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## Ultrasonographic pattern of intraventricular hemorrhage in preterm neonates in Lagos, Nigeria

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### Abstract

Intraventricular hemorrhage (IVH) commonly occurs in preterm neonates. Transfontanelle ultrasonography (TFUSS) is a non-invasive technique for the detection and characterization of IVH in preterm.

The aim of this study was to determine the incidence, grades, time of evolution of IVH and to correlate the findings with demographics.

Serial Transfontanelle sonography was performed on three hundred preterm neonates admitted into a tertiary hospital. Sonographic findings, relevant antenatal, perinatal, and postnatal history were obtained, with relevant tests of statistical significance.

Ninety-five neonates (31.7%) had IVH, 90.5% of hemorrhages occurred in the first week of life. Incidence of IVH was higher in babies born at gestational age less than 32 weeks and birth weight < 1.5kg. There was no statistical correlation between grades of IVH and the degree of prematurity.

The incidence of IVH in preterm neonates is high therefore all preterm neonates should be serially scanned. The lower the gestational age at birth the higher the risk of IVH and the severity of IVH is independent of degree of prematurity.

### Key words:

Transfontanelle ultrasound, Intraventricular hemorrhage, Preterm neonate.

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### Introduction

Preterm neonates usually presents with spontaneous hemorrhage in and around the cerebral ventricles<sup>1,2,3</sup> and intracranial hemorrhage has been reported at autopsy in 50 to 70% of these babies.<sup>4</sup> These call for aggressive antenatal care and concerted effort to reduce morbidity and mortality in these frail neonates.

Determining IVH pattern in preterm neonates becomes more relevant considering the statistics of preterm deliveries and the significant percentage of morbidity and mortality in these babies especially those with low birth weight. In Nigeria, approximately 14% of deliveries per year are preterm.<sup>5</sup> Twenty five percent of all infants weighing less than 1500grams die by one year compared to 2% for infants weighing 1500 – 2499 grams and 0.3% for infants weighing 2500grams or more.<sup>5</sup> In the United Kingdom, approximately 7% of all deliveries are preterm, approximately 30% and 80% of babies born at 24 and 27 weeks of gestation survive to childhood<sup>6</sup>

This outcome is as a result of better antenatal, perinatal and post-natal care in terms of supportive facilities put in place as a result of identified needs in the course of research studies.

The prevalence of IVH in preterm neonates varies in different studies, predominantly depending on the degree of prematurity of neonates included in the study. The prevalence increases with decreasing gestational age, infants delivered at <32 weeks gestation have a prevalence of 15-20%.<sup>1,7,8,9.</sup>

The pattern {incidence, severity (grades), time of evolution, comparison of gestational age and birth weight with incidence} of Intraventricular hemorrhage (IVH) in preterm and low birth weight neonates has been well documented worldwide. Although Nzeh and Ajayi reported an incidence of 24.5% in African preterm neonates in a study carried out in Kwara state, Nigeria,<sup>14</sup> similar study has not yet been done in Lagos, a metropolis and the commercial centre of Nigeria.

Ultrasonography is a safe imaging modality for early detection and follow up of IVH with

sensitivity and specificity of 96% and 94% respectively in the diagnosis of intracranial hemorrhage.

The objectives of this study is, to determine the prevalence, and pattern of IVH in Lagos. This will help to identify neonates that should be managed more intensively and followed up more closely.

### Subjects and method

This prospective, cross-sectional study was carried out in the neonatal unit of the Lagos University Teaching Hospital (LUTH), Idi- Araba, Lagos over a period of 12 months, following Health Research and Ethics Committee's approval and written informed consent by the parents. Cranial ultrasonography was carried out using a portable "PCO 90" Ultrasound system equipped with a 7.5MHz broadband curvilinear 11mm scan head transducer.

Three hundred Preterm neonates admitted in LUTH during the study period, were recruited for the study. The Transfontanelle ultrasound scan for each child was performed in both coronal and sagittal planes.

Coronal images were obtained by placing the scan head of the transducer transversely across the anterior fontanelle. The ultrasound beam was swept in an anterior to posterior direction completely through the brain along the coronal plane. Care was taken to maintain symmetrical imaging of each half of the brain and skull. An initial sweep of the brain to obtain parallel alignment of thick glomus of the choroid plexus in each trigone was carried out, being a good method to obtain symmetry. At least six standard coronal images were obtained during this anterior to posterior sweep.

The sagittal images were obtained by placing the transducer longitudinally in the mid-sagittal plane at the anterior fontanelle and angulating it to each side in the three standard planes.

All scans were carried out by the researcher to avoid inter-observer error.

The first scan on each neonate was within the first 24hrs of life. Serial scans were carried out on each neonate the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> and 7<sup>th</sup> days of life. Afterwards the child was scanned once weekly until discharged or till the corrected 40weeks was attained.

Gestational age was determined from maternal dates (last menstrual period) and gestational assessment by Ballard score.<sup>17</sup> If a menstrual date was uncertain or if there was a discrepancy of more

than 2weeks between postmenstrual age and Ballard score, the latter was taken as the true gestational age. All infants were weighed on admission and weight for age percentile was determined for each neonate using weight for age chart. The neonate was considered to be small for gestational age if his/ her birth weight was below the 10<sup>th</sup> percentile for gestational age on Olowe's chart.<sup>18</sup>

The Sonographic findings in each neonate were documented using a proforma and in their respective case notes. The age at which IVH was diagnosed was recorded and maximum grade of haemorrhage also determined using the Papille Grading system.<sup>19</sup>

Patients with IVH were formally referred to the pediatricians for effective management and follow up.

### Statistical analysis:

Data were analyzed using IBM SPSS Statistic software, version 20.0 Chi – square test was used to determine association between the Incidence of IVH and sex, gestational age at birth and birth weight.

### Results

A total of 300 preterm neonates were studied. Their gestational age at birth ranged between 24 and 36 completed weeks with a median of 31completed weeks.

There were 136 males and 164females (1: 1.2). One hundred and sixty five (55.0%) of the recruited preterm neonates were delivered at gestational age (G.A) < 32 weeks and 135 (45.0%) at G.A ≥ 32 weeks.

One hundred and ten (36.7%) of these neonates had birth weights < 1.5kg (Very low and Extreme low birth weights) while the birth weights of 181 (60.3%) preterms were ≥1.5kg - <2.5kg (Low birth weight), and 9 preterms (3.0%) had birth weights ≥2.5kg.

### Pattern of Intraventricular Haemorrhage

The overall incidence of IVH in this study was 31.7% (95) and of 136 males recruited, 46 (33.8%) had IVH while 49 (29.9%) of the 164 females recruited had IVH. There was however no statistically significant difference (P=0.465) in the proportion of males to females with IVH. The incidence in preterm neonates delivered at < 32weeks was 41.8% and 19.3% in those who were delivered at G.A. ≥ 32 weeks. The age of highest IVH incidence were 30 weeks (69.1%) and 29

weeks (55.2%) (Table1). The incidence in those with birth weights less than 1.5kg was 40.3% and 24.7% in those with birth weights  $\geq 1.5$ kg (Table2). Twenty four (25.3%) of the 95 cases of IVH occurred on day One, 18 (18.9%) on day 2 and 16 (16.8%) on day 3, while 28 (29.5%) and 9 (9.5%) cases occurred between the 3<sup>rd</sup> and 7th day and after seven days respectively. Cumulatively 58 (61.1%) of IVH had occurred by the end of third day of life and 90.6% had occurred by the end of one week (Table3).

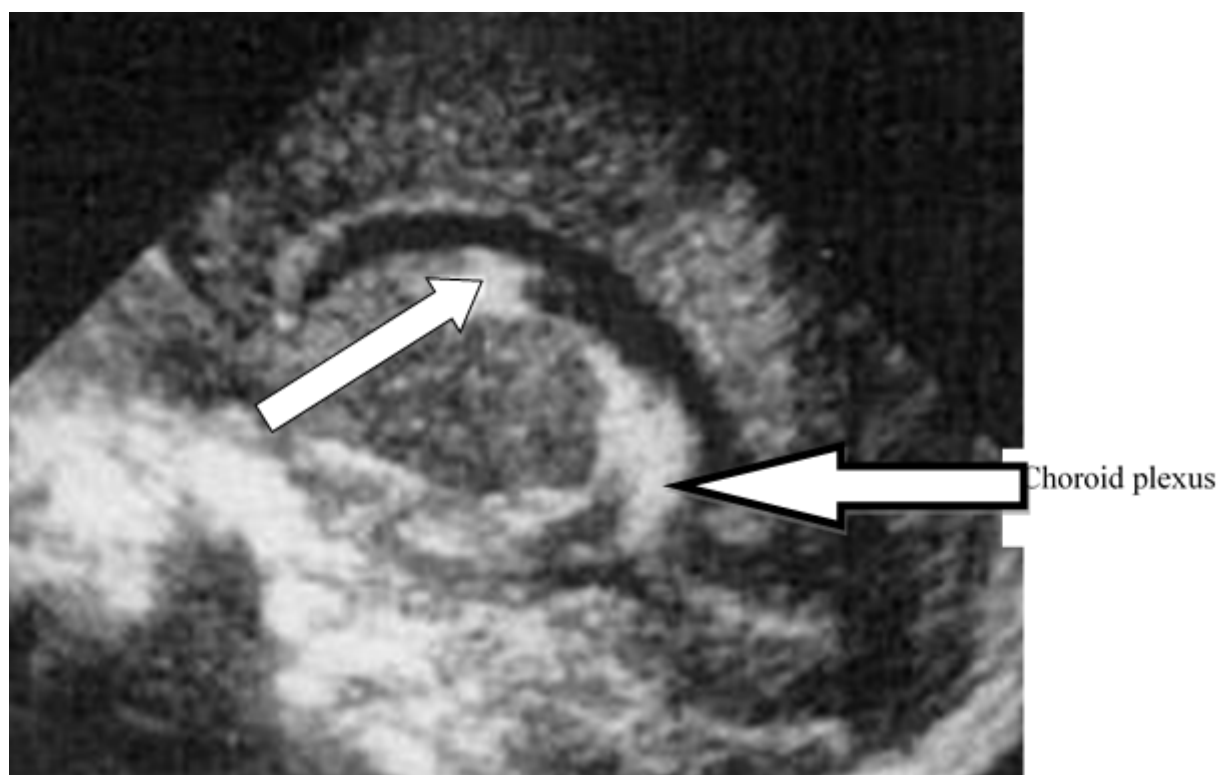
Fifty eight (61.1%) of 95 preterm neonates that had IVH, had grade I (Fig. 1) and 37 (38.9%) had grade II (Fig. 2). Forty one (70.7%) of 58 preterm neonates who had grade I IVH were delivered at gestational age (GA) less than 32 weeks, while 29.3% were delivered at GA>32weeks

birth.

Of the 95 who had IVH, 69 were delivered at G.A less than 32 weeks and 26 were delivered at G.A. $\geq 32$ weeks, with IVH incidence of 41.8% and 19.3% respectively. The difference in the incidence of IVH was statistically significant ( $P = 0.000$ ) (Table 5). Fifty four of the babies who had IVH were  $<1.5$ kg at birth and 41 were  $\geq 1.5$ kg with IVH incidence of 40.3% and 24.7% respectively. There was significant statistical difference ( $P = 0.004$ ) in patients with IVH and those without IVH in terms of birth weight (Table 6).

Other Sonographic findings include: Periventricular Leucomalacia (Fig 3), subdural hematoma and hydrocephalus (Fig 4) with incidences of 32%, 1.3% and 1.3% respectively (Table 6).

**Fig. 1:** Showing a sagittal Sonographic section of the brain of a preterm neonate with a Large acute subependymal (grade I IVH) bleed (white arrow).



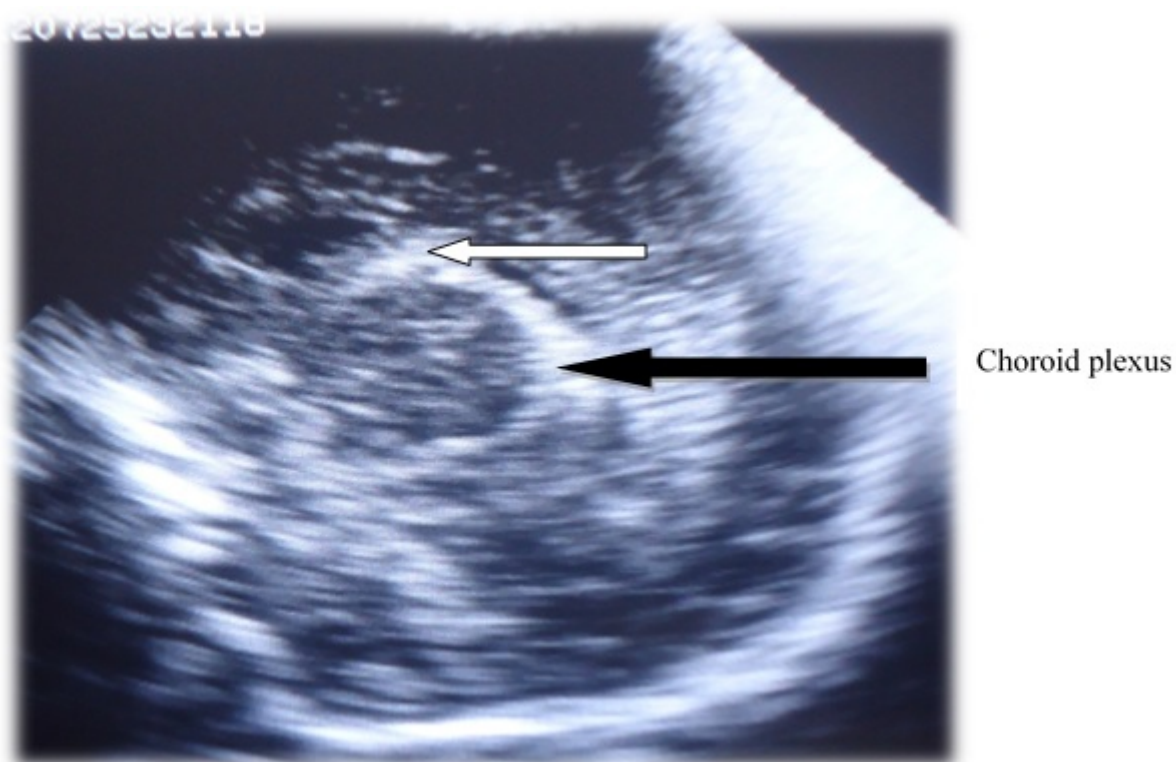
Also 28 (75.7%) of 37 preterm neonates who had Grade II IVH were delivered at GA less than 32weeks, while 9 (24.3%) were delivered at GA >32weeks (Table 4). There were no grade III or IV. There was also no statistical correlation ( $r=0.000$ ) between the grades of IVH and gestational age at

## Discussion

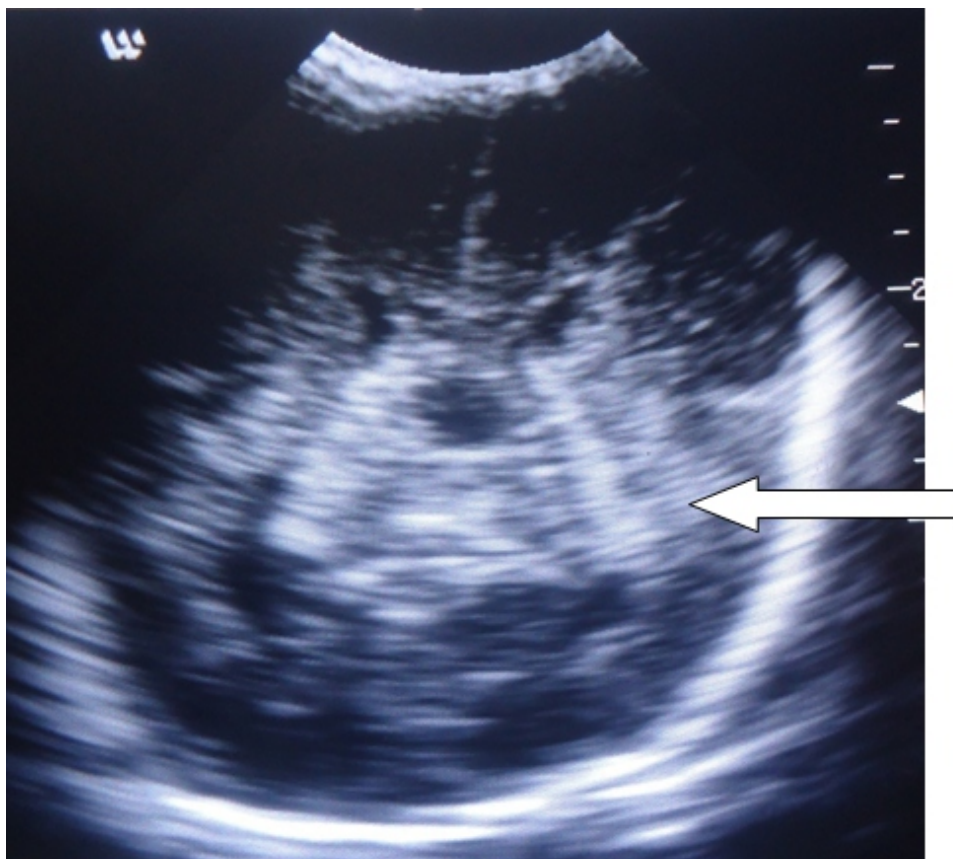
The incidence (31.7%) of IVH in this study is higher than those reported in previous studies. Although in the 1970s, the incidence of IVH in preterm neonates was 50%,<sup>7, 9, 10, 20</sup> by the 1980s, its incidence in newborns  $< 1500$ g dropped to 20% and has not changed (i.e said to be stable) in the last two decades.<sup>5, 12, 14, 23</sup> Over thirty years ago, Nzeh and Ajayi<sup>14</sup> reported an incidence of 24.5% in African neonates. However the conventional prevalence of



**Fig. 2:** A sagittal Sonographic section of the brain of a preterm neonate showing acute germinal matrix haemorrhage extending into the ventricle (white arrow) with normal ventricular size (grade IIIVH).



**Fig.3:** A coronal sonographic section of the brain of a very low birth weight preterm neonate, demonstrating increased periventricular parenchymal echogenicity (arrow) (Same echogenicity as choroid plexus – PVL grade I).



**Fig. 4:** A coronal Sonographic section of the brain of a low birth weight preterm neonate, demonstrating dilated frontal horns in a case of non-communicating hydrocephalus.



IVH in preterm neonates is 15-20%<sup>4</sup> which is lower than that found in the current study. It is observed that in the previous studies, only patients with G.A. of 32 weeks or less were usually included.

**Table1:** Incidence of IVH per group of gestational age recruited and the overall Incidence of IVH.

| Gestational age at birth (weeks) | Total no recruited | IVH per group (N) | Incidence per group (%) |
|----------------------------------|--------------------|-------------------|-------------------------|
| 24.00                            | 9                  | 4                 | 44.4                    |
| 26.00                            | 5                  | 0                 | 0                       |
| 27.00                            | 4                  | 0                 | 0                       |
| 28.00                            | 42                 | 12                | 28.6                    |
| 29.00                            | 29                 | 16                | 55.2                    |
| 30.00                            | 42                 | 29                | 69.1                    |
| 31.00                            | 34                 | 8                 | 23.5                    |
| 32.00                            | 37                 | 10                | 27.0                    |
| 33.00                            | 17                 | 4                 | 23.5                    |
| 34.00                            | 27                 | 12                | 44.4                    |
| 35.00                            | 14                 | 0                 | 0                       |
| 36.00                            | 40                 | 0                 | 0                       |
| <b>Total</b>                     | <b>300</b>         | <b>95</b>         | <b>31.7</b>             |

The high incidence observed in this study may probably be due to larger sample size. The sample

sizes in the previous studies have been less than two hundred<sup>4,7,9,14</sup> unlike 300 recruited in this study.

**Table2:** Frequency of IVH per group of birth weight recruited

| Birth weight (Kg) | IVH       |            | Total      |
|-------------------|-----------|------------|------------|
|                   | Present   | Absent     |            |
| < 1               | 0         | 4          | 4          |
| ≥ 1 < 1.5         | 42        | 64         | 106        |
| ≥ 1.5 < 2.5       | 49        | 132        | 181        |
| ≥ 2.5             | 4         | 5          | 9          |
| <b>Total</b>      | <b>95</b> | <b>205</b> | <b>300</b> |

Inclusion of neonates up to 36 completed weeks is a factor that may be contributing to the high incidence. Although the incidence of IVH in babies delivered at GA > 32 weeks is comparatively lower than those delivered at GA less than 32 weeks. Twenty six cases of IVH in this former group,

commonly excluded in previous studies, is clinically significant. A miss of twenty six cases of IVH is not negligible in clinical management; hence all preterm neonates should be scanned to rule out IVH.

**Table 3:** Time of evolution of IVH and frequency of IVH per day

| Time of evolution of IVH (days) | Frequency of IVH |
|---------------------------------|------------------|
| 1                               | 24               |
| 2                               | 18               |
| 3                               | 16               |
| 4                               | 4                |
| 5                               | 8                |
| 6                               | 4                |
| 7                               | 12               |
| 8                               | 5                |
| 9                               | 4                |
| Total                           | 95               |

**Table 4:** Relationship between Gestational age and grades of IVH

| Gestational Age at birth (completed weeks) | Grades of IVH |         |         | Total |
|--|---------------|---------|---------|-------|
|  | None          | Grade 1 | Grade 2 |       |
| 24.00                                      | 5             | 4       | 0       | 9     |
| 26.00                                      | 5             | 0       | 0       | 5     |
| 27.00                                      | 4             | 0       | 0       | 4     |
| 28.00                                      | 30            | 8       | 4       | 42    |
| 29.00                                      | 13            | 12      | 4       | 29    |
| 30.00                                      | 13            | 13      | 16      | 42    |
| 31.00                                      | 26            | 4       | 4       | 34    |
| 32.00                                      | 27            | 5       | 5       | 37    |
| 33.00                                      | 13            | 4       | 0       | 17    |
| 34.00                                      | 15            | 8       | 4       | 27    |
| 35.00                                      | 14            | 0       | 0       | 14    |
| 36.00                                      | 40            | 0       | 0       | 40    |
| Total                                      | 205           | 58      | 37      | 300   |

P < 0.001

Inclusion of babies delivered outside the hospital and post natively transferred to LUTH in less than 24hours post-delivery may be another contributory factor to higher incidence in this study. A higher incidence of IVH was observed in babies delivered outside compared to those delivered in LUTH. This is similar to the finding in a study by Levene et al.<sup>2</sup> In their study, they reported that in the most immature

group (30 weeks and below) the incidence of IVH ranged from 49% for the in utero transfers to about 60% for post natal transfer. In the more matured groups, out- born babies had a higher incidence of IVH than either the local babies or the in utero transfers born at the institution where the investigation was carried out.

**Table 5:** Relationship between risk factors (GA and BW) and IVH

| FACTORS                 | STATUS (N) | IVH        |             | P-VALUES |
|-------------------------|------------|------------|-------------|----------|
|                         |            | WITH IVH   | WITHOUT IVH |          |
|                         |            | N (%)      | N (%)       |          |
| Gestational age (weeks) | <32 (165)  | 69 (41.8%) | 96 (58.2%)  | <0.001   |
|                         | ≥32 (135)  | 26 (19.3%) | 109 (80.7%) |          |
| Birth weight (kg)       | <1.5KG     | 54(40.3%)  | 80(59.7%)   | 0.004    |
|                         | ≥1.5KG     | 41(24.7%)  | 125(75.3%)  |          |

**Table 6:** Frequency and incidence of sonographic findings in preterm neonates in this study.

| Sonographic findings | Frequency | Incidence (%) |
|----------------------|-----------|---------------|
| Normal               | 101       | 33.7          |
| IVH                  | 95        | 31.7          |
| Hydrocephalus        | 4         | 1.3           |
| PVL                  | 96        | 32.0          |
| SDH                  | 4         | 1.3           |
| Total                | 300       | 100           |

IVH – Intraventricular haemorrhage, PVL – Periventricular leucomalacia.

SDH – Subdural haematoma

The observed incidence in the current study also shows that the incidence of IVH is not stable, as suggested by the reports in the 1980s and the last two decades<sup>12, 14, 21</sup>, rather it is increasing. This is corroborated by a recent and similar study by Jodeiry et al<sup>22</sup> that reported an incidence of 36.8%. Premature infants primarily bleed into the germinal matrix, which is subependymal, and extends in varying degrees into the lateral ventricles and not in the cortical mantle or white matter. This fact is substantiated by the pattern observed in this study. The most frequent grade of IVH observed in this study is grade I, 61.1% of the 95 IVH cases, and the site of haemorrhage being subependymal germinal



matrix overlying the caudothalamic groove. The pattern of grades of IVH observed in this study is same as those in previous studies<sup>2,9,15,23,24</sup> These agree with the report of Leech et al<sup>20</sup> that the source of IVH is the germinal matrix in more than 90% of preterm neonates.

Papile et al<sup>19</sup> from their study concluded that IVH in preterm neonates classically emanates from small vessels, principally capillaries in the subependymal germinal matrix, which is a richly vascular structure and is more pronounced in the 24 -32 weeks old foetus. In this study also, there is statistical association between degree of prematurity and IVH. About seventy one percent (70.7%) of preterm neonates that had grade I IVH were delivered at gestational age (GA) less than 32 weeks, while 29.3% were delivered at GA  $\geq$  32 weeks. Also 75.7% of those that had Grade II IVH were delivered at GA less than 32 weeks, while 24.3% were delivered at GA  $\geq$  32 weeks. This shows clearly that the commonest grade of IVH in preterm neonates is grade I and lower gestational age babies had higher incidence of higher grade of IVH.

In this study, the percentage of IVH that occurred in the 1<sup>st</sup>, 2<sup>nd</sup> and 3rd days of life were 25.3%, 18.9% and 16.8% respectively. Cumulatively 61.1% of IVH had occurred in the first 3 days. By the end of first week 90.6% of total IVH had occurred, the remaining 9.5% occurred after the first week. This is similar to the findings from other studies.<sup>1, 24</sup> Tounce et al<sup>21</sup> reported 78% of total IVH by the end of first week and 15% after a week. Levene<sup>2</sup> did frequent scanning to the nearest day and found 24% on day 1 and cumulatively 78% by the third day and one had IVH after one week of life i.e. on day 11.

Other findings in this study include: periventricular Leucomalacia (PVL), hydrocephalus (32.0%) and subdural haematoma (1.3%). The high incidence of Periventricular Leucomalacia is of note, however this was also the finding by Nzeh and Ajayi<sup>14</sup> They observed that premature African neonates have a lower incidence of intracranial haemorrhage but a higher incidence of PVL especially when compared to babies from the temperate regions which they attributed to genetic and environmental factors. In this study PVL in most of the babies were due to perinatal hypoxic Ischaemic encephalopathy.

## Conclusion

The incidence of IVH in preterm neonates is high and all preterm neonates should be serially scanned on Day 1, 4 and 7 of life. The lower the gestational

age at birth the higher the risk of IVH; however the severity (Grade) of IVH is independent of degree of prematurity.

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## Conflict of interest

There is no conflict of interest.

## Authors' Contribution

A.A. conceived and designed the study, recruited the patients, collected the data, interpreted the results and wrote the first draft of the manuscript. K.S. participated in the study design, interpretation of results and critically reviews of the manuscript. I.F. participated in patients' recruitment and critically reviews the manuscript. All authors approved the final manuscript.

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