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Anatomy

SONOGRAPHIC ASSESSMENT OF ATRIUM OF LATERAL VENTRICLE IN FOETUSES OF DIFFERENT GESTATIONAL AGES

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ABSTRACT **BACKGROUND:** Lateral ventricle is the CSF filled cavity inside the cerebrum. Atrium, the meeting point of the body of lateral ventricle, its posterior horn and inferior horn, can be demonstrated radiologically in foetus as early as 12 weeks. Ventriculomegaly is often seen associated with structural anomalies of foetus. It is the earliest ultrasonographic indicator capable of detecting trivial changes in ventricular dilatation in the foetal brain. **METHOD:** The study was done in 175 antenatal ultrasound scans of gestational age ranging between 13 and 40 weeks. The measurements were taken from the axial images directly from the screen by the Sonologist. Atrial width (AW), Cerebro Atrial distance (CAD) and Hemispheric width (HSW) were also measured. Two ratios were calculated AW/CAD & AW/HSW. These values were correlated with Gestational Age (GA), Foetal weight(FW) and Biparietal diameter (BPD) were also evaluated for right left asymmetry. **RESULTS:** AW was found to be fairly constant throughout intra uterine life, unaffected by GA, FW or BPD. Its mean value was 6.8 ± 1.4mm. No significant difference between right and left sides was observed. The value that increased across GA was CAD & HSW which indicated the increasing thickness of the cerebral tissue.

KEYWORDS : Atrial Width, Lateral Ventricle, Anatomy, Ultrasonography

INTRODUCTION:

Anatomy of lateral ventricle can be studied from intrauterine life using ultrasonography. Size of the ventricle and its relative size with that of brain were measured at different gestational ages to assess the normal brain growth. Measuring the atrial region of the lateral ventricles is a sensitive method for determining ventricular size. Atrium is the junction of body of lateral ventricle, its posterior and inferior horns. It is also the earliest ultrasonographic indicator capable of detecting trivial changes in ventricular dilatation in the foetal brain. Ventriculomegaly is often associated with a variety of disorders including neurological, motor and cognitive impairments and hence not to be missed in the antenatal scans. If it is detected, further investigations including genetic evaluation should be carried out before proceeding with the pregnancy.

In this study, measurement of the lateral ventricle was taken at the atrium and its relative size was assessed with respect to the brain in the foetus. Atria can be visualized radiologically from 12th week of intrauterine life onwards. Atrial width (AW) was found to be constant throughout gestation and can be taken as a single measurement to diagnose ventriculomegaly. The upper limit of normal was taken as 10mm as per the results from the previous studies.

MATERIALS AND METHODS:

The study was done in 175 routine antenatal scans, of gestational age ranging between 13 and 40 weeks, taken in the Radiology Department of a tertiary care hospital.

The Gestational age (GA) was noted, Foetal weight (FW) and the Bi parietal diameter (BPD) were taken. BPD was measured to assess the head size of the foetus.

The measurements of ventricular atrium and the brain were taken by the sonologist from axial images just above the trans thalamic plane, at its widest part.

The distance between lateral and medial walls of the atrium was taken as Atrial Width (AW), the distance between midline and the lateral wall of the atrium as Cerebro Atrial Distance (CAD) and the distance from midline to the outer margin of cerebral cortex at that level as Hemispheric width (HSW). All the measurements were taken in mm (Fig 1).

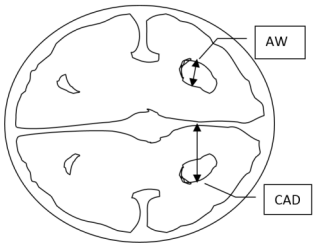

Fig 1

The ratios were calculated from these values – AW/CAD, AW/HSW and CAD/HSW. These measurements and ratios were correlated with GA, FW and BPD. The values were compared between right and left side for evaluating the symmetry.

Inclusion criteria: Routine antenatal scans after 12 weeks with AW less than 10mm

Exclusion criteria: All scans with obvious congenital anomaly of brain

Statistical Analysis: Correlation between the variables was tested using Pearson Correlation coefficient and significance level was calculated using 2 tailed test. P value of less than 0.05 is taken as statistically significant.

Observation:

Of the 175 antenatal scans, 84 foetuses were of GA less than 28weeks and 91 foetuses of GA greater than 28weeks.

Ventricular lumen appeared as brightly echogenic ovoid structure, due to the presence of choroid plexus. Until mid gestation, atria appeared large and rounded. From 20th week, the relative size of atria decreased and progressive development of posterior horn can be visualized as sonolucent posterior prolongation, pointing towards midline.

The AW was fairly constant throughout the gestational period with an average value around 6.8mm. The minor difference detected before and after 28 weeks was not significant statistically (Table 1).

Table 1: Mean ±SD in mm for the Atrial Width (AW) and Cerebro Atrial Distance (CAD) in foetuses before and after 28weeks of GA

	13 –28 wks	>28 wks	p value
	(N = 84)	(N = 91)	
Rt AW	6.84 ± 1.42	6.89 ± 1.04	.850
Lt AW	6.95 ± 1.25	6.83 ± 1.04	.854
Rt CAD	12.69 ± 2.49	18.66 ± 2.10	.000
Lt CAD	12.88 ± 2.74	18.58 ± 1.98	.000

The CAD increased significantly from 12.6 ± 2.4mm before 28weeks to 18.6 ±2.1mm after 28weeks (Table 1).

No significant difference was detected between right and left side for any of the values (AW or CAD) in any stage of gestation.

The ratios were calculated to assess the relative size of the ventricle with the brain. All the ratios showed a statistically significant correlation with gestational age. These decreased from second to third trimester (Table 2)

Table 2: Mean ±SD of the ratios between AW with CAD, AW with HSW and CAD with HSW in first and second trimesters

	13 –28 wks	>28 wks	P value
Rt AW/CAD	0.56 ± 0.17	0.37 ± 0.06	0.000
Lt AW/CAD	0.56 ± 0.16	0.37 ± 0.06	0.000
Rt AW/HSW	0.35 ±0.14	0.19 ± 0.03	0.000
Lt AW/HSW	0.36 ± 0.13	0.18 ± 0.03	0.000
Rt CAD/HSW	0.62 ± 0.08	0.51 ± 0.05	0.000
Lt CAD/HSW	0.63 ±0.08	0.50 ± 0.05	0.000

Table 3: Correlation of values with Gestational age, Foetal weight and BPD

		GA	FW	BPD
AW	Pearson Correlation	-0.031	0.010	-0.028
	Sig. (2 tailed)	0.789	0.931	0.809
CAD	Pearson Correlation	0.893(**)	0.848(**)	0.900(**)
	Sig. (2 tailed)	0.000	0.000	0.000
AW/CAD	Pearson Correlation	-0.753(**)	-0.660(**)	-0.771(**)
	Sig. (2 tailed)	0.000	0.000	0.000
AW/HSW	Pearson Correlation	-0.819(**)	-0.710(**)	-0.846(**)
	Sig. (2 tailed)	0.000	0.000	0.000
CAD/HSW	Pearson Correlation	-0.740(**)	-0.654(**)	-0.765(**)
	Sig. (2 tailed)	0.000	0.000	0.000

DISCUSSION:

Though the attempts to outline the ventricle with ultrasonography way back to 1937 by the brothers Dussik, it was the French, Wild & Neal in 1951 who accomplished that, although nearly, in their post craniotomy study of brain. Ford & Mc Ray (1966), Schiefner & Kazner (1967) and Geschwind et al (1968) measured brain mantle index at frontal and temporal horn levels to look for enlargement of ventricle. Ultrasonography was largely ignored until late 1970's. Dunne & Johnson (1979) and Hadlock, Peter & Park (1981) studied lateral ventricle in foetuses in-utero with Real Time USG.

Hadlock et al (1981) was the first to turn attention to the ventricular atrium in foetuses by real time USG. Mc Gahan & Phillips (1983) took AW as a single measure for foetal lateral ventricle. The mean value was 6.8 ±1.2 mm, similar to the present study. Cardoza et al (1988) reported the mean value as 7.6 ± 0.6 mm in a study done retrospectively in 100 healthy foetuses. Attempts to quantify atrium alone were done by Heiserman et al (1991), Alagappan & Browning (1994), Hilpert et al (1995) Farrel et al (1996) etc.. The mean values obtained in their study have been summarized (Table 4). Ishola et al (2016) reported a slight increase of AW from 6.60 ± 0.94 in second trimester to 6.95 ± 0.06 in third trimester. All other investigators had the same observation as the present study, that the AW was fairly constant throughout the gestational period.

Table 4: Comparison of Mean value of AW in mm with previous studies

Investigator	Antenatal scans	GA	AW (Mean ± SD)
Mc Gahan & Phillips		19 to 40wks	6.8 ± 1.2
Cardoza et al	100		7.6 ± 0.6
G Pilu, E A Reece et al	171	15 to 40wks	6.9 ±1.3
R A Filly et al			6.5 ± 1.3
R Alagappan et al	500	12 to 40wks	6.6 ± 1.4
Heiserman et al	52		6.5 ± 1.3
B Almog et al	427	20 to 40wks	6.2 ± 1.2
T H Chiu et al	1125	18 to 36wks	6.7 ± 1.2
Udoh et al	685	20 to 40wks	6.62 ± 2.51
Present study	175	13 to 40wks	6.8 ± 1.4

All these investigators suggested 10mm as the upper limit of normal and it was taken as the inclusion exclusion criteria in the present study.

The study done by Chiu et al (2014) reported an association between neurological deficits like ADHD, epilepsy and hearing loss with the ventriculomegaly of AW >10mm. Still they included a "gray zone" for AW between 7-10mm that needed a follow up scan to check whether it is crossing the limit over time. Larcos et al (1994) found that moderate ventriculomegaly was more associated with structural anomalies when compared to milder enlargement.

The distance from the midline to the lateral wall of the atrium was taken (CAD in the present study) as the lateral ventricular width by many investigators. The values as such were given only in some studies (Table 5). In the remaining studies, only its ratio with the hemisphere was given.

Table 5: Mean value of CAD in various studies

	GA	CAD in 2nd trimester	CAD in 3rd trimester
Mc Gahan & Phillips	19 to 40wks	1.3cm	2.4cm
G Pilu, E A Reece et al	15 to 40wks	11.6± 0.8mm	23.6 ±1.5mm
Present study	13 to 40 wks	12.6 ± 2.5mm	18.2 ± 2.1 mm

The present study is in agreement with previous studies suggesting a decrease in relative size of the lateral ventricle with brain growth (Table 6).

Table 6: Values of different ratios calculated and change according to GA in various studies

	GA in wks	Ratio	2nd trimester	3rd trimester
Hadlock et al	28 to 40	CAD/HSW	0.63	0.47
Campbell & Pearce	15 to 24	AW/HSW	50%	30%
Hilpert et al		AW/CAD		Decreased
Ants Toi et al	16 to 25	CAD/HSW	0.74	0.35
Ishola et al	14 to 40	CAD/HSW	0.56	0.42
Present study	13 to 40	AW/CAD	0.56	0.37
		AW/HSW	0.35	0.18
		CAD/HSW	0.62	0.51

CONCLUSION:

Atrial Width can be considered as a sole parameter for assessing the lateral ventricular enlargement because it was fairly constant throughout gestational period. The measurements of CAD and the ratio of AW with the CAD or HSW can be taken as values for assessing normal brain growth.

The present study goes in par with the values of main variables and their ratios obtained in the previous studies. The early detection of ventriculomegaly by the measurement of atrial width plays a pivotal role in providing urgent medical intervention, even in the absence of associated anomalies.

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