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Nomogram of Fetal Cisterna Magna Width at 15-24th Gestational Weeks

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Abstract

Objective: To obtain nomogram of fetal cisterna magna width at 15-24 weeks of gestation with known prognosis of normal pregnancies.

Methods: Cisterna magna width and other routine biometric measurements of 1822 structurally normal fetuses at 15-24 weeks of gestation were measured by transabdominal ultrasonography, prospectively. The distribution of cisterna magna width is established according to gestational weeks and percentiles between 15-24 weeks are calculated. Relationship between cisterna magna width and the other parameters were assessed by regression analysis.

Results: Mean values of cisterna magna width between 15-24 weeks were 3,41±0,82-6,58±1,24 mm respectively. Cisterna magna width is linearely increased between 15-24 weeks. Significant correlation was also found between the cisterna magna width (SMW) and gestational weeks (GH) (SMW=GH x 0.337-1.6203 (r2=0.32; p<0.001)), head circumference (HC) (SMW=HC x 0.0285+0.2137 (r2=0.352; p<0.001)) and biparietal diameter (BPD) (SMW=BPD x 0.1043+0.2681 (r2= 0.336; p<0.001)).

Conclusion: Cisterna magna width showed a linear increase between 15-24 weeks of gestation. Gestational weeks should be taken into consideration during the evaluation of the cisterna magna width and when a value above or below the cut-off is determined, fetal ultrasonographic evaluation must be done systematically.

Keywords: Nomogram of fetal cisterna magna width at 15-24th gestational weeks.

Gebeliğin 15-24 haftalarında sisterna magna genişliğinin nomogramı

Amaç: Prognozu bilinen normal gebeliklerde 15-24. gebelik haftalarında fetüsün sisterna magna genişliğinin nomogramının elde edilmesi.

Yöntem: Bu prospektif çalışmada 15-24. gebelik haftalarında yapısal olarak normal 1822 fetusa ait fetal biyometrik ölçümler transabdominal ultrasonografi ile yapıldı. Bu fetüslerin sisterna magna genişliğinin gebelik haftalarına göre dağılımı çıkarıldı ve 15-24.gebelik haftaları arasında persantil değerleri hesaplandı. Sisterna magna genişliği ile diğer biyometrik parametreler arasında regresyon analizi yapıldı.

Bulgular: 15-24 gebelik haftaları arasında ortalama sisterna magna genişliği (SMG) sırasıyla 3,41±0,82-6,58±1,24 mm arasında tespit edildi. Sisterna magna genişliğinin gebelik haftası (GH) ile ilişkisi incelendiğinde, 15-24 gebelik haftaları arasında lineer olarak arttığı saptandı. Lineer regresyon analizinde; (SMG=GHx0.337-1.6203 (r2=0.32; p<0,001)), baş çevresi (HC) (SMG=HCx0.0285+0.2137 (r2=0.352; p<0.001)) ve bipariyetal çap (BPD) (SMG=BPDx0.1043+0.2681 (r2= 0,336; p<0.001)) arasında anlamlı korelasyon saptandı.

Sonuç: Sisterna magna genişliği 15-24 gebelik haftaları arasında lineer bir artış göstermiştir. Sisterna magna genişliğinin değerlendirilmesinde gebelik haftası göz önünde bulundurulmalı ve uç değerlerin saptanması durumunda fetusta sistematik fetal ultrasonografik inceleme yapılmalıdır.

Anahtar Sözcükler: Sisterna magna genişliği, baş çevresi, gebelik haftası nomogram.

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Introduction

Central nervous system develops from the structure called neural plate which is formed with thickening of ectoderm layer after fifth gestational week. Cisterna magna (cisterna cerebellomedullaris) is one of the enlargements made by subarachnoid interval (in which cerebrospinal fluid circulates) on brain base and it is limited with occipital bone, medulla oblongata and cerebellum.[1-5] While cerebral structures are observed in fetal examinations, it is one of the sonoluscent cavities that should be paid attention and it is observed on third axial plan. Sagittal and coronal plans also should also be examined in their pathologies.[2] It may be confused terminologically with posterior fossa which is between foramen magnum and tentorium cerebelli and includes mid-cerebrum, pons, cerebellum, medulla oblongata and interior surface of occipital bone.[4]

The width of cisterna magna (SMG) is the measurement of the distance between posterior edge of cerebellar vermis and interior surface of occipital bone. Normal width is 2-10 mm.[5] However, cerebellar vermis is not fully developed at second trimester and observing at early weeks may cause to misevaluate normal appearance. Therefore, exact evaluation of cisterna magna and posterior fossa should not be performed before 18th gestational week.[2,6]

Pilu et al. researched posterior fossa structures of 19 fetuses with spina bifida in their prospective study and reported that the diameter of transverse cerebellar was shorter than normal in all cases and cisterna magna was obliterated.[7] The obliteration (<2 mm) or non-appearance of cisterna magna was associated with neural tube defects and Arnold Chiari Type 2 malformation in many studies.[8-14] While mega cisterna magna (>10 mm) can be with structural (Dandy Walker Malformation, arachnoid cyst) or chromosomal anomalies, it also can exist in normal fetuses in an isolated way.[15-19]

In this study, we aimed to obtain the nomogram of SMG in normal pregnancies in our population and to evaluate its relationship with GW (gestational week), BPD (biparietal diameter) and head circumference (HC).

Methods

1822 pregnants chosen prospectively in between 01.01.2006 and 01.01.2010 were included into our study. Our study was formed of single pregnancies between 15th and 24th gestational weeks. Last menstruation date for pregnancy week, head-back distance at first trimester for those with unknown menstruation date or biparietal diameter measurements at second trimester were based on. Those with structural defect or karyotype anomaly, multiple pregnancies, those who gave stillbirth, those with early membrane rupture and intrauterine growth retardation and with systemic disease were excluded from the study.

Ultrasonographic measurements were performed via Voluson 730 (General Electric, USA) ultrasonography device with a transabdominal approach (2-8 MHz) by a single operator. The measurement of SMG was performed by taking the furthest distance between posterior edge of cerebellar vermis and interior surface of occipital surface on suboccipitobregmatic plan where thalamus, cavum septum pellucidum, cerebellum, cisterna magna and nuchal translucency are seen together. Normal SMG is shown in Figure and expanded SMG is shown in Figure 2. Other biometric measurements (BPD, HC) related with the fetus head were completed.

SPSS 11.0 software was used in statistical analyses. SMG was taken as dependent variable in descriptive statistical analyses and linear regression analyses were performed by matching with GW, BPD and HC. The relationship of dependent and independent variables were evaluated by Pearson correlation test. One-way Onova, Post Hoc-Test (Tukey HSD method) analyses were done. Percentile values of SMG

Figure 1. Normal cisterna magna width.

Figure 2. Abnormal cisterna magna width.

according to weeks in between 15th and 24th gestational weeks were calculated. Results were evaluated at $p<0.05$ significance level within 95% confidence interval.

Results

In our study, age range of pregnants complying with research criteria was 19-45 and their mean age was 30.97±4.32. Examined gestational week range was 15-24 and their mean gestational week was 20.96±2.14.

Mean SMG between 15th and 24th gestational week was 3.41±0.82–6.58±1.24, respectively. SMG was found significantly different according to gestational weeks and there is positive correlation with gestational week. SMG measurements according to gestational week at 95% confidence interval are given in Table 1 and the distribution of SMG percentiles according to gestational week is given in Table 2.

Regression equation by linear regression analysis between SMG and GW is given as SMG = GW x 0.337 – 1.6203 ($r2=0.32$; $p<0.001$) (Diagram 1). Regression equation by linear regression analysis between SMG and BPD is given as SMG = BPD x 0.1043 + 0.2681 ($r2=0.336$; $p<0.001$) Regression equation by linear regression analysis between SMG and HC is given as SMG = HC x 0.0285 + 0.2137 ($r2=0.352$; $p<0.001$) (Diagram 2). It is seen that SMG exhibits correlation mostly with HC.

Table 1. Measurement results of cisterna magna width according to gestational week at 95% confidence interval.

GW	N	Average	Std. Dev.	Std. Error	Minimum	Maximum
15	28	3.41	0.82	0.15	2.2	5.1
16	63	3.78	0.83	0.10	2.4	7.1
17	117	4.06	0.74	0.07	2.4	6.5
18	76	4.49	0.92	0.11	2.9	7.3
19	78	4.92	0.92	0.11	3.2	7.5
20	174	5.10	0.91	0.07	3.1	7.9
21	388	5.44	1.05	0.05	2.5	8.7
22	468	5.81	1.11	0.05	3.2	9.5
23	321	6.07	1.19	0.07	3.6	9.4
24	109	6.58	1.24	0.12	3.8	9.5
Total	1822	5.44	1.28	0.03	2.2	9.5

Table 2. Percentile distribution of cisterna magna width according to pregnancy week.

	Percentiles						
Gestational week	**5**	**10**	**25**	**50**	**75**	**90**	**95**
15	2.25	2.39	2.80	3.25	4.00	4.81	5.01
16	2.70	2.74	3.30	3.60	4.10	4.88	5.36
17	3.08	3.20	3.60	3.90	4.40	5.30	5.50
18	3.20	3.40	3.73	4.40	5.10	5.80	6.15
19	3.40	3.79	4.38	4.80	5.50	6.31	6.62
20	3.68	3.90	4.50	5.00	5.73	6.30	6.80
21	4.00	4.20	4.70	5.40	6.18	6.90	7.20
22	4.10	4.40	5.00	5.70	6.60	7.30	7.66
23	4.30	4.60	5.20	6.00	6.80	7.78	8.20
24	4.70	5.00	5.60	6.40	7.45	8.40	8.80

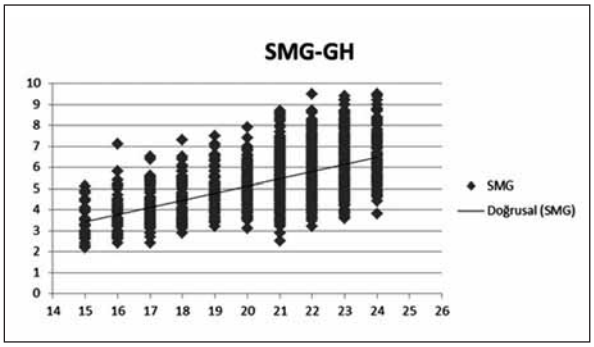

Diagram 1. The distribution of cisterna magna width according to gestational week.

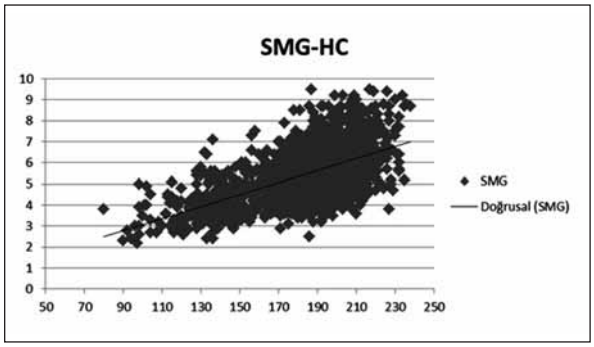

Diagram 2. The distribution of cisterna magna width according to head circumference.

Discussion

It was shown in many studies that the width of cisterna magna increased with gestational week and its normal range was 2-10 mm.[5,11,19-21] Mahony et al. reported SMG in their study as averagely 5±3 mm on 219 pregnants at or after 15th gestational week. They called mega or wide cisterna magna when the width is above 10 mm. Also they reported that isolated wide cisterna magnas are clinically not significant.[5] In our study, we found that SMG increased linearly with gestational week (r2=0.32, P<0.001) and showed significant difference according to gestational week. We found mean SMG as 5.44±1.28 mm.

Haimovici et al. researched prognosis of 15 fetuses of whom isolated wide cisterna magna (11-19 mm) was examined in between 26th and 37th gestational weeks. All of these pregnancies were resulted with normal phenotype newborns and all eight cases which were reached in their long-term (2-69 months) follow-ups were reported as normal.[22] Dror et al. compared 29 fetuses having wide cisterna magna with 35 normal fetuses in terms of their development. When children were evaluated by Gesell Development Schedules and Peabody Developmental Motor Scale, it was reported that study group had a significantly worse performance at Gesell test; however, general performance of both groups was within normal limits. It was reported that walking age was statistically and significantly late in the study group. Consequently, it was emphasized in this study that children with wide cisterna magna

are under risk in terms of slight growth retardation.[23]

Steiger et al. reported that SMG had a better correlation (r2=0.54 P<0.001) during 15th–35th gestational weeks.[18] In our study, we thought that the reason for being weaker of this correlation was gestational weeks we examined which were more limited than those of Steiger et al. Thus, mean cisterna magna widths we found during 15th–24th gestational weeks are similar with the results of the study performed by Steiger et al. (Table 3).

We found in our study that SMG increased with BPD (r2= 0.336) and HC (r2= 0.352) linearly. It was reported in the study of Köktener et al. performed on 194 fetuses between 16th–24th gestational weeks that SMG was in correlation mostly with GW (r2=0.75 P<0.001) and also there was a linear correlation with BPD (r2=0.74 P<0.001).[20] However, this correlation coefficients were very high because of the low number of cases. Also in our study, the correlation of SMG with HC and BPD was found higher than the correlation with gestational week.

No difference was found between the percentile distribution of SMG given in the study of Snijders and Nicolaides[21] with the percentile distribution given in our study (Table 4).

Table 3. The comparison of current study values with the study of Steiger et al.[17]

	Current study		The study of Steiger et al.	
GW	Average	Std. deviation	Average	Std. deviation
15	3.4	0.8	3.3	0.9
16	3.8	0.8	3.7	0.9
17	4.1	0.7	3.8	0.9
18	4.5	0.9	4.6	1.1
19	4.9	0.9	5.1	1.2
20	5.1	0.9	5.5	1.0
21	5.4	1.1	5.5	1.3
22	5.8	1.1	6.2	1.5
23	6.1	1.2	6.4	1.5
24	6.6	1.2	6.2	1.5

Table 4. The comparison of percentile values of current study with the study of Snijdrs et al.[20]

	Percentile values of current study			Percentile values of Snijders and Nicolaides		
GH	5	50	95	5	50	95
15	2.3	3.3	5.0	2.1	3.5	5.3
16	2.7	3.6	5.4	2.4	3.8	5.7
17	3.1	3.9	5.5	2.6	4.1	6
18	3.2	4.4	6.2	2.8	4.3	6.3
19	3.4	4.8	6.6	3.1	4.6	6.6
20	3.7	5.0	6.8	3.3	4.9	7.2
21	4.0	5.4	7.2	3.5	5.1	7.5
22	4.1	5.7	7.7	3.7	5.4	7.7
23	4.3	6.0	8.2	3.9	5.6	8
24	4.7	6.4	8.8	4.1	5.8	8.2

Nicolaides et al. included 70 fetuses into their retrospective study which were established the diagnosis of open spina bifida by ultrasonography during 16th–23rd gestational weeks and they reported that cerebellar hemisphere bent frontward in 12 (57%) of 21 fetuses with suboccipitobregmatic view in cranium and they had also cisterna magna obliteration (banana sign) synchronously.[8] Campbell et al. scanned 436 fetuses who were at high risk in terms of fetal anomaly and 26 of them were established open spina bifida diagnosis, and 16 fetuses (62%) were reported as having banana sign (Chiari II malformation).[9] Goldstein et al. reported in their study that cisterna magna was gone in 18 of 19 case with meningomyelocele of whom posterior fossa could be followed well and one case had very narrowed cisterna magna. Also they were reported that cisterna magna was gone in 5 of 13 cases with isolated Ventriculomegaly of whom posterior fossa could be followed well.[11]

Ghi et al. followed up 57 of 66 fetuses that they diagnoses as spina bifida during 16th–34th gestational weeks and defined 93% of these cases as open defect and 7% of them as closed defect. During mid-gestation, they always found open defect cases with banana sign and lemon sign. However, they detected ventriculomegaly only in 64.2% of cases with open defect. They reported that intracranial anatomy was normal in those with closed defect diagnosed lately.13 Güven et al. found in their study that there was enlarged cisterna magna in 60% of cases (3/5) with Dandy-Walker malformation and in 13% of cases (1/3) with Dandy-Walker variant.[15] It was reported in the study of Filly et al. that brain and spinal cord anomaly risk was 0.005% in fetuses who had normal cisterna magna and lateral ventricle.[10]

Nyberg et al. evaluated 33 fetuses with wide cisterna magna in their study in terms of chromosomal anomaly and found normal karyotype in 15 fetuses and chromosomal anomaly in 18 fetuses. 12 of chromosomal anomalies were reported as Trisomia 18, 3 of them as Trisomia 13, one of them as 45 X0, one of them as 46 XX t(21q) and one of them as 46,XY del(6 q25). Also it was reported that there was an advanced correlation between wide chromosomal anomalies and wide cisterna magnas which were not accompanied by Ventriculomegaly.[17]

Steiger et al. stated in their study that the sensitivity of +2.5 SD value of SMG was low for Trisomia 18.18 It was reported in the study performed by Watson et al. that SMG measurement during 14th–21st gestational weeks was not helpful for scanning chromosomal anomalies.[19]

Conclusion

Consequently, cisterna magna width exhibits a linear increase in between 15th and 24th gestational weeks. This increase is closely associated with BPD and especially HC. Evaluating the width of cisterna magna may enable to establish early diagnosis of defects and anomalies which may exist in posterior fossa and adjacent organs. Gestational week should be considered while performing this evaluation and systematic ultrasonographic examination should be done on fetus if extreme values are detected.

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