Intracranial Ventricular Sizes And Correlates In Term Nigerian Infants At Birth And Six Weeks
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Citation

Abstract
Background: Ventricular size measurements aid early determination of deviation from normal and facilitate early intervention. This study seeks to establish normal ranges for measurements of intracranial ventricles in a term African population at birth and six weeks and define effects of modes of delivery and changes in anthropometry on the measurements. Study design: Dimensions of the width of the third ventricle, the width and length of the fourth ventricle, anterior horn width and the thalamo-occipital distance of the lateral ventricles were measured through transfontanelle ultrasound scans of 103 term newborns and 82 of the same infants six weeks later. Results: Ventricular sizes were similar in both genders at birth and at six weeks. At birth LLVW was 0.0 – 4.0mm, RLVW 0.0 – 4.0mm, TOD 11.7 – 27.0mm, TVW 0.7 – 4.0mm, FVW 5.6 – 14.3mm and FVL 2.0 – 10.6mm. OFC at 6 weeks only correlated with dimensions of TOD, TVW and FVW (p = 0.002, 0.022, 0.02 respectively). Vaginal delivery was associated with smaller mean left and right lateral ventricular measurements and fourth ventricular widths at birth compared with caesarean section (p< 0.05) but not at 6 weeks. Conclusions: This study has provided reference ranges for the intracranial ventricles at birth and six weeks in term African infants also demonstrated that the impact of mode of delivery was transient on ventricular sizes.

INTRODUCTION
The use of normogram charts of intracranial ventricular sizes aid early detection of hydrocephalus and other deviations from normal. Neuro-sonograms in the newborn period have been shown to detect intracranial abnormalities including abnormal ventricular enlargement and subsequent post neonatal scans may detect other missed abnormalities. The most rapid increase in the size of intracranial ventricles occur during the first six weeks of life. Mild enlargement of the lateral ventricles detected in early newborn neurosonograms have been associated with some neuropsychiatric disorders in later life.

There is limited data on early intracranial ventricular measurements in healthy African neonates and data on follow up studies are not available. This study therefore seeks to define normal reference ranges for lateral, third, and fourth ventricular sizes in term Nigerian infants at birth and at six weeks of life as well as evaluate associations between mode of delivery, gender, changes in anthropometry and ventricular size measurements.

MATERIALS AND METHODS
One hundred and three consecutive healthy term newborns delivered at the University College Hospital, Ibadan, Nigeria were studied. Physical examination including occipitofrontal circumference measured to the nearest mm (Using non stretchable tape), weight measured to the nearest 10g (SECA 835 Digital Baby Scale, Seca GmBH & Co. Hammer Steindamm 9-25, 22089 Hamburg Germany) and length measured to the nearest mm (Seca Infantometer, Seca GmBH & Co. Hammer Steindamm 9-25, 22089 Hamburg Germany) were recorded. Exclusion criteria from sonographic studies included birth weight <2500gm, 5 minute Apgar score < 6 or craniospinal malformation. Gestational age assessment was determined by Ballard score performed within 48 hours of birth on all the 103 infants and first trimester ultrasound scan records for dates was available in only 56 of the babies, with coefficient of correlation between Ballard scores and first trimester USS dates of 0.856. Transfontanelle ultrasound scan was performed using ALOKA SSD-1700 Scanner (Aloka Co. Limited, Mure,
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Mitaka-shi Tokyo Japan) equipped with a 7.5MHz paediatric curvilinear probe. Using the anterior fontanelle as acoustic window, sonograms were obtained in the parasagittal and coronal planes involving linear dimensions of the thalamo-occipital distance and anterior horn width of the lateral ventricles as described by Davies et al. The third ventricle width was measured in the axial plane between the thalami at a level just above a line from the outer canthus of the eye to the upper point of insertion of the ear while the fourth ventricle width and length were measured in a transverse plane using the posterior fontanelle as acoustic window. Measurements were taken within 72 hours of life in 103 subjects and repeat measurements taken six weeks later in only 82 subjects with 21 not being available for follow up scans.

DATA ANALYSIS
Analysis of data was by SPSS 11.0 for Windows Software programme. Categorical variables were compared using chi square or Fischer’s exact tests and estimates expressed as proportions, ratios and percentages. Continuous variables were analysed using the Student t test or analysis of variants (ANOVA) and expressed as mean (SD). Probability (p) value of < 0.05 was taken as significant.

RESULTS
GENERAL CHARACTERISTICS
One hundred and three infants were recruited with 56 males and 47 females giving a male: female ratio of 1.2:1.0. The gestational ages of the babies ranged from 37 weeks to 42 weeks with a mean (SD) of 39.3(1.2) for males and 39.1(1.2) for females (p= 0.265). At birth, the mean birthweight of the male neonates of 3.20kg (0.47) was significantly higher (p= 0.038; 95% CI= 0.019-0.298) than 3.05kg (0.41) in the females and the mean occipitofrontal circumference (OFC) of 34.5cm (1.3) in males was significantly larger than the 34.0cm (1.3) in females (p = 0.016). The mean (SD) length at birth of 49.3 cm (2.55) in the males was significantly larger than the 48.6cm (2.5) in females (p<0.048). At six weeks, M: F ratio was 1.3: 1.0; the males remained heavier at 4.89 kg (0.68) compared with females with weight of 4.51 kg ((0.55) (p= 0.008), and had larger OFC of 38.66 cm (1.25) than the females of 37.98 cm (1.08) (p=0.011). Table I shows the percentile distribution of the intracranial ventricular sizes at birth and six weeks by gender.

Table I: Percentile values of ventricular sizes at birth and six weeks (By Gender)

LATERAL VENTRICULAR MEASUREMENTS
The left lateral ventricular size at birth in the males was 0.00 – 4.00mm with a mean (SD) of 1.41mm (0.90) and was similar (p = 0.882) to 0.00-3.40mm and a mean (SD) of 1.44mm (0.83) in the females (Table II). The mean (SD) of the right lateral ventricle in the male of 1.33mm (0.89) was similar (p=0.540) to 1.25mm (0.83) in the female. At birth and six weeks, no gender differences were observed in the left and right lateral and thalamo-occipital distance (TOD) measurements (Table II). In either gender, there were significant mean differences between the measurements at six weeks and birth of the lateral ventricles and TOD (Table III).

THIRD VENTRICLE MEASUREMENTS
There was no significant difference in the mean (SD) third ventricle width at birth of 1.53mm (0.6) in the males and 1.44 mm (0.83) in the females and at six weeks (Table II). No significant difference between the measurements at birth and 6weeks (Table III).
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FOURTH VENTRICLE MEASUREMENTS

The mean (SD) length of the fourth ventricle was similar in the males and females at birth and at 6 weeks (Tables II) and mean difference was significant only in the males (Table III). The fourth ventricle width was significantly increased in both gender by 6 weeks compared with measurements at birth (Tables II and III).

CORRELATIONS BETWEEN VENTRICLE MEASUREMENTS AND ANTHROPOMETRY

There were weak but significant correlations between the anterior horn widths of the left and right lateral ventricles as well as the fourth ventricle width and the OFC at birth (p < 0.05) but these were not significant on linear regression analysis (Tables IVa and b). By six weeks of age (Table V a and b), OFC correlated significantly with measurements of all the intracranial ventricles except for the fourth ventricle length but on linear regression it only correlated significantly with TOD, TVW and FVW. Weight at six weeks also showed a significant correlation with the left and right lateral ventricular widths (p = 0.002; 0.013 respectively) but not so on regression analysis.
Table Vb: Linear Regression Analysis for Ventricular Measurements at Six Weeks

Table VI: Correlation of the mean increase in ventricular size with mean increase in OFC, Body Weight and Length

Table VI shows that there were weak but significant correlations between the mean increases in the LLVW and OFC ($r=0.323$; $p=0.003$), weight ($r=0.321$; $p=0.003$) and length ($r=0.442$; $p=0.000$). The mean increase in third ventricle width and increases in OFC, weight and length also showed weak but significant correlations while TOD showed no significant correlations with mean increases in OFC length and weight (Table VI).

SIZE AND MODE OF DELIVERY

Fifty seven (55.3%) infants were delivered by the vaginal route, while forty six (44.7%) were delivered by caesarean section. The mean (SD) anterior horn widths of both the left and right lateral ventricles at birth of 1.65mm (0.92) and 1.56mm (0.86) for infants delivered by caesarean section were significantly larger than 1.25mm (0.70) and 1.05(0.80) respectively for infants delivered through the vaginal route ($p=0.013$; $0.003$) respectively (Table VII). The mean (SD) fourth ventricle width was also significantly larger for infants delivered by caesarean section compared with that of infants delivered vaginally ($p=0.000$). By 6 weeks of age, there was no significant difference in the mean ventricle sizes between infants delivered vaginally and those delivered by caesarean section.
**DISCUSSION**

Reference ranges of ventricular sizes in the newborn period are useful in the evaluation and monitoring of the infants at risk of ventricular enlargement. Early newborn neurosonograms showing mild ventriculomegaly are assumed to arise during pre- and perinatal brain development and have been associated with conditions like autism, idiopathic and syndromic mental retardation, fragile X syndrome, learning disorders and schizophrenia in later life.

This study provides reference ranges and percentiles for the linear measurements of all four intracranial ventricles in term healthy Nigerian infants at birth and at six weeks of age. The values obtained may aid the early detection of ventricular enlargement in the term African newborn at birth and at 6 weeks of age that might have been missed in the earlier scan. Mild cerebral ventriculomegaly may be associated with mild cognitive or motor delay which should prompt further targeted ultrasonographic examination.

This study using the method described by Davies et al showed similar values for the anterior horn width of the lateral ventricles at birth of 0.00 to 3.00mm compared with 1.00 to 3.10mm in Indian neonates. However, the mean values for the TOD and fourth ventricular width at birth are larger than those obtained in Indian newborns of similar gestational age. Larger mean (SD) lateral ventricle width of 2.40(0.8)mm was reported in Chinese newborns compared with 1.43(0.9)mm in the present study, it is not known if racial factors could account for this.

This study, as others demonstrated a significant increase in size of the ventricles in the first six weeks of life with the greatest increase in ventricular size observed in the TOD and least in the third ventricle width. Thalamo-occipital distance is a very sensitive marker of change in lateral ventricular size and is therefore of significant clinical use in the early detection of ventricular dilatation as seen in post-meningitic and post-haemorrhagic hydrocephalus. Though infant growth is expected to affect all parts of the body, this study however found a weak correlation between mean increases in the left lateral, third and fourth ventricular widths with mean increases in the OFC, weight and length over the six week period. This weak correlation will suggest that OFC without additional evaluation of ventricular size should be interpreted with caution in the evaluation of infants at risk for ventriculomegaly as ventricular dilatation may precede observable increases in head size by days.

Some studies demonstrated no significant effect of mode of delivery on ventricular size, however, this study showed that vaginal delivery was associated with significantly smaller lateral ventricular width as well as smaller fourth ventricular width at birth probably as a result of compression by the birth canal which was not apparent at six weeks and therefore of non pathological significance hence mode of delivery should not be an impediment to the use of ultrasonography for follow up studies. Long term follow-up studies will be useful in further demonstrating normal outcomes in these infants.

**CONCLUSION**

This study has provided baseline values for intracranial ventricular sizes in term Nigerian infants at birth and at six weeks of age. Study also demonstrated significant increases in the sizes of the intracranial ventricles by six weeks of age with the greatest increase observed in the thalamo-occipital distance and the least increase in the third ventricle width with a weak correlation of these increases with anthropometry. These reference ranges and mean increases in sizes would be of value in the early detection of ventricular enlargement in Nigerian newborns.

**References**

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