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Original article

Role of imaging the fetal cerebellum and fourth ventricle and their correlation with gestational age.

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ABSTRACT

Objectives: To examine the ultrasonographic feasibility of imaging the fetal cerebellum and fourth ventricle to correlate with gestational age.Materials & Methods: A cross-sectional, prospective study on 100 healthy fetuses of low-risk pregnancies between 18 and 36 weeks was performed. Biometric measurements were obtained. The fetal head was scanned in the axial plane, fourth ventricle was identified, and its anteroposterior diameter and width were measured. The transfontanel approach, via the abdominal route, was used to evaluate the transverse diameter of cerebellum.Results & conclusion :the anteroposterior and transverse diameter of forth ventricle, transeverse cerebellar diameter of fetus show linear correlation with gestational age , (r=0.969 ,r=0.988, r=0.986 respectively)also with other biometric parameters as BPD- Biparietal diameter, HC- Head circumference, AC -Abdominal circumference, FL- Femoral lemgth.The forth ventricle parameters and transverse cerebellar diameter can be used to correlate with gestational age of the fetus. The results of our study provide normative data for growth of the fetal fourth ventricle for south Indian population. Also these results can be useful for evaluating the fourth ventricle in the fetus since we are providing the percentile values of these parameters. This might be of help in future studies aiming to verify the level of obstruction in cases of prenatal hydrocephaly. More studies are required to know the usefulness of these data in evaluating different developmental anomalies and their prognostic value. no decisions should be based solely on An isolated enlarged fourth ventricle found in the early second trimester. Transvaginal ultrasonography allows a better evaluation of the posterior fossa and therefore is an important tool for a precise diagnosis of posterior fossa malformations. So use of Transvaginal ultrasonography is advised as routine in our part of country.

1.Introduction:

Most fetal brain anomalies are detectable by using the well-known three axial planes of the brain, as was reported by Filly et al. [1]. The mid-sagittal plane is essential for the visualization of the metencephalon and brainstem and reporting congenital brain anomalies involving the median structures during fetal life. The brainstem, includes part of the hypothalamus (diencephalon), the midbrain (mesencephalon), the pons, and the medulla oblongata [2]. The pons, as the main part of the brainstem, can be optimally visualized only by the mid-sagittal view. Although the transfontanel mid-sagittal view is a cornerstone in neonatal brain imaging[3], and quantitative measurements for the brainstem were suggested by magnetic resonance imaging technology [4]. There is a lack of in utero data regarding the normal development during human gestation .Basic knowledge of the normal appearance and development of the fetal pons is essential for any prenatal evaluation in cases suspected of brain anomalies, such as Dandy–Walker complex, pontocerebellar atrophy and rhombencephalosynapsis [5-10]. Little information is found in the literature regarding the ultrasonographic characteristics of the fetal fourth ventricle throughout pregnancy [11]. This information might be important for estimating gestational age (GA), ruling out fourth ventricle abnormalities, and following up cases with enlarged fourth ventricles.

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2.Materials and Methods

A cross-sectional, prospective study on 100 healthy fetuses of low-risk pregnancies between 18 and 36 weeks was performed. Routine biometric measurements were obtained. Patients with known GA based on the last menstrual period and confirmed by first-trimester ultrasonography were included in study and fulfilled the following criteria (1) their GA, as predicted by the last menstrual period, confirmed by early ultrasonography (<13 weeks); (2) no discrepancy of more than 4 days existed between the GA predicted by the last menstrual period and that estimated by the ultrasonographic measurements; (3) no evidence of impaired fetal growth or malformation was found (3) the estimated fetal weight (EFW) was within the 10th to 90th percentile, (4) absence of maternal disease (e.g. diabetes, pregnancy-induced hypertension (PIH)/ pre-eclampsia, intrauterine growth restriction (IUGR), (5) no known maternal or previous sibling with central nervous system defect.

3.Ultrasonographic Examinations

The scans were performed with the electronic calipers of ALOKA 55D 4000 ultrasonography machines equipped with 1.5 -MHz transabdominal transducers.The biometric parameters obtained included the BPD- Biparietal diameter, HC- Head circumference, AC -Abdominal circumference, FL- Femoral lemgth, TCD -Transcerebellar diameter, FV- Fourth ventricle, EFBW- Estimated fetal birth weight, GA -Gestational age. The estimated fetal weight was calculated by the formulas of both Shepard et al. [12] and Hadlock et al. [13] Special focus was given to the posterior fossa of the fetal brain.The fourth ventricle was identified in the axial plane of the brain, below the level of the cerebellum. Its anteroposterior (AP) diameter and width were then measured. [Fig: I.] The transfontanel approach, via the abdominal, was used to evaluate the fetal cerebellum. To perform this examination, we viewed the axial plane and moved the transducer posteriorly to pass through the posterior fontanel, visualizing the cerebellum. [Fig: II]In each case, at least two optimal consecutive measurements were performed, and the mean was established. Freeze frame ultrasound capabilities and electronic on-screen calipers were used for the measurements. The following statistical tests were used in the analysis of the data:

4.Statistical Analysis

Pearson correlation coefficients were calculated to examine the strength of the linear relationship between each of the fourth ventricle parameters, TCD -Transcerebellar diameter and GA, BPD- Biparietal diameter, HC- Head circumference, AC -Abdominal circumference, FL- Femoral lemgth, EFBW- Estimated fetal birth weight . precentile values of anteroposterior and transverse diameter of forth ventricle , transverse cerebellar diameter were determined for each gestational age group.(table 2)

5.Results

100 fetuses between 13 and 40 weeks gestation were scanned. The fourth ventricle was ultrasonographically visualized in 95% of cases with the use of the transabdominal route. The fourth ventricle was shown in the posterior fossa as a hypoechoic triangle below the level of the cerebellum. the anteroposterior and transverse diameter of forth ventricle, transeverse cerebellar diameter of fetus show linear correlation with gestational age , (r=0.969 ,r=0.988, r=0.986 respectively) also with other biometric parameters as BPD- Biparietal diameter, HC- Head circumference, AC -Abdominal circumference, FL- Femoral lemgth, mentioned in table 1& graph -1

Fig : I showing image of forth ventricle and anteroposterior diameter is marked.

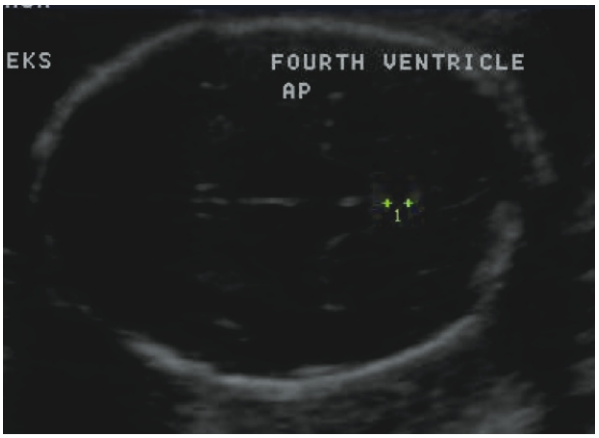

Fig: II showing image of cerebellum and transverse cerebellar diameter is marked.

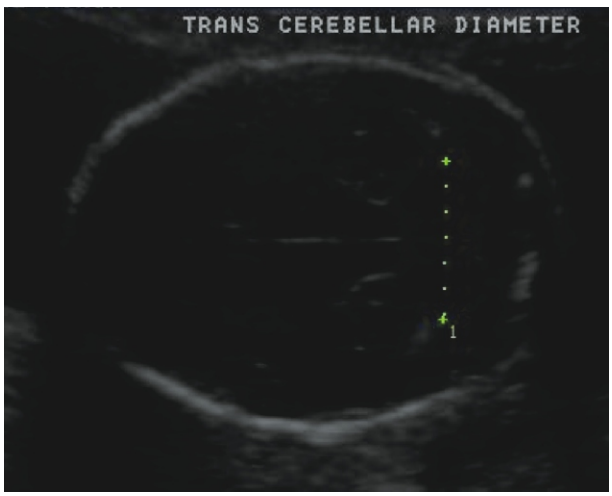

Table :1 mean values of parameters for each gestational age group

GA Wk	4 V AP mm	4 V TR mm	TCD mm	BPD mm	HC mm	AC mm	FL mm	EFBW kg
18-19	1.5	1.9	19	41	174	151	31	0.33
20-21	1.9	2.8	21	50	190	161	35	0.402
22-23	3.3	4	22	56	211	176	40	0.585
24-25	3.7	4.5	23	62	226	202	44	0.725
26-27	4.1	5.6	24	67	246	225	49	0.995
28-29	7.2	6.5	26	74	270	247	55	1.277
30-31	7.4	7.7	29	76	275	267	58	1.605
32-33	7.9	8.2	32	82	299	288	66	2.06
34-35	8.5	8.3	33	88	315	315	68	2.65
36-37	8.5	8.9	35	89	321	319	70	2.83
GA r	0.96907	0.98826	0.98671	0.99198	0.99589	0.99593	0.99543	0.975832
BPD r	0.97324	0.989613	0.96649					
HC r	0.97920	0.990383	0.976303					
AC r	0.97312	0.984571	0.983374					
FL r	0.97819	0.990997	0.984062					
EFBW r	0.93103	0.93969	0.988342					

Graph :1 Showing Linear Relation Between Gestational Age And Different Parameters Fvap-forth ventricle Anteroposterior Diameter,fvtr-forth Vetricle Transverse Diameter,tcd-transverse Cerebellar Diameter,bpd-biparietal Diameter, hc-head Circumference ,ac- Abdominal Circumference ,fl-femoral Length ,efbw-expected Fetal Birth Weight

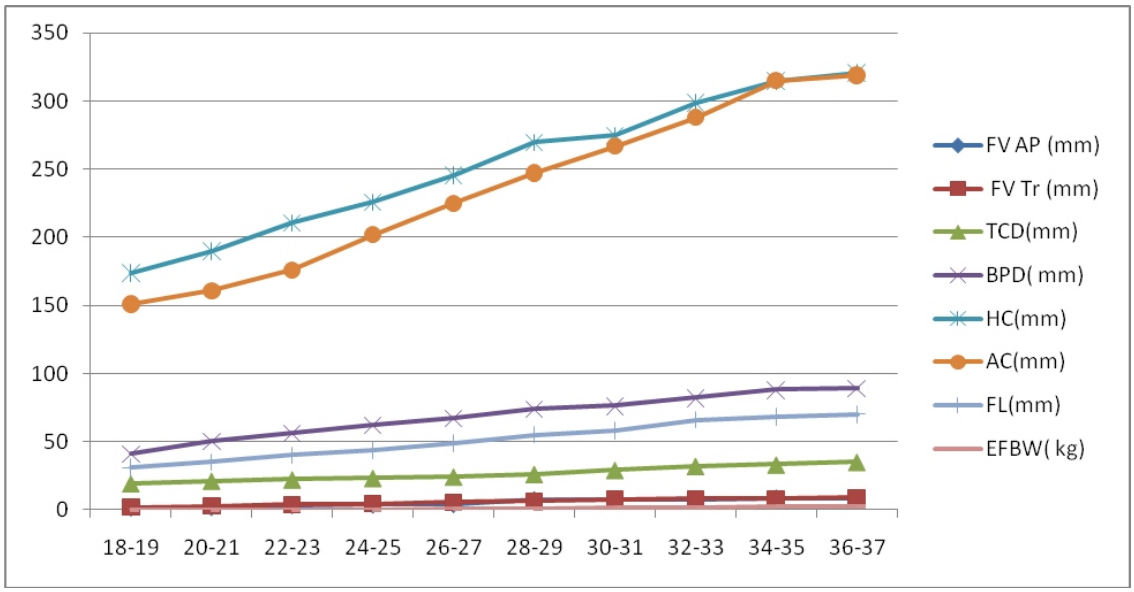

Table :2 percentile values of parameters for each gestational age group

PERCENTILE	5th	25th	50th	75th	95th
GA 18-19TCD (mm)	19	19	19	19	19
FV AP(mm)	1.5	1.5	1.55	1.6	1.6
FV WIDTH (mm)	1.8	1.8	1.9	2	2
GA 20-21TCD(mm)	20	20	21	21	22
FV AP(mm)	1.8	2	2	2	2
FV WIDTH (mm)	2.2	2.8	2.9	3	3
GA 22-23TCD(mm)	21	21	23	23	23
FV AP(mm)	2.1	2.1	3.9	4	4
FV WIDTH (mm)	3.2	3.2	4.3	4.4	4.4
GA 24-25TCD(mm)	23	23	23.5	25	28
FV APFV WIDTH (mm)	3.9	3.9	3.95	4.025	4.1
GA 26-27TCD(mm)	4.3	4.375	4.45	4.525	4.6
FV AP(mm)	24	24	24.5	25	25
FV WIDTH (mm)	4	4	4.1	4.2	4.2
GA 28-29TCD(mm)	4.5	4.5	4.65	4.8	4.8
FV AP(mm)	26	26	27	27	27
FV WIDTH (mm)	7	7	7	7.6	7.6
GA 30-31TCD(mm)	7.8	7.8	8	8.1	8.1
FV AP(mm)	29	29	29	29	29
FV WIDTH (mm)	7.2	7.2	7.45	7.7	7.7
GA 32-33TCD(mm)	7.9	7.9	7.95	8	8
FV AP(mm)	30	30.75	31.5	32.75	35
FV WIDTH (mm)	7.6	7.9	8	8.05	8.2
GA 34-36TCD(mm)	7.9	8.05	8.2	8.35	8.5
FV AP(mm)	32	32	34	35	35
FV WIDTH (mm)	8	8	8	8.1	8.1
GA 37-38TCD(mm)	8.3	8.3	8.4	9	9
FV AP(mm)	31	31	32.5	34	34
FV WIDTH (mm)	8.2	8.2	8.35	8.5	8.5
	8.8	8.8	8.9	9	9

6.Discussion

The ultrasonographic localization of the fourth ventricle is at the midline below the level of the thalami and anterior to the cerebellar hemispheres. The small foramen of Magendie serves as an egress point in the lower aspect of the fourth ventricle. (12) Identification of the fetal fourth ventricle is essential for the characterization of abnormalities of the posterior fossa, cystic masses, hydrocephaly, and enlarged fourth ventricles. However, little information is found in the literature, [13-20] regarding the x

The ultrasonographic localization of the fourth ventricle is at the midline below the level of the thalami and anterior to the cerebellar hemispheres. The small foramen of Magendie serves as an egress point in the lower aspect of the fourth ventricle. (12) Identification of the fetal fourth ventricle is essential for the characterization of abnormalities of the posterior fossa, cystic masses, hydrocephaly, and enlarged fourth ventricles. However, little information is found in the literature, [13-20] regarding the normal size of the fourth

ventricle throughout gestation, and no nomograms could be found in the published works. Blaas et al [13] examined 29 healthy pregnant women by transvaginal ultrasonography to evaluate the embryonic development in vivo between 7 and 12 weeks gestation. They identified and measured the rhomboencephalon, the cerebellum, and the fourth ventricle and its choroid plexus. Baumeister et al[l2] ultrasonographically observed the fourth ventricle in 221(71.3%) of 310 second- and third-trimester fetuses. The mean ± SD AP diameter at this GA was 3.5 ± 1.7 mm, and the mean width was 3.9± 1.7 mm. Laing et al[14] had a success rate of 75% for depiction of the fourth ventricle in 93fetuses at25 to 40 weeks gestation. However, they did not find any statistical correlation between the GA and the depiction of the fourth ventricle. In our study, we found linear correlation between anteroposterior diameter and gestational age as well as between transverse diameter of forth ventricle and gestational age (r = ,r= respectively). These measurements conform with those reported by Baumeister et al.[2] Other investigators, such as Castriota Scanderbeg,[15] also evaluated this structure in neonates. The high visualization rate of the fourth ventricle can be achieved by using transvaginal ultrasonograpy, routinely between 14 and 17 weeks gestation for performing the first anatomic survey of the fetus.

An enlarged fourth ventricle might represent abnormal variant and could be explained by the fact that the caudal fourth ventricle roof is not shown on ultrasonography until 16 weeks, giving the false impression of communication between the fourth ventricle and the cisterna magna.[20] The superior and inferior portions of the cerebellar vermis do not achieve their mature appearance until week 18.[16,17] Transvaginal ultrasonography allows a better evaluation of the posterior fossa and therefore is an important tool for a precise diagnosis of posterior fossa malformations.[18] An isolated enlarged fourth ventricle found in the early second trimester should be followed, but no decisions should be based solely on this isolated finding.

The results of our study provide normative data for growth of the fetal fourth ventricle that show a linear growth. In addition, our data provide a useful characterization of the fourth ventricle dimensions in the fetus. This might be of help in future studies aiming to verify the level of obstruction in cases of prenatal hydrocephaly. Further studies are required in order to examine the usefulness of these data in evaluating different developmental anomalies, Transvaginal ultrasonography allows a better evaluation of the posterior fossa and therefore is an important tool for a precise diagnosis of posterior fossa malformations. So use of Transvaginal ultrasonography is advised as routine in our part of country.

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