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# Nomogram of Fetal Cisterna Magna Width in the Second Trimester of Pregnancy

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**BACKGROUND/AIMS**
We aimed to determine the normal value interval for the Turkish population by measuring the cisterna magna width of fetuses in the 18-24th weeks of gestation and to determine the correlation of cisterna magna width with gestational week, maternal age, maternal body mass index, and fetal parameters.

**MATERIAL and METHODS**
This study included 1,236 healthy fetuses in the 18-24th gestational week of cases aged from 18 to 40 years. The cisterna magna width, biparietal diameter, femur length, and abdominal circumference of the fetuses were measured. Additionally, groups were divided according to the maternal age and body mass index.

**RESULTS**
The cisterna magna width of fetuses from 18 to 24 weeks of gestation was identified to vary from 3.84 ± 0.57 to 5.25 ± 0.83 mm. Additionally, the mean and standard deviation of cisterna magna width and fetal parameters were determined according to the gestational week, maternal age, and maternal body mass index. Later, the correlations of cisterna magna width with pregnancy week, maternal age, maternal body mass index, and fetal parameters were examined. Cisterna magna width was correlated with pregnancy week and fetal parameters ($P < .01$) but was not correlated with maternal age ($P > .01$). Additionally, cisterna magna width and fetal parameters were determined to show negative correlation with maternal body mass index ($P < .01$).

**CONCLUSION**
We believe our data related to the cisterna magna width obtained at the end of the study will be beneficial for the assessment of fetal development and identification of fetal anomalies.

**Keywords:** Cisterna magna, pregnancy, ultrasonography

## INTRODUCTION

The central nervous system developed from neural plates forming by thickening of the ectoderm layer after the 5th week of pregnancy. The cisternae are larger cavities than the subarachnoid structures. The cisternae have more cerebrospinal fluid accumulation than other regions in the central nervous system. The main cisternae are the cisterna magna, pontine, interpeduncular, and chiasmatic. The cisterna magna is the largest of these, and the localization is the internal face of the cerebellum in the posterior fossa between the dorsal section of the medulla oblongata and the roof of the fourth ventricle.[1-4] There is a communication with the fourth ventricle through the foramen Magendie and Luschka.[4]

In the fetal period, assessment of the posterior fossa is important in terms of evaluating the nervous system.[1,4-7] Many different malformations such as the Arnold–Chiari malformation, Dandy–Walker syndrome, mega cisterna magna, arachnoid cyst, and vermis hypogenesis or hypoplasia may occur.[1-8] As the cerebellar vermis has not fully developed in the

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**TABLE I.** Mean and Standard Deviation (mm) of Cisterna Magna width and Fetal Parameters According to Week of Pregnancy

| Gestational weeks | N | Cisterna magna width | BPD | FL | AC |
|---|---|---|---|---|---|
| 18 | 112 | 3.84 ± 0.57 | 43.30 ± 4.81 | 27.98 ± 4.17 | 142.03 ± 18.28 |
| 19 | 117 | 4.06 ± 0.73 | 46.34 ± 3.76 | 32.28 ± 3.52 | 153.81 ± 13.27 |
| 20 | 118 | 4.45 ± 0.75 | 47.61 ± 3.18 | 33.61 ± 2.44 | 156.02 ± 10.14 |
| 21 | 436 | 4.70 ± 0.85 | 50.22 ± 2.93 | 35.64 ± 2.34 | 164.50 ± 10.36 |
| 22 | 241 | 4.96 ± 0.82 | 52.83 ± 2.75 | 37.77 ± 2.30 | 173.45 ± 10.44 |
| 23 | 104 | 5.00 ± 0.80 | 55.60 ± 2.97 | 40.43 ± 2.34 | 183.12 ± 10.73 |
| 24 | 108 | 5.25 ± 0.83 | 58.90 ± 3.91 | 43.87 ± 2.77 | 200.24 ± 33.21 |
| Total | 1236 | 4.66 ± 0.89 | 50.69 ± 5.24 | 35.97 ± 4.77 | 167.08 ± 20.83 |

$P < .05$: difference between weeks for all parameters (apart from cisterna magna width parameter between weeks 18-19, 22-23 and 23-24 and AC parameter between weeks 19-20).

second trimester, observation of this region in the early weeks may lead to mistaken assessments. As a result, full assessment of the cisterna magna and posterior fossa should not be performed before the 18th week of gestation.[2]

Normal cisterna magna width is stated to be between 2 and 10 mm.[1,2,9] In situations where the cisterna magna is smaller than 2 mm or is not observed, it may mean malformations like neural tube defects, and Arnold–Chiari 2 are observed.[2,8,10] In situations of mega cisterna magna where the cisterna magna width is larger than 10 mm, it is stated that structural and chromosomal anomalies like arachnoid cyst and Dandy–Walker malformations may be seen.[2,5,8,9,11,12] As a result, anterior–posterior length measurement of the fetal cisterna magna performed in the second trimester of pregnancy is an important parameter in terms of identifying abnormalities of the posterior fossa.[1]

There are radiologic studies performed related to the fetal cisterna magna morphometry during the pregnancy.[1-13] These studies have taken morphometric measurements like cisterna magna length, width, and anterior–posterior diameter, and developmentally assessed the cisterna magna and neighboring structures belonging to the nervous system.[1-13]

Different to other studies, we aimed to determine the normal value interval for the Turkish population by measuring the cisterna magna width of fetuses from 18 to 24 weeks of gestation and to determine the correlation of the cisterna magna width with gestational week, maternal age, maternal body mass index, and the fetal parameters of biparietal diameter (BPD), femur length (FL), and abdominal circumference (AC).

## MATERIAL and METHODS

This study was completed retrospectively using screening files recorded in Radiology Clinic from January 1, 2017 to December 31, 2017. This study included 1,236 healthy fetuses from 18 to 24 weeks of gestation of pregnant cases aged from 18 to 40 years (mean: 28.70 ± 5.26). Pregnant cases with any chronic or systemic disease and fetuses with chromosome anomalies or developmental retardation were not included in the study. An informed oral consent was obtained from all participants. Permission to conduct this study was granted from the ethics committee of the Ankara Yıldırım Beyazıt University Faculty of Medicine (date: December 19, 2018, protocol no: 280).

Later, the cisterna magna width, BPD, FL, and AC parameters of the fetuses were recorded. Additionally, pregnant cases were divided into five groups according to the age, 20 years or younger (n: 60), 21-25 years (n: 327), 26-30 years (n: 409), 31-35 years (n: 304), and older than 35 years (n: 136), and body mass index, 20 or less (n: 475), 20-24.99 (n: 406), 25-29.99 (n: 234), 30-34.99 (n: 57), and 35 or higher (n: 10).

### Statistical Analysis

Using the Statistical Package for the Social Sciences (SPSS) version 17.0 (SPSS Inc.; Chicago, IL, USA) statistical program, mean and standard deviation of parameters according to the gestational age and groups were determined. Statistical comparisons within and between the groups used the t test. The correlations between parameters and gestational age and groups were determined using the Pearson correlation test. For statistical analyses, the significance level was taken as $P < .05$. $P$ values obtained are given in the results section and under the relevant tables.

## RESULTS

In this study, the mean age of pregnant cases was 28.70 ± 5.26 (18-40) years. Later, cisterna magna width and fetal parameters had mean and standard deviations determined according to the gestational week, maternal age, and maternal body mass index groups (Tables 1-3). Comparison of cisterna magna width with fetal parameters (apart from cisterna magna width parameter between the weeks 18 and 19, 22 and 23, and 23 and 24, and AC parameter between weeks 19 and 20) according to the gestational week observed differences between the weeks ($P < .05$; Table 1). Comparison of maternal age with maternal body mass index (apart from BPD and FL parameters in groups 1 and 3) did not observe differences between the groups ($P > .05$; Tables 2 and 3). Additionally, the correlations between cisterna magna width and pregnancy week, fetal parameters, maternal age, and maternal body mass index were examined. Cisterna magna width was correlated with pregnancy week and fetal parameters ($P < .01$, Table 4 and Figure 1) but not correlated with maternal age ($P > .01$, Table 4 and Figure 2). Additionally, there were negative correlations determined between cisterna magna width and fetal parameters with maternal body mass index ($P < .01$, Table 4 and Figure 3).

## DISCUSSION

In the fetal period, assessment of the posterior fossa is important in terms of evaluating the nervous system.[1,4-7] Because various malformations occur in this region, these malformations have variable prognosis. As a result, definite diagnosis and the determination of the localization of these malformations are

**TABLE 2.** Mean and Standard Deviation (mm) for Cisterna Magna Width and Fetal Parameters According to Maternal Age Groups

| Maternal age | N | Cisterna magna width | BPD | FL | AC |
|---|---|---|---|---|---|
| Group 1 (≤20 years) | 60 | 4.56±0.82 | 50.20±5.17 | 35.53±4.81 | 165.61±18.95 |
| Group 2 (21-25 years) | 327 | 4.68±0.86 | 50.60±5.42 | 35.81±4.66 | 166.93±19.95 |
| Group 3 (26-30 years) | 409 | 4.68±0.93 | 50.62±5.25 | 35.90±4.95 | 167.01±18.49 |
| Group 4 (31-35 years) | 304 | 4.67±0.85 | 50.79±5.19 | 36.06±4.84 | 167.28±24.33 |
| Group 5 (>35 years) | 136 | 4.65±0.89 | 51.02±5.03 | 36.41±4.40 | 167.83±16.11 |
| Total | 1236 | 4.66±0.89 | 50.69±5.24 | 35.97±4.77 | 167.08±20.83 |

*P* > .05: no difference between groups for all parameters.

**TABLE 3.** Mean and Standard Deviation (mm) for Cisterna Magna Width and Fetal Parameters According to Maternal Body Mass Index Groups

| Maternal BMI | N | Cisterna magna width | BPD | FL | AC |
|---|---|---|---|---|---|
| Group 1 (< 20) | 475 | 4.70±0.89 | 51.06±4.63 | 36.43±4.12 | 168.40±17.13 |
| Group 2 (between 20-24,99) | 460 | 4.68±0.90 | 50.84±5.46 | 36.14±5.55 | 166.87±19.00 |
| Group 3 (between 25-29,99) | 234 | 4.66±0.87 | 50.49±6.41 | 35.91±4.94 | 165.96±22.17 |
| Group 4 (between 30-34,99) | 57 | 4.60±0.91 | 49.82±5.46 | 35.21±5.24 | 165.45±28.92 |
| Group 5 (≥35) | 10 | 4.19±1.04 | 48.60±7.66 | 33.80±7.06 | 158.30±26.16 |
| Total | 1236 | 4.66±0.89 | 50.69±5.24 | 35.97±4.77 | 167.08±29.83 |

*P* > .05: no difference between groups for all parameters (apart from BPD and FL parameters in group 1 and group 3).

**TABLE 4.** Correlation between Cisterna Magna Width and Other Parameters

| | Age | BMI | Week | BPD | FL | AC | Cisterna magna width |
|---|---|---|---|---|---|---|---|
| Age | 1 | | | | | | |
| BMI | 0.116** | 1 | | | | | |
| Week | 0.014 | −0.073* | 1 | | | | |
| BPD | 0.021 | −0.079** | 0.771** | 1 | | | |
| FL | 0.033 | −0.083** | 0.814** | 0.876** | 1 | | |
| AC | 0.018 | −0.060 | 0.685** | 0.805** | 0.798** | 1 | |
| Cisterna magna width | 0.003 | −0.046 | 0.435** | 0.484** | 0.487** | 0.416** | 1 |

*$P < .05$.
**$P < .01$.

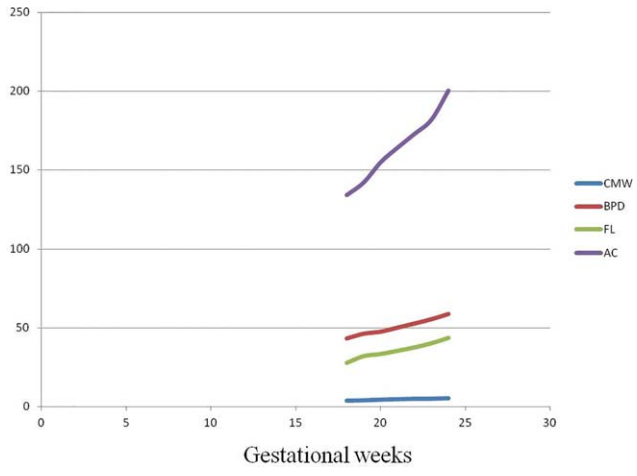


**FIGURE 1.** Correlation between cisterna magna width (CMW) and fetal parameters in gestational weeks

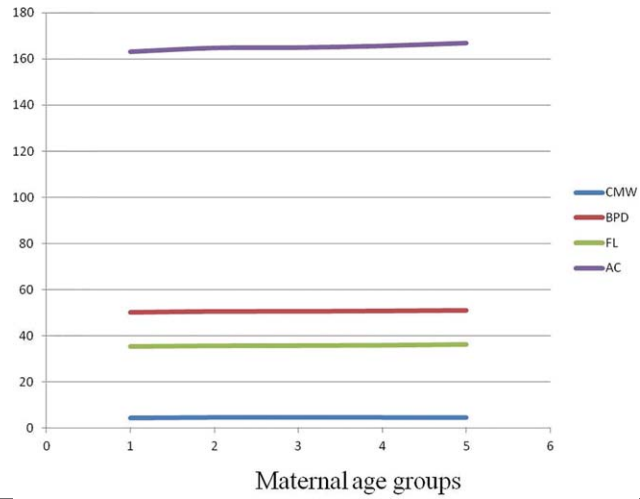


**FIGURE 2.** Correlation between cisterna magna width (CMW) and fetal parameters in maternal age groups

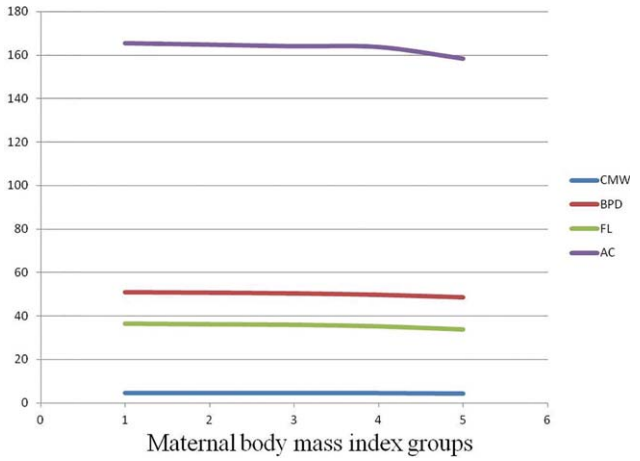


**FIGURE 3.** Correlation between cisterna magna width (CMW) and fetal parameters in maternal body mass index groups

necessary in terms of monitoring the development of the fetus.[1,4-8]

In our study, first, the mean and standard deviation according to the gestational week were determined for the cisterna magna width of 1,236 fetuses from the 18 to 24th week of gestation. As a result of the study, we identified the mean cisterna magna width was 4.66 ± 0.89 mm (varying from 3.84 ± 0.57 to 5.25 ± 0.83 mm) (Table 1). When we examine previous studies, Araujo Júnior et al.[1] in a study of 3,862 fetuses from 18 to 24 weeks stated the mean cisterna magna width was 4.29 ± 0.93 mm (varying from 2.60 to 7.00 mm). Arısoy and Yayla[2] studied 1,822 fetuses from 15 to 24 weeks of gestation and stated the mean cisterna magna width was 5.44 ± 1.28 mm (varying from 3.41 to 6.58 mm). Koktener et al.[7] stated the mean cisterna magna width was 3.84 ± 0.89 mm (varying from 2.88 to 5.90 mm) in a study of 194 fetuses from 16 to 24 weeks of gestation. A study of 160 fetuses from 16 to 38 weeks of gestation by Serhatlioglu et al.[8] determined the mean cisterna magna width was 4.8 ± 1.4 mm in the second trimester and 6.5 ± 1.4 mm in the third trimester. Tao et al.[9] in a study of 337 fetuses from 22 to 38 weeks of gestation stated the mean cisterna magna width was 8.01 ± 1.79 mm (varying from 5 to 14 mm). As in the results of other studies, in our study, we identified the cisterna magna width increased during the weeks of gestation. We interpret this result as showing that the cisterna magna width continues to develop through the gestational weeks and development continues after birth to complete in later periods. In our study, we observed some differences in cisterna magna width values we measured through the pregnancy weeks, compared to the cisterna magna width values obtained in other studies. However, when we compare our study data with other study results from the 18 to 24-week period, we did not determine a significant difference ($P > .05$). We interpreted the difference between cisterna magna width values in the studies as due to different gestational weeks, populations and case numbers, cases not focused on defined weeks, due to the person measuring, or device used for measurements.

Additionally, we determined the mean and standard deviation of cisterna magna width according to the maternal age and maternal body mass index. We did not encounter this parameter in other studies related to the cisterna magna width. The results of the study determined that the cisterna magna width increased until the age of 30 and decreased after the age of 30 (Table 2 and Figure 2), and that as the body mass index increased, the cisterna magna width decreased (Table 3 and Figure 3). Additionally, comparing the cisterna magna width between maternal age and maternal body mass index groups, we did not identify a statistical difference ($P > .05$, Tables 2 and 3). We interpreted this result as showing that the cisterna magna development is positively affected until maternal age 30 and is negatively affected after the age of 30, while maternal body mass index negatively affected the fetal cisterna magna development.

Later in our study, we determined the mean and standard deviation of fetal parameters like BPD, FL, and AC according to the gestational week, maternal age, and maternal body mass index (Tables 1-3). Fetal parameters increased during the gestational weeks, and comparing the weeks, we determined differences between the weeks (apart from the AC parameter for 19th and 20th weeks) ($P < .05$, Table 1 and Figure 1). We identified a very low amount of increase in the maternal age groups, with no difference when groups were compared ($P > .05$, Table 2 and Figure 2). For maternal body mass index groups, there was a reduction in fetal parameters, but we observed no significant difference when groups were compared (apart from BPD and FL parameters between groups 1 and 3) ($P > .05$, Table 3 and Figure 3). We interpret the data obtained as a result of our study as that pregnancy week and maternal age positively affect fetal parameters, while maternal body mass index negatively affects them.

When we examine previous studies, the correlation between cisterna magna width and BPD and HC was examined.[2,7] Different to other studies, our study added FL and AC to BPD and examined the correlation with cisterna magna width. Other study results stated there were correlations between cisterna magna width and BPD and HC.[2,7,8] We observed a positive correlation between cisterna magna width and BPD, FL, and AC in the results of our study (Table 4). Arısoy and Yayla[2] stated the BPD and HC were better correlated with cisterna magna width than gestational week. Koktener et al.[7] stated that BPD and gestational week were correlated with cisterna magna width to the same degree. In our study, we determined that BPD and FL were better correlated with cisterna magna width compared to gestational week and AC. We interpret this result as showing that fetal parameters and cisterna magna width increase in correlated fashion during the fetal development process.

Cisterna magna width shows a linear increase from the 16 to 24th weeks of pregnancy. This increase is closely associated with BPD, HC, AC, and FL. Assessment of the cisterna magna width in the fetal development period is important in terms of early diagnosis of anomalies and defects in the posterior fossa and neighboring organs. When evaluating the cisterna magna width, the gestational week should be noted, and in situations with excessive values related to the cisterna magna width obtained, systemic examination should be performed to assess fetal development. Additionally, cisterna magna length of 10 mm is used as a standard marker of posterior fossa fetal anomalies.[3,5,12] If the cisterna magna is small or absent, it

indicates that malformations such as spina bifida and Arnold Chiari 2 may be observed in the fetus.[2,10] In situations where the cisterna magna is wide (≥10 mm), it indicates that anomalies such as trisomy 18, Dandy–Walker syndrome, cyst in the fourth ventricle, lack of cerebellar vermis, and hydrocephalus may be observed.[2,5,7] As a result, it is necessary to routinely examine the posterior fossa and cerebellum structure in terms of fetal development.

There are some limiting aspects to our study; our study is a retrospective study of 1,236 fetuses. Additionally, as our study involved fetuses with normal development, no comparison was made in relation to fetuses with chromosomal anomalies and development retardation.

The results of studies emphasize that cisterna magna width is important in terms of assessing the posterior fossa, cerebellum, nervous system, and fetal anomalies.[1-13] In conclusion, we believe cisterna magna width is an important parameter that should be examined with routine measurements in terms of assessing fetal development. Additionally, we think multicenter studies are required to assess more fetuses and to compare ethnic groups and normal fetuses with anomalous fetuses to provide more reliable and accurate results.

**Ethics Committee Approval:** Ethical committee approval was received from the Ankara Yıldırım Beyazıt University Faculty of Medicine (date: December 19, 2018, protocol no: 280).

**Informed Consent:** Verbal informed consent was obtained from all participants who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept - R.D., A.F.Y.; Design - R.D.; Supervision - K.D., M.G.; Resources - R.D., A.F.Y.; Materials - A.I.; Data Collection and/or Processing - A.I., M.G.; Analysis and/or Interpretation - R.D., K.D.; Literature Search - K.D.; Writing Manuscript - R.D., A.F.Y.; Critical Review - A.I., M.G.

**Conflict of Interest**: The authors have no conflicts of interest to declare.

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