In our study almost 90% of the study population are screened within 2 weeks, remaining population are screened after 2 weeks.

Figure 1: Showing the age distribution

Table 2: Showing the gender distribution

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>77</td>
<td>36.49</td>
</tr>
<tr>
<td>Male</td>
<td>134</td>
<td>63.51</td>
</tr>
<tr>
<td>Grand Total</td>
<td>211</td>
<td>100.00</td>
</tr>
</tbody>
</table>

In the study population, males babies are affected more than female babies.

Figure 2: Showing the gender distribution
Table 3: Showing the mode of delivery

<table>
<thead>
<tr>
<th>Mode of delivery</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assisted</td>
<td>49</td>
<td>23.22</td>
</tr>
<tr>
<td>LSCS</td>
<td>67</td>
<td>31.75</td>
</tr>
<tr>
<td>NVD</td>
<td>95</td>
<td>45.02</td>
</tr>
<tr>
<td>Grand Total</td>
<td>211</td>
<td>100.00</td>
</tr>
</tbody>
</table>

In the study population, most of the babies delivered by normal vaginal delivery followed by LSCS and assisted delivery.

Figure 3: Showing the mode of delivery

Table 4: Showing the birth weight of the study population

<table>
<thead>
<tr>
<th>Birth weight</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5-3.0 kgs</td>
<td>165</td>
<td>78.67</td>
</tr>
<tr>
<td>3.1-3.5 kgs</td>
<td>35</td>
<td>16.59</td>
</tr>
<tr>
<td>&gt;3.5 kgs</td>
<td>10</td>
<td>4.74</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100.00</td>
</tr>
</tbody>
</table>

In the study population, most of the babies belong to weight 2.5-3 kgs, followed by other weight groups.

Figure 4: Showing the birth weight of the study population

Table 5: Showing the APGAR at 1 min

<table>
<thead>
<tr>
<th>APGAR @ 1 min</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; or equal to 3</td>
<td>45</td>
<td>21.32</td>
</tr>
<tr>
<td>4 - 6</td>
<td>166</td>
<td>78.67</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100</td>
</tr>
</tbody>
</table>

In the study population, moderate asphyxia cases are found to be more than severe asphyxia cases.

Figure 5: Showing the APGAR at 1 min

Table 6: Showing the APGAR at 5 min

<table>
<thead>
<tr>
<th>APGAR @ 5 min</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 3</td>
<td>8</td>
<td>3.79</td>
</tr>
<tr>
<td>4-6</td>
<td>109</td>
<td>51.65</td>
</tr>
<tr>
<td>&gt;6</td>
<td>94</td>
<td>45.54</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100</td>
</tr>
</tbody>
</table>

Among the study population, 3.79% had APGAR score of Less than or equal to 3, 51.65% had APGAR score of 4-6, 45.54% had APGAR score of >6 at 5 min. This indicates improved apgar scores at 5 mins due to effective resusation in our hospital.

Figure 6: Showing the APGAR at 5 min.

Table 7: Showing the HIE stage

<table>
<thead>
<tr>
<th>HIE</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>86</td>
<td>40.76</td>
</tr>
<tr>
<td>2</td>
<td>105</td>
<td>49.76</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>9.48</td>
</tr>
<tr>
<td>Grand Total</td>
<td>211</td>
<td>100.00</td>
</tr>
</tbody>
</table>

In the study population, HIE STAGE 2>STAGE 1>STAGE 3.

Figure 7: Showing the HIE stages
Out of 20 HIE 3 cases - 4(20%) cases had hearing loss
Out of 105 HIE 2 cases - 12(11%) cases had hearing loss
Out of 86 HIE 1 cases - 4(4%) cases had hearing loss
Here in our study more HIE 3 cases are found to have hearing loss than HIE 2 and 1.

Table 8: Showing the OAE I results

<table>
<thead>
<tr>
<th>OAE I</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>173</td>
<td>81.99</td>
</tr>
<tr>
<td>Refer</td>
<td>38</td>
<td>18.01</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Among the study population, out of total 211 cases screened OAE I results were normal in 81.99%, 18.01% were referred for OAE – II for further evaluation.

![OAE I results](image)

Figure 8: Showing the OAE I results

Table 9: Showing OAE – II results

<table>
<thead>
<tr>
<th>OAE II</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>10</td>
<td>26.32</td>
</tr>
<tr>
<td>Refer</td>
<td>26</td>
<td>68.42</td>
</tr>
<tr>
<td>TND(test not done)</td>
<td>2</td>
<td>5.26</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Out of 38 cases which were referred in OAE I, 26 babies were referred, 10 cases were pass and 2 cases test not done.

![OAE - II results](image)

Figure 9: Showing OAE-II results

Table 10: showing BERA results

<table>
<thead>
<tr>
<th>BERA</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>6</td>
<td>14.29</td>
</tr>
<tr>
<td>Fail</td>
<td>20</td>
<td>71.43</td>
</tr>
</tbody>
</table>

![BERA results](image)

Figure 10: Showing the BERA results

Table 11: Showing the incidence of hearing loss

<table>
<thead>
<tr>
<th>Hearing loss</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>20</td>
<td>9.48</td>
</tr>
<tr>
<td>Absent</td>
<td>191</td>
<td>90.52</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100</td>
</tr>
</tbody>
</table>

Among the study population, 9.48% had hearing loss.

![Hearing loss](image)

Figure 11: Showing the incidence of hearing loss

Table 12: Showing the association between hyponatremia and hearing loss

<table>
<thead>
<tr>
<th>Hyponatremia</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Present</td>
<td>3</td>
</tr>
<tr>
<td>No</td>
<td>Present</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.02

In the study population, hyponatremia and hearing loss were significantly associated with P value of 0.02 using chi square test.
Figure 12: Showing the association between hyponatremia and hearing loss

HL: hearing loss

Table 13: Showing the association between hyponatremia and hearing loss

<table>
<thead>
<tr>
<th>Hyponatremia</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>188</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.1882
In the study population, hyponatremia and hearing loss were not significantly associated with P value of 0.1882 using chi square test.

Figure 13: Showing the association between hyponatremia and hearing loss

HL: hearing loss

Table 14: Showing the association between hyperkalemia and hearing loss

<table>
<thead>
<tr>
<th>Hyperkalemia</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>183</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.04
Among the study population, hyperkalemia and hearing loss were significantly associated with P value of 0.04.

Figure 14: Showing the association between hyperkalemia and hearing loss

HL: hearing loss

Table 15: Showing the association between hypokalemia and hearing loss

<table>
<thead>
<tr>
<th>Hypokalemia</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>188</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.1882
Among the study population, hypokalemia and hearing loss were not significantly associated with P value of 0.1882.

Figure 15: Showing the association between hypokalemia and hearing loss

HL: hearing loss

Table 16: Showing the association between hypocalcemia and hearing loss

<table>
<thead>
<tr>
<th>Hypocalcemia</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
<td>188</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.1882
Among the study population, hypocalcemia and hearing loss were not significantly associated with P value of 0.1882.
Figure 16: Showing the association between hypocalcemia and hearing loss

Table 17: Showing the association between deranged RFT and hearing loss

<table>
<thead>
<tr>
<th>Deranged RFT</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>No</td>
<td>15</td>
<td>180</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.005
Among the study population, deranged RFT and hearing loss were significantly associated with P value of 0.005.

Figure 17: Showing the association between deranged RFT and hearing loss

Table 18: Showing the association between assisted ventilation and hearing loss

<table>
<thead>
<tr>
<th>Assisted ventilation</th>
<th>Hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>No</td>
<td>16</td>
<td>183</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>191</td>
</tr>
</tbody>
</table>

P=0.001
Among the study population, assisted ventilation and hearing loss were significantly associated with P value of 0.001.

DISCUSSION

211 babies with birth asphyxia admitted in SNCU are screened in our audiology department. The results of the study are as follows:

Age distribution (age at hearing screening): In the present study, Among the study population, 55.45% belonged to the age group of less than or equal to 7 days, 34.12% belonged to age group of 8-14 days, 7.10% belonged to the age group of 15-21 days and 3.31% belonged to age group of 22-28 days. So around 90% of the babies are screened in the first 2 weeks of life.

Gender distribution: In the present study, Among the study population, 36.49% were females, 63.51% were males. So male babies are more involved than female babies which is comparable to other studies.

Mode of delivery: In the present study, 31.75% were born through LSCS, 45.02% were born through Normal vaginal delivery. 23.22% were assisted deliveries.

APGAR Score at 1 min: In the present study, 21.32% had severe asphyxia, 78.67% had moderate asphyxia. In the present study, 3.79% had APGAR score of less than or equal to 3, 51.65% had APGAR score of 4-6, 45.54% had APGAR score of >6 at 5 min.

HIE: In the present study, Among the study population, 49.76% belonged to HIE stage II, 40.76% were in HIE stage I, 9.48% were in HIE stage III.

HL: hearing loss

Table 19: Showing the deranged liver enzymes, seizure activity and hypoglycemia among the hearing loss cases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deranged liver enzymes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Seizure activity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Among the study population, there were no cases of deranged liver enzymes, seizure activity, hypoglycemia.
Out of 20 HIE 3 cases- 4(20%) cases had hearing loss
Out of 105 HIE 2 cases -12(11%) cases had hearing loss
Out of 86 HIE 1 cases -4(4%) cases had hearing loss

Here in our study more HIE 3 cases are found to have hearing loss than HIE 2 and 1

Summary of 211 Neonates

- Around 90% of the babies were screened in the first 2 weeks rest of the babies next 2 weeks depending on their clinical condition
- 36.49% were females, 63.51% were males.
- 31.75% were born through LSCS, 45.02% were born through Normal vaginal delivery. 23.22% were assisted deliveries.
- 78.67% had birth weight between 2.5-3.0 kgs. 16.59% had their birth weight between 3.1-3.5 kgs. 4.74% had their birth weight >3.5 kgs.
- Among the study population, 21.32% had APGAR score of < or equal to 3(severe asphyxia) 78.67% had APGAR score of 4-6(moderate asphyxia)
- Among the study population, 3.79% had APGAR score of Less than or equal to 3, 51.65% had APGAR score of 4-6, 45.54% had APGAR score of >6 at 5 min
- Among the study population, 49.76% belonged to HIE stage II, 40.76% were in HIE stage I, 9.48% were in HIE stage III.
- In our study more HIE 3 cases are found to have hearing loss than HIE 2 and 1
- Among the study population, OAE I results were normal in 81.99%, 18.01% were referred for OAE – II for further evaluation.
- Among the study population, 68.42% were further refereed for further evaluation by BERA.
- Among the study population, 71.43% of the total population who were referred for BERA had hearing loss.
- Among the study population, 9.48% had hearing loss.
- Factors associated with hearing loss: Hyponatremia, hyperkalemia, deranged RFT and Assisted ventilation were significantly associated with hearing loss.

CONCLUSION

- The study was conducted in the Department of Pediatrics, Niloufer hospital, affiliated to Osmania Medical College. It is the largest tertiary care center in the state of Telangana, situated in the heart of Hyderabad.
- Incidence of hearing loss was 9.48%
- Hyponatremia, Hyperkalemia, deranged RFT and assisted ventilation were significantly associated with hearing loss.

Limitations

- Only 211 cases has been taken in this study so the study population is less
- Loss to followup are 4 cases among 38 cases which are referred in OAE iso test not done in these cases
- Incidence of hearing impairment among normal babies not done in this study.

REFERENCES

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17. World Health Organization (WHO). Situation review and update on deafness, hearing loss and intervention programs proposed plans of action for prevention and alleviation of hearing impairment in countries of the South East Asia Region. New Delhi WHO Regional Office for South East Asia; 2007.


