

**Clinical study of hypoxic ischaemic encephalopathy in neonates with special reference to non invasive assessment of anterior fontonalle pressure**

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**Abstract**

**Background:** The anterior fontanelle of the human infant is open, making it an available site to measure ICP in an infant. The methods used to fix or stabilize the device could cause deviations in the measured ICP, and interuser application force also caused variations in ICP measurements. In the proposed study, we plan to use schioltz tonometer for assessment of fontanelle pressure in newborns diagnosed with HIE.

**Aim:** To study the role of schioltz tonometry with respect to anterior fontonalle pressure measurement in neonates, comparison of anterior fontonalle pressure to outcome and usg cranium findings in hie neonates.

**Materials and Methods:** In this prospective study, 50 clinically diagnosed cases of HIE were enrolled and subjected to measure AFP by schioltz tonometer ,period January 2019 to January 2020.Cases were divided according to AFO range and hie staging..

**Results:** In this study we found Out of 50 neonates enrolled in the case group having suffered asphyxia 42(84%) were discharged, 6(12%) were LAMA, 2(4%) died.AFP is significantly higher in study group compared to Control with  $t=11.052$ ;  $P<0.001$ . In our study Cranial USG were normal in 55.55 % of asphyxiated babies. Increase periventricular

echogenicity and intracranial heamorrhage are most frequent findings in asphyxiated babies.

**Conclusions:** No finding of AFP by Schioltz tonometer is diagnostic or pathognomonic of hypoxic ischemic encephalopathy but these raise AFP is high degree of suspicion of injury to brain parenchyma due to hypoxia correlate to increase intracranial pressure. Thus, AFP measurement is not a confirmative tool for ICP measurements in neonates.

**Keywords:** ICP, AFP, IMR, SRS, HIF.

**Introduction**

Infant mortality rate (IMR) i.e. deaths under one year of age per 1000 live births, is an important indicator of child health and development. According to the SRS bulletin, IMR of India has declined from 37 per 1000 live births in 2015 to 28.3 deaths in 2019, which is still unacceptably high. Birth asphyxia is responsible for a large number of neonatal deaths after preterm births. Perinatal asphyxia is thus a serious problem for child survival globally, more in developing countries. The underlying pathologic events of HIE are a result of impaired cerebral blood flow and oxygen delivery to the brain during perinatal period resulting in primary and secondary energy failure. Intracranial pressure (ICP) is defined as the pressure inside the skull, and

therefore, the pressure inside the brain tissue and the cerebrospinal fluid (CSF). The gold standard for monitoring ICP is an intraventricular catheter connected to an external pressure transducer; the catheter is placed into one of the ventricles through a burr hole. The anterior fontanelle of the human infant is open, making it an available site to measure ICP in an infant. The methods used to fix or stabilize the device could cause deviations in the measured ICP, and interuser application force also caused variations in ICP measurements. The "fontanometer" is an adaptation of the Schiötz tonometer, (routinely used by ophthalmologist, to assess intraocular pressure) for estimating the intracranial pressure in the young infant.<sup>[27,28,50]</sup>

In the present study, we have used Schiötz tonometer for assessment of anterior fontanelle pressure in newborns diagnosed with HIE.

#### **Material And Methods**

The present study was carried out in January 2019 to January 2020 in the Department of Pediatrics and Neonatology in Neonatal Intensive Care Unit of Mahila Chikitsalya, J.L.N. Medical College, Ajmer which provides neonatal care at this center. The study was conducted on 50 asphyxiated newborn infants at birth and 50 normal healthy newborn as control.

The general physical examination and systemic examination including cardiovascular system, respiratory system, gastrointestinal system and central nervous system including neonatal reflexes like rooting, sucking, swallowing, Moro's, Graps reflex and muscle tone were done. LEVENE classification was used to label and grade HIE

Based on gestation, neonates can be classified as preterm (less than 37 week), post-term (more than 42 week) or term (37-41 completed weeks) by using New Ballard Score.

Apgar Scoring system used

Measurement of AFP by using Schiötz tonometer  
Preparation

Test the tonometer using the spherical mould in the

box and the 5.5 g weight. The pointer should immediately reach the 'O' marking.

#### **Method**

Observer should wash and dry hands.

Observer should position correctly: stand upright, beside the head of the patient, with observer hands level with the patient's head. Bad posture can affect the tonometry reading.

Make patient lie flat with his or her head supported on a pillow. Raise upper half of baby's body so that head and trunk around 90 degree compare to the rest of body.

Clean the plunger and disc of the tonometer with a gauze swab /cotton wool soaked with methylated spirit. Wipe dry with a clean dry gauze swab. Holding Tonometer in vertical position on neonates anterior fontanell reading is recorded. Reading were taken at day 3 and day 7 of life of neonates.

The case group also had other relevant biochemical investigations and cranium USG done as per protocol.

Sonographic examination -The selected babies were subjected to detailed ultrasonographic examination of the brain in Department of Radiology J.L.N. Medical College, Ajmer. When the babies were hemodynamically stable. Scanning was done 1/2 hour to 1 hour after feeding, no sedation was given, and baby's scalp (at the level of anterior fontanelle) was shaved. The brain was scanned through anterior fontanelle by high-resolution real time ultra sound machine SONQACE X7 by trained sonologist and their details were recorded. Clinical course was closely monitored and final outcome was recorded.

#### **Observations and Results**

A study of 50 cases (neonatal asphyxia) and control of 50 cases (normal newborns), was undertaken to have an insight into clinical picture of HIE in asphyxiated newborn with special reference to assess role of Schiötz tonometry in anterior fontanelle pressure (AFP) measurement via anterior fontanelle.

**Distribution of findings of cranial ultrasonography according to HIE**

| Sn. | Cranial USG Findings                                  | Control n=50 |     | Asphyxiated |     |              |       |             |       |            |       |
|-----|---|--------------|-----|-------------|-----|--------------|-------|-------------|-------|------------|-------|
|     |   |              |     | Mild N=16   |     | Moderate =14 |       | Severe N =6 |       | Total N=36 |       |
|     |   | NO.          | %   | NO          | %   | NO           | %     | NO.         | %     | NO.        | %     |
| 1.  | Intracranial hemorrhage                               | 0            | 0   | 0           | 0   | 2            | 14.28 | 3           | 50.00 | 5          | 13.88 |
| 2.  | Diffuse or focal increase in parenchymal echogenicity | 0            | 0   | 0           | 0   | 2            | 14.28 | 2           | 33.33 | 4          | 11.11 |
| 3.  | Increase periventricular echogenicity                 | 0            | 0   | 0           | 0   | 6            | 42.85 | 1           | 16.66 | 7          | 19.44 |
| 4.  | normal  | 50           | 100 | 16          | 100 | 4            | 28.57 | 0           | 0     | 20         | 55.55 |

In our study cranial USG were normal in 55.55 % of asphyxiated babies. Increase periventricular echogenicity (19.44%) and intracranial hemorrhage (13.88%) were most frequent findings in asphyxiated babies.

**Correlation of anterior fontanelle pressure with HIE status in cases**

| Anterior fontanelle pressure    | Total number of patients (n=50) | HIE stage                  |                         |                         |                         | P value |
|---------------------------------|---------------------------------|----------------------------|-------------------------|-------------------------|-------------------------|---------|
|                                 |                                 | Not in HIE (n=14) (Mean ±) | Stage I (n=16) (Mean ±) | Stage II (n=14) (Mean±) | Stage III (n=6) (Mean±) |         |
| Avg ± Range 3 <sup>rd</sup> day | 07 to 19                        | 09.0±2.0                   | 11.0±2.0                | 14±2.0                  | 18±1.0                  | >0.005  |
| Avg ± Range 7 <sup>th</sup> day | 07 to 20                        | 09.0±2.0                   | 11±1.0                  | 13±1.0                  | 19±1                    |         |

The correlation of HIE status with anterior fontanelle pressure which was not significant with a p value of 0.068.

**Comparison of AFP in asphyxiated babies with significant cranium USG findings**

| Sn. | Asphyxiated babies | AFP Average ± Range |                     | Significant |       |
|-----|--------------------|---------------------|---------------------|-------------|-------|
|     |                    | 3 <sup>rd</sup> day | 7 <sup>th</sup> day | No          | %     |
|     |                    |                     |                     |             |       |
| 1.  | Non HIE            | 09.0±2.0            | 09.0±2.0            | 0           | 0     |
| 2.  | HIE -1             | 11.0±1.0            | 11.0±2.0            | 0           | 0     |
| 3.  | HIE-2              | 13.0±1.0            | 12.0±2.0            | 10          | 71.43 |
| 4.  | HIE-3              | 17.0±1.0            | 18±2.0              | 6           | 100   |

In our study showing No HIE and HIE stage 1 had no cranial usg abnormalities with range of AFP is 07 to 11, 10 to 13 on 3rd and 7th day of life respectively. in HIE 2nd stage 71.43% cases had significant USG cranium findings with AFP range of 12 to 14 on 3rd day, 10 to 14 on 7th day respectively. In HIE stage 3rd all cases had significant USG cranium finding with AFP range 16 to 18 on day 7. Statistically AFP range does not correlate significantly with USG cranium findings with p value with >0.005.

**Discussion**

The present study entitled “Clinical study of Hypoxic ischemic encephalopathy in neonates with special reference to non-invasive assessment of anterior fontanelle pressure” was conducted at Department of Paediatrics and Neonatology, at Neonatal intensive care unit of Rajkiya Mahila Chikitsalya, J.L.N. Medical College, Ajmer. The AFP estimation was done by Schiotz tonometer at the level of anterior fontanelle on 3rd and 7th day of life.

Cranial ultrasound examination was performed in each baby as soon as the condition of baby was hemodynamically stable. In the present study all the 50 (100%) neonates in the case group had an Apgar score of <7 at 1 minute out of them 45 (90%) had an Apgar score between 0-3 (severe birth asphyxia) and 5 (10%) had Apgar score between 4-6 (moderate birth asphyxia). V.K Paul et al (1989) studied thirty six neonates with severe birth asphyxia (Apgar score less than or equal to 3 at 1 min), 32 with moderate birth asphyxia (Apgar score 4 to 6 at 1 min) and 35 controls (Apgar score greater than or equal to 7 at 1 min) matched for weight and gestation and they were followed up prospectively for neuro developmental outcome. At 5 minute of life of the 50 neonates in the case group 18 (36%) had an Apgar score of <7, remaining 32(64%) cases had Apgar score of >7 at 5 min. H. Trotman et al 2011 did not find the 5-min Apgar score to be a good predictor of outcome. In fact, it was not until the 15-min Apgar score that the score began to predict differences in outcome for our study. This is in keeping with results by Drag et al. and Nelson et al. who have proposed the value of an extended Apgar score in predicting outcome. At 10 minute of life 50(100%) neonates in the case group 9 had an Apgar score of <7 at 10 min. None had an Apgar score between 0-3 (severe birth asphyxia) and 9 (18%) had Apgar score between 4-6 (moderate birth asphyxia) remaining 41 cases had Apgar score of >7 at 10 min. In our study the correlation of APGAR score at 1 min with HIE status among the cases and it was not found to be statistically significant. The correlation of APGAR score at 5 min with HIE status among the cases was found to be statistically significant with p value of <0.001. There by Apgar score being helpful as an important tool for the diagnosis and severity of birth asphyxia and timely helping in choosing appropriate resuscitation intervention. In the present study ultrasound of brain was done in the first week as soon as the condition of baby became hemodynamically stable. Cranial USG were normal in 55.55 % of asphyxiated babies. Increase periventricular echogenicity (19.44%) and intracranial hemorrhage (13.18%) are most frequent findings in asphyxiated babies. Diffuse or focal increase parenchymal echogenicity was seen in 11.11% of cases. In the control group ultrasound brain was

normal in all newborns. Similarly Martin et al (1983) also found cerebral oedema in 25% babies on early ultrasound scanning. Siegal M.J. et al. (1984) studied cranial ultrasonographic abnormalities in 32 term infants who had HIE. Diffused parenchymal abnormalities were found in 5 (15.62%) out of 32 patients of HIE in first week of life, focal parenchymal abnormalities in 3 cases (9.37%). However, non-visualized ventricles were also present in 16 (61%) control cases. In this study patients included were those with Apgar score of less than 4 at 1 minute or necessity at birth for ventilation for longer than 5 minute. Tran's fontanelle ultrasound scanning has been found to be indispensable tool not only for the early diagnosis of brain damage but also as a guide to prognosis in the new born at risk. Ommetto E fazzi 1989 et al. observed that a normal ultrasound scan pre supposes normal neuropsychic development in 87% of cases, as happens in the event of uncomplicated hemorrhage. Major sequelae occur in as many as 83% of cases of complicated hemorrhage. Cranial ultrasonography (CS) has been used widely in neonatal practice, as it is a convenient, non-invasive, safe and quick imaging technique to visualize the neonatal brain parenchyma and ventricular system serially without disturbing or moving the patient. Cranium USG is helpful to exclude structural abnormalities and to detect calcifications and cysts, atrophy or cerebral haemorrhage. Sequential cranial ultrasound examinations following a recent hypoxic-ischemic insult are helpful for assessing the evolution of injury, and particularly for defining the pattern of lesions and the timing of their onset. In the present study range of anterior fontanelle pressure assessed by Schiotz tonometer in cases are 11-19, with mean of AFP is 14.2. While control group had range with 9-14 with mean of 10.45. AFP is higher in study group compared to Control but not significant with P value >0.005. Range of AFP in cases on 3rd day was 07-19, on 7th day range was 07-20. Mean of AFP in cases according to grading of HIE in stage 1st are  $11 \pm 2.0$  on 3rd day and  $11 \pm 1.0$  on 7th day. In stage 2nd it was  $14 \pm 2.0$  on 3rd day and  $13 \pm 1.0$  on 7th day. In stage 3rd it was  $18 \pm 1.0$  on 3rd day and  $19 \pm 1.0$  on 7th day. A thorough review of literature revealed that only a few studies have been done previously in asphyxiated neonates to assess

anterior fontanelle pressure (AFP) by Schiotz tonometer and to correlate it with clinical course and outcome A.M Kaiser et al. (1987) studied simultaneous assessment of intracranial pressure by anterior fontanelle palpation and direct measurement from a cerebrospinal fluid cannula and showed that mean pressure was significantly different between 'soft' fontanelles (5.4 mm Hg) and 'tense' fontanelles (14.0 mm Hg) but with considerable overlap. Normal fontanelle tone was often confirmed, whereas clinical assessment of raised intracranial pressure was unreliable. Other authors used other methods to measure the intracranial pressure by use of anterior fontanelle window and its correlation with ICP measured simultaneously with invasive method and found variable results, Salmon et al. studied the use of an appplanation transducer (called the fontonogram) and found that the pressures recorded by the fontonogram corresponded to direct measurements of ICP through an invasive catheter; the correlation coefficient was 0.98 and P value <0.001, indicating a very good correlation. It was concluded that it was accurate to use fontanelle pressure and ICP interchangeably. Vidyasagar et al. reported assessment of ICP changes via ladd intracranial pressure monitoring device which had a transducer over the anterior fontanelle. They stated that there is a significant correlation of CSF pressure with AFP (correlation coefficient = 0.95, P < 0.01), indicating that the AFP was representative of ICP. Bunegin-Ablin et al. investigations concluded that the new AFP monitor was able to achieve a highly significant correlation (r = 0.962, confidence level >95%) between AFP and ICP. Sajjadi et al. used Schiotz tonometer to measure IOP and a lumbar puncture was performed for ICP. They reached the conclusion that there was in fact a positive correlation between IOP and ICP (P < 0.001, r = 0.955). They also stated that the correlation was independent of factors such as BMI, age, and type of disease. On the contrary other studies have shown that AFP measurement could not be a reliable method to assess ICP. Czarnik et al. conducted a study using the Schiotz tonometer for IOP and an intraparenchymal sensor for the ICP. Their study was conducted on 22 patients, and they found that a positive correlation between IOP and ICP was seen in only 2 patients. Likewise, Golan et al

concluded that the tonometer was not an effective device for screening ICP due to its poor specificity and sensitivity.

### Conclusion

To conclude the AFP reading as measured by Schiotz tonometer was higher in cases as compared to the control and even the babies with poor outcome had higher AFP readings. But we cannot prognosticate or intervene as per AFP values in HIE cases due to its statistically nonsignificant values in relation to cranium USG findings and final outcome. Moreover, AFP measurement has inter observer variation which depends on anterior fontanelle diameter of different babies, its tensile property and pressure applied by observer on the anterior fontanelle. Realising the importance of monitoring the ICP for optimum management of HIE neonates, there is urgent need to develop some noninvasive tool which is reliable, affordable sensitive and specific.

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