

Compared Ultrasonographic Study of the Third and Lateral Ventricles of Newborn at Term and of the Premature One

Yekpe Ahouansou HP^{1*}, Biaou O¹, Savi De Tove KM², Gandji S³, Sotchenou M³ and Boco V¹

¹National Hospital Koutoukou Hubert Maga, Medical scanning unit / University of Abomey-calavi, Benin

²Borgou Departmental Centre, medical scanning unit, University of Parakou, Benin

³Polytechnic College of Abomey -calavi, medical scanning department, Benin

*Corresponding author: Yekpe Ahouansou HP, medical scanning unit of CNHU - HKM, Cotonou (Benin), P.O Box: 386 Cotonou, France, Tel: +00 229 954 269 81/670 885 85; E-mail: Yfrida_pat@yahoo.fr

Received date: August 04, 2015; Accepted date: September 04, 2015; Published date: September 08, 2015

Copyright: © 2015 Yekpe Ahouansou HP et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Aim: Define the average values of the cerebral ventricles size in ultrasonography transfontanelar in premature newborns and newborns at term in Benin environment.

Patients and Methods: This is a prospective cross-sectional study of analytical aiming. It took place over a period of 6 months, from May 1st to October 31st, 2012 at the National Hospital University Centre Koutoukou Hubert Maga in neonatal units and medical scanning. It focused on 100 newborns (subjects) including 50 premature newborns and 50 newborn at term. They all met the inclusion criteria. The cranial perimeter was also measured.

Results: The average cranial perimeter in premature newborn was 30.38 ± 2.18 cm between 26-32 and 31.67 ± 3.50 between 33-36 of gestational age (GA) and 33.34 ± 2.20 cm in newborn at term. In cerebral ultrasonography, in premature newborns the age of group of 26-32 the average size of the right side of the lateral ventricle was 2.74 ± 1.31 mm, that of the left side was 2.85 ± 1.13 mm and the one of the third ventricle was 4.03 ± 2.06 mm. In the one between 33-36 the average size of the right side was 2.29 ± 0.93 that of the left was 2.17 ± 0.92 and the third ventricle 3.42 ± 1.60 . In new born at term, the right side was 1.81 ± 0.78 that of the left was 2.02 ± 0.68 and the third ventricle 2.32 ± 1.31 .

Conclusion: there was a statistically significantly difference between the ventricles size in premature newborns and newborns at term; and the ventricles size in preterm newborns was higher than the newborn at term.

Keywords: Ultrasonography transfontanelar; Cerebral ventricles size; Premature newborn; Newborn at term

cerebral ventricles in premature newborns with the one of newborns at term.

Introduction

Prematurity is a big public health problem considering the frequency and often serious complications which it leads to. The highest rates of premature birth are found in AFRICA, accounting for 11.9 % of all births [1]. This is one of the three first causes of newborn death [2]. In Benin, it is one of the main causes of admission in neonatal units. At the National Hospital and University of Cotonou, it represented 10 % of admission in neonatal unit in the years 2008 and 2009 [3]. Premature birth can disturb the development of several organs, particularly the brain and can be responsible for intracranial lesions like intracranial haemorrhage.

To diagnose the ventricular dilatation and to evaluate the need for an intervention, measuring the ventricular size by imaging is more accurate [4]. In the 1980s [5], Levene was the first to publish reference values for the size of the lateral ventricles in newborns on ultrasonographic images. Since then, many other studies have been carried out and reference values have been published. However, in black Africa, no study has been conducted in this field; hence the purpose of our work aims at comparing the morphology of the

Patients and Methods

It is a descriptive cross-sectional study of analytical aiming conducted over a period of 6 months from May 1st to October 31st, 2012 in neonatal units and medical scanning of National Hospital University Centre / Koutoukou Hubert Maga (CNHU/HKM) of Cotonou. The purposive sampling has 100 newborns. We included during the period of this study, premature newborns admitted into the neonatal units and healthy newborns at term in which ultrasonography transfontanelar was performed. Newborns whose gestational age was not precisely known and newborns with an infected central nervous system have been excluded from this study. We also got the consent of the well-informed parents of each enrolled child.

Our sample is made of two groups: 50 premature newborns and 50 healthy newborns at term. The preterm has been defined as a gestational age less than 37 weeks of amenorrhea at birth. It is classified into two groups. That between 26-32 and the one of 33-36.

Ultrasonography examination was carried out by transfontanelar way (ETF), after an aseptic shaving of skull to remove the artifacts

generated by the interposition aeric between the probe and the scalp. We used a brand SIEMENS ACUSON X150 ultrasonograph equipped with a probe convex variable frequency (2.5-5 MHz) and also a linear probe variable frequency (5-10 MHz). After applying a linkage gel on the anterior fontanel, several reference cuts were performed:

In the frontal plan:

- An anterior cut passing by the frontal horns of the lateral ventricles in order to visualize the roof of the lateral ventricles.
- A median cut passing by the third lateral ventricle enabling to measure the size of the ventricles at the level of the inter ventricular foramina and that of the third ventricle.
- A more posterior cut through the choroid plexus easily identified due to their strong echogenicity.

In the sagittal plan:

- A median sagittal cut enabling to visualize the third ventricle in a quadrangular shape, corpus callosum as a whole, as well as the structures of the posterior fossa.
- Two parasagittal cuts right and left.

The standard of the examination is assessed on:

- The morphology and the situation of the cerebral structures
- The size and the aspect of the ventricular cavities
- The normality of echostructure and echogenicity of the cerebral parenchymal
- The aspect of pericerebral space and the absence of effusion on that level regarding the meninges.

The measurement of the lateral ventricles size was taken transversely on a frontal cut at foramens ventricular level. All the ultrasonographic examinations were carried out by the same operator. The measurement of the cranial perimeter has been done by measurement tape. It is placed at level of front , and goes round the head passing through the most posterior occiput The normal values of the birth weight varies 2,5-3,5kg and the one of the cranial perimeter33-35cm[6]. The different variables studied were: the age, the weight, the cranial perimeter, the lateral ventricles size and the third ventricle size. The statistical data were processed and analyzed by SPSS 20.0 software.

Results

The results are shown in tables 1,2,3,4,5 and 6.

Epidemiological and demographic features

Age at "ETF" time: The average age when implementing "ETF" is 7 ± 5.68 days old. Ninety-five percent of ultrasonography examinations were performed between 0 and 2 weeks (Table 1).

Gestational age	Average	Cranial perimeter (cm)		
		Min	Max	Standard deviation
26-32	30.38	25.00	33.00	2.18
33-36	31.67	27.00	44.00	3.50
37-40	33.34	32.00	39.00	2.20

Table 4: Minimal ,maximal average value, and standard deviation of the newborns' cranial perimeter according to the gestational age.

Age(days)	Number	%
0-3	26	26
4-7	33	33
8-14	36	36
>14	5	5
Total	100	100

Table 1: Division of newborns according to the age (in days) to the date of ETF implementation.

Gestational age at birth: The largest age of preterm was the one between 33-36 GA that is 33% percentage (Table 2).

Period of birth (SA)	Number	Percentage %
26-32	17	17
33-36	33	33
37-40	50	50
Total	100	100

Table 2: Division of newborns according to the gestational age at term.

Birth weight according to the gestational age: In our sample, 47 premature newborns out of 64 newborns showed a low weight at birth. Among these 47 premature, 11% were hypotrophe (Table 3).

Birth Weight(g)	Gestational age				
	26-32	33-36	37-40	Total	Frequency%
< 1500	7	4	4	15	15
1500-2500	10	26	13	49	49
>2500	0	3	33	36	36
Total	17	33	50	100	100

Table 3: Division of newborns according to the birth weight and the gestational age at birth.

Cranial perimeter according to the gestational age

In premature newborns, the average value of the cranial perimeter was 31.24 ± 6.23 cm and 33.34 ± 4.31 cm in newborn at term (Table 4).

Cerebral ventriculars cavities size

In premature newborns, the average size of the right side of the lateral ventricle was 2.43 ± 2.13 mm, that of the left side was 2.39 ± 2.03 mm and the one of the third ventricle was 3.62 ± 3.50 mm (Table

5). A case of hydrocephalus detected, measured at the right side of the lateral ventricle 43,6 mm; 10.9 mm at the left side and 7.7 mm for the third ventricle.

Ventricles	Gestational age	Average			Minimal			Maximal			Standard deviation		
		RL	LL	3 rd V	RL	LL	3 rd V	RL	LL	3 rd V	RL	LL	3 rd V
Preterm	26-32	2.74	2.85	4.03	1.00	1.60	0.10	6.70	5.60	7.60	1.31	1.13	2.06
Normal	33-36	2.29	2.17	3.42	1.00	1.60	1.00	4.90	4.00	7.60	0.93	0.92	1.60
Newborns (Subjects)	37-40	1.81	2.02	2.32	0.80	0.90	0.60	3.90	3.00	4.70	0.78	0.68	1.31

RL = Right lateral
LL = Left lateral
3rd V = Third ventricle

Table 5: Minimal, maximal and average values of newborns' cerebral ventricles according to the gestational age.

Comparison of averages sizes of ventricular cavities

When comparing the average sizes of the lateral ventricles there is a significant difference between the age groups of 26-32 and 33-36 in premature newborns. In the same way, there was a significant

difference between the one of premature newborns and the newborns at term (Table 6). The average size of the third ventricle as well as larger in the two groups of premature newborns than the newborns at term. The difference was significant (Table 6).

Term (GA)	Paramètres	RL	LL	3RDV	CP
26 – 32	Average	2,74	2,85	4,03	30,38
	Standard D	1,31	1,13	2,06	2,18
33 - 36	Average	2,29	2,17	3,42	31,67
	Standard D	0,93	0,92	1,60	3,50
>=37	Average	1,81	2,02	2,32	33,34
	Standard D	0,78	0,68	1,31	2,20
p- value	p	<0,001	<0,001	<0,001	<0,001

CP= cranial perimeter GA= Gestational age Standard D= Standard deviation

Table 6: Averages comparison of cerebral ventricles in preterm infants and newborns at term.

Relationship between the ventricles size, gestational age and the cranial perimeter

The different relationship studies between the lateral ventricles size and the gestational age were negative and weak. It was also the same for the third ventricle and the gestational age. Not only were the relationship between the ventricles size and cranial perimeter positive, but also weak.

fewer numbers of references on the ultrasonographic dimensions of the ventricles particularly the third ventricle in premature newborns.

Discussion

Our study has some limitations. The first is related to fewer numbers of patients available. Since the very premature newborns were dependents; it limited their movement, which would explain their fewer numbers in our study. We faced some difficulties as far as discussion is concerned due to the different classifications of prematurity from one study to another. We were also confronted with

The average age of newborns on the date of ultrasonography was 7 ± 5.68 days old. The majority of ultrasonography examinations that is 95% was carried out within a period of zero to two weeks old. According to a study conducted by SAUVE and al [7] in Canada, a ultrasonography transfontanellar performed at the coming of the second week of old would enable the most complete and reliable diagnosis of hemorrhagic lesions.

In the preterm infants group, gestational age at birth varied from 26 to 36 week of amenorrhea. Our division of preterm infants into two groups namely the group of very large and very preterm (26-32 week of amenorrhea) and the one of lightweight preterm (33-36) was different from the one of Chowdhury and al [8] in new Delhi, who divided the preterm infants into four gestational age groups ranging from 28 to 36 week of amenorrhea. Still in India, it differed from SHAH and al [9] who conducted their study on a group of preterm

infants with gestational age at birth varying from 34 to 36 week of amenorrhea. But our division was similar to SONI and al [10] ones. Most of preterm infants had a gestational age between the group of 33 - 36 week of amenorrhea (33%). This majority is also reported in the study conducted by Chowdhury and al in New Delhi on preterm infants of the same gestational age group at birth like ours.

The average cranial perimeter of very large and very preterm as well as the lightweight preterm in preterm infants was respectively 30.38 ± 2.18 , 31.67 ± 3.50 and 33.34 ± 2.20 cm. These results were comparable to those of SONI and al [10] in India, who got as cranial perimeter's average value 29.6 ± 2.05 cm in preterm infants and 32.6 ± 2.14 cm in the newborn at term.

There was a significant statistically difference ($p < 0.001$) between the average cranial perimeter in premature newborns from 26 to 32 week of amenorrhea, and those of 33 to 36 week of amenorrhea. This difference ($p < 0.001$) was also found between the average cranial perimeter in preterm infants and the one of newborns at term.

The average value of the lateral ventricle of very large and very preterm in preterm infants was 2.74 ± 1.31 mm to the right side and 2.85 ± 1.13 mm to the left. And the lightweight preterm was 2.29 ± 0.93 on the right side and 2.17 ± 0.92 on the left side. Those values were lower than those of SHAH and al [9] (4.64 ± 1.86 mm) and much lower than those obtained by Chowdhury and al [8] that is 8.67 ± 1.85 mm. The difference between the findings can be due to the fact that our study included premature newborns with gestational age at birth, much Lower than those of the others studies.

However, those findings remained within the limit of those of DAVIES and al [11] who had found as normal value, any value less than 2.9 mm and those of BROUWER and al [12] who concluded that the lateral cerebral ventricles size previously measured at frontal horns level of lateral cerebral ventricles should be inferior or equal to 3mm.

Some authors [10,12,13] have used in addition ventricular index as another complementary method to measure the lateral ventricles size. BROUWER [13] has recently updated the old values of the ventricle size in newborn of 24-42 GA by using the ventricular index (VI), anterior horn width (AHW), and thalamo-occipital distance (TOD). According to her study the VI and TOD increased with maturity whereas AHW was not affected. Further she founded that the ventricle size in preterm infants after a week old was larger the newborn.

There was a significant statistically difference between the average size of the right and left lateral ventricles in preterm of 26 to 32 week of amenorrhea and those of 33 to 36 week of amenorrhea ($p < 0.001$). The averages comparison of the right and left lateral ventricles size between the preterm infants and the newborns at term gave a result of ($p < 0.001$). It showed therefore a significant statistically difference between the averages of the right and left lateral ventricles of the two groups. According to BERTELOITE this could be explained by the immature development of the brain structures in preterm [14].

In newborns at term the lateral ventricle had an average value of 1.81 ± 0.78 mm to the right side and 2.02 ± 0.68 mm to the left. Those values were too small relatively to the ones of SHAH and al [9] (5.32 ± 1.72 mm), but were in the limit of those of BROUWER and al [12] in Netherlands.

The third ventricle measured on average in very large and very preterm 4.03 ± 2.06 mm and in the lightweight preterm infants 3.42 ± 1.60 mm and 2.32 ± 1.31 mm in the newborns at term. The findings related to the newborns at term were close to the one of LOMBROSO and al [15] in Boston who obtained as normal values of third ventricle any value between 4 and 7mm.

The study carried out by DAVIES and al [11] in Australia was the first one to supply the normal value to measure the third ventricle in preterm infants. They got as average of the third ventricle size 1.07 ± 0.74 mm. Our findings were therefore higher than those of DAVIES and al [11]. This difference can be explained by the fact that the preterm infants of DAVIES and al's study had a gestational age at birth between 23 and 33 week of amenorrhea meaning it is very inferior to most of premature newborns of our sample.

In the third ventricle, a significant statistically difference derived on the one hand from the average comparison between the preterm of 26 to 32 week of amenorrhea and those of 33 to 36 week of amenorrhea ($p < 0.001$) and between the preterm and the newborns at term ($p < 0.001$) on the other hand.

We noticed a low negative relationship between the measurements of the right and left lateral ventricles size and gestational age ($r^2 = 0.0933$ et $r^2 = 0.0686$). This result is different from the one noticed by DAVIES and al [11] in Australia, who had observed a low but positive relationship ($r^2 = 0.004$) between the measurement of the lateral ventricles size and gestational age.

All the same the relationship between the third ventricle size and gestational age showed a low negative relationship between the two parameters ($r^2 = 0.221$). DAVIES and al [11] got a low positive relationship ($r^2 = 0.038$) between the third ventricle size and the gestational age. This difference between the findings of DAVIES and al may be due to the fact that their study was only focused on preterm gestational age at birth inferior to 33 GA while the current study was performed on preterm infants of gestational age at birth between 26 and 36 week of amenorrhea and newborn at term.

The relationship between the values of the cranial perimeter and those of the lateral ventricles size showed a positive but low relationship, almost nil between the lateral ventricles size and the cranial perimeter ($r^2 = 0.0007$ et $r^2 = 0.005$). These findings were contrary to those got by Chowdhury and al [8] who had observed a good relationship between the lateral ventricles size and the cranial perimeter.

This difference noticed could be explained by the fact that Chowdhury and al conducted their study only on preterm infants of gestational age at birth between 28 and 36 week of amenorrhea unlike our study carried out both on preterm infants of gestational age at birth between 26 and 36 week of amenorrhea and newborns at term. Furthermore, the relationship between the third ventricle size and the cranial perimeter also showed a positive but low, even nil relationship ($r^2 = 0.000$) between these different values.

Conclusion

The ventricles size in preterm infants in Benin is lower than the one of the newborn at term, with a significant statistically difference. It is also lower than the premature infants in Asia but is in accordance with the Western newborns.

References:

1. Beck S (2010) Incidence mondiale de la naissance avant terme : revue systématique de la mortalité et de la morbidité maternelle. Bull World Health Organ.
2. Black RE, Cousens S, Johnson HL, Lawn JE, Rudan I, et al. (2010) Global, regional, and national causes of child mortality in 2008: a systematic analysis. Lancet 375: 1969-1987.

3. d'Almeida M, Bagnan L, Alao M, Alihonou F, Ayivi B (2011) [Usefulness of new born's systematic exam at Cotonou University Hospital, Benin]. *Mali Med* 26: 8-11.
4. Volpe JJ (2008) Intracranial hemorrhage : germinal matrix-intraventricular hemorrhage of the premature infant. In : *Neurology of the newborns*. (5th edition) Philadelphia : Saunders Elsevier.
5. Levene MI (1981) Measurement of the growth of the lateral ventricles in preterm infants with real-time ultrasound. *Arch Dis Child* 56: 900-904.
6. Lansac J, Magnin G, Sentilhes L (2013) *Obstétrique pour le praticien*. (6th edition) Paris: Masson.
7. Sauve R (2001) Le dépistage systématique par échographie transfontanelle pour prévoir les issues neurodéveloppementale à long terme des prématurés. *Paediatr Child Health* 6: 47-52.
8. Chowdhury V, Gulati P, Arora S, Thirupuram S (1992) Cranial sonography in preterm infants. *Indian Pediatr* 29: 411-415.
9. Shah PS, Sarvaiya JB, Rawal JR, Kabra SK, Patel VB, et al. (1992) Normal ventricular size and ventriculo-hemispheric ratio in infants upto 6 months of age by cranial ultrasonography. *Indian Pediatr* 29: 439-442.
10. Soni JP, Singhanian RU, Sharma A (1992) Measurement of ventricular size in term and preterm infants. *Indian Pediatr* 29: 55-59.
11. Davies MW, Swaminathan M, Chuang SL, Betheras FR (2000) Reference ranges for the linear dimensions of the intracranial ventricles in preterm neonates. *Arch Dis Child Fetal Neonatal Ed* 82: F218-223.
12. Brouwer MJ, de Vries LS, Groenendaal F, Koopman C, Pistorius LR, et al. (2011) New reference values for the neonatal cerebral ventricles. *Radiology* 262: 224-233.
13. Brouwer MJ, De Vries LS, Groenendaal F, Koopman C, Pistorius LR, et al. (2012) New reference values for the neonatal cerebral ventricles. *Radiology* 262: 224-233.
14. Berteloite CE (2009) Les séquelles à l'âge scolaire d'un ancien grand prématuré. *Mémoire de Psychomotricité: Faculté de Médecine Toulouse*.
15. Lombroso C (1968) Two-dimensional ultrasonography: a method to study normal and abnormal ventricles. *Pediatrics* 42: 157.