

Transabdominal sonography of the cavum septum pellucidum in normal fetuses in the second and third trimesters of pregnancy

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KEYWORDS: Ultrasound, Fetus, Congenital anomalies, Septum pellucidum, Agenesis of corpus callosum

ABSTRACT

Objectives To assess the visualization rate and size of the cavum septum pellucidum (CSP) by transabdominal sonography in normal fetuses throughout pregnancy.

Methods The CSP was prospectively researched and measured using an axial transventricular plane in 286 consecutive uncomplicated singleton pregnancies between 15 and 41 weeks of gestation.

Results The CSP was seen in 40% of cases at 15 weeks, 82% at 16–17 weeks, 100% at 18–37 weeks and 79% at 38–41 weeks. Compared to biparietal diameter (BPD), the visualization rate was 33% between 31 and 32 mm, 45% between 33 and 34 mm, 84% between 35 and 43 mm, 100% between 44 and 88 mm and 86% between 89 and 99 mm. Mean CSP width was 5.3 ± 1.7 mm (range 2–9 mm). The CSP width increased with gestational age and BPD but with a slight decrease around term.

Conclusions In normal fetuses the CSP should always be visualized between 18 and 37 weeks, or with a BPD of 44–88 mm. Failure to observe the CSP in this interval, or possibly the presence of a large CSP, may indicate abnormal cerebral development and warrant further investigation. Conversely, absence of the CSP prior to 18 weeks, or later than 37 weeks, is a normal finding.

INTRODUCTION

The cavum septum pellucidum (CSP) is a fluid-filled cavity situated between the membranes which form the septum pellucidum (Figure 1). It is commonly demonstrated with ultrasound in the second- and third-trimester fetus in most premature infants and in about 50% of full-term infants^{1–3}. Failure to demonstrate the CSP with antenatal ultrasound is typical of many cerebral anomalies including

agenesis of the corpus callosum⁴, holoprosencephaly^{5,6}, septo-optic dysplasia⁷ and schizencephaly⁸. Enlargement of the fetal CSP has also been reported in association with anatomic and chromosomal anomalies⁹.

The aim of our study was to assess the visualization rate and size of the CSP by transabdominal sonography in normal fetuses throughout gestation.

PATIENTS AND METHODS

The fetal CSP was prospectively identified and measured in 286 consecutive uncomplicated singleton pregnancies between 15 and 41 weeks of gestation, using a 3.5–5 MHz transabdominal probe (Esaote Au4, Genoa, Italy). Gestational age was confirmed in all cases either by optimal menstrual history and/or an ultrasound scan

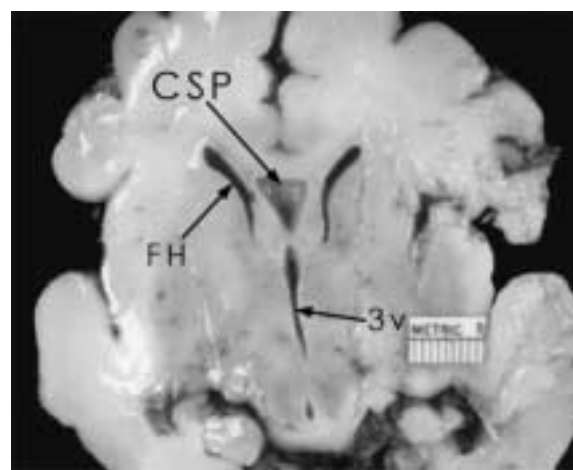


Figure 1 Coronal section of the brain of a 35-week fetus demonstrating a patent cavum septum pellucidum (CSP). FH, frontal horn; 3v, third ventricle.

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Received 21-3-00, Revised 22-6-00, Accepted 11-7-00

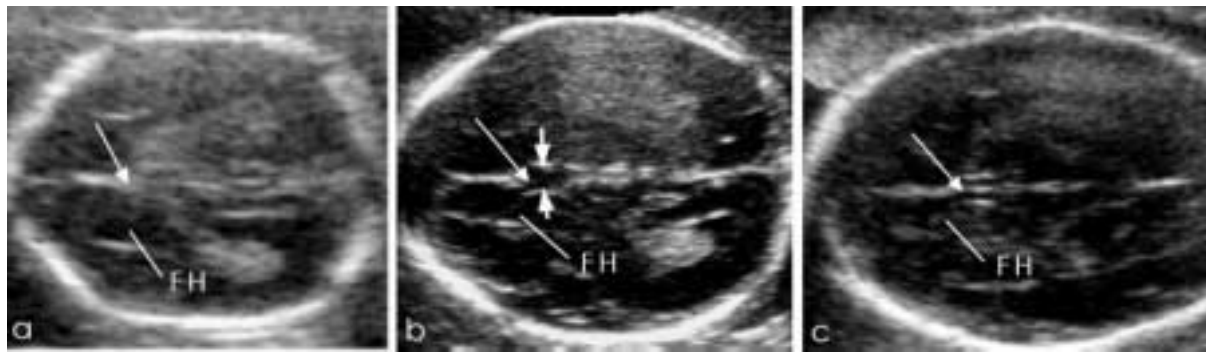


Figure 2 Axial sections of the fetal brain obtained with transabdominal sonography at (a) 16 weeks, (b) 22 weeks and (c) 38 weeks. The cavum septum pellucidum (arrow) is well visualized in (b) (arrow heads), while it is not seen in either (a) or (c). FH, frontal horn.

performed in the first trimester. The CSP was identified on an axial transventricular plane (Figure 2) and its antero-posterior diameter measured by placing the intersection of the caliper markers on the inner borders of its proximal and distal boundary, respectively ('inner-to-inner'). Because the CSP is triangular in shape in the coronal plane (Figure 1), the axial scanning plane demonstrating the maximal width was chosen for the measurement. A polynomial regression model was used to assess the relationship between CSP width and gestational age, and between CSP and biparietal diameter (BPD). A separate regression model was fitted to estimate the relationship between the SDs of residuals with the independent variable¹⁰. No follow-up was obtained from these pregnancies.

RESULTS

Visualization and measurement of the CSP were possible in the majority of cases without significantly modifying the standard time required for the anatomic evaluation of the fetal intracranial anatomy. The CSP was identified in 251 cases (88%). The visualization rate was 40% (15/37 cases) at 15 weeks, 82% (33/40 cases) at 16–17 weeks, 100% (181/181 cases) at 18–37 weeks and 79% (22/28 cases) at

38–41 weeks (Figure 3). When compared to the BPD, the visualization rate was 33% (5/15 cases) between 31 and 32 mm, 45% (10/22 cases) between 33 and 34 mm, 84% (36/43 cases) between 35 and 43 mm, 100% (162/162 cases) between 44 and 88 mm and 86% (38/44 cases) between 89 and 99 mm (Figure 4). We postulate that in late gestation reabsorption of the fluid within the CSP reduces its size so that its now closely opposed borders cannot be distinguished from the interhemispheric midline echo. The mean width of the CSP was 5.3 ± 1.7 mm (range 2–9 mm). A second-degree polynomial equation was found to adequately describe the data. The CSP width was found to increase with gestational age and BPD, with a slight decrease around term (Figures 5 and 6, Tables 1 and 2). The equation describing the relationship between CSP width and gestational age is:

$$\begin{aligned} \text{CSP width (mm)} = & -5.51374 + 0.70287 \times \text{weeks} \\ & - 0.01008 \times \text{weeks}^2 \\ (R^2 = 0.63), \end{aligned}$$

$$\text{SD} = -0.1493 + 0.040849 \times \text{weeks} (R = 0.77).$$

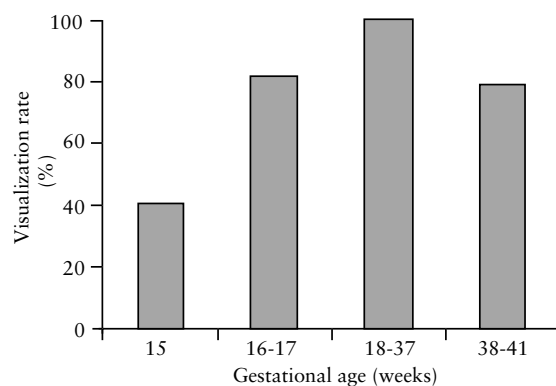


Figure 3 Visualization rate of the cavum septum pellucidum from 15 to 41 weeks of gestation.

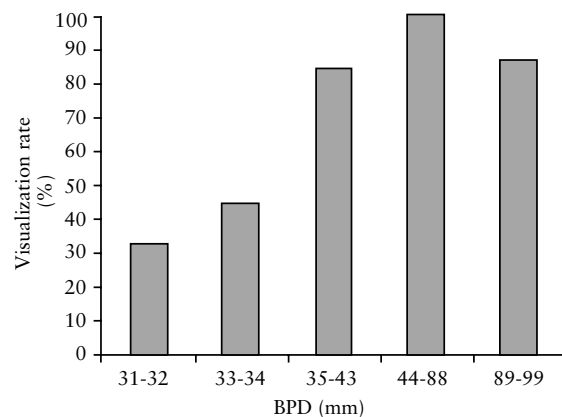


Figure 4 Visualization rate of the cavum septum pellucidum according to biparietal diameter (BPD) values.

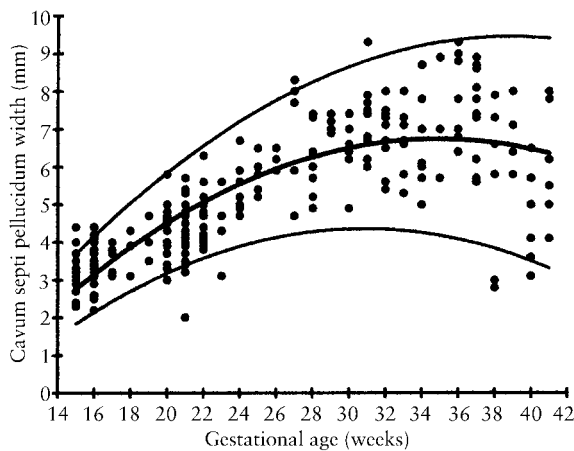


Figure 5 Relationship between cavum septum pellucidum width (mm) and gestational age (weeks) ± 2 SD.

The equation describing the relationship between CSP width and BPD is:

$$\begin{aligned} \text{CSP width (mm)} = & -1.46748 + 0.15781 \times \text{BPD (mm)} \\ & - 0.00073 \times \text{BPD}^2 \text{ (mm)} \\ & (R^2 = 0.62), \end{aligned}$$

$$\text{SD} = -0.04906 + 0.015565 \times \text{BPD (mm)} (r = 0.70).$$

DISCUSSION

The CSP is a fluid-filled cavity situated between the membranes which form the septum pellucidum (Figure 1). It is bounded superiorly and anteriorly by the corpus callosum and inferiorly by the fornix. Rakic and Yakovlev have suggested that it is formed as the result of cavitation of the inferior aspect of the commissural plate, presumably at around 17 weeks of gestation¹¹. In a minority of cases, the CSP may extend caudally, forming a pouch in close

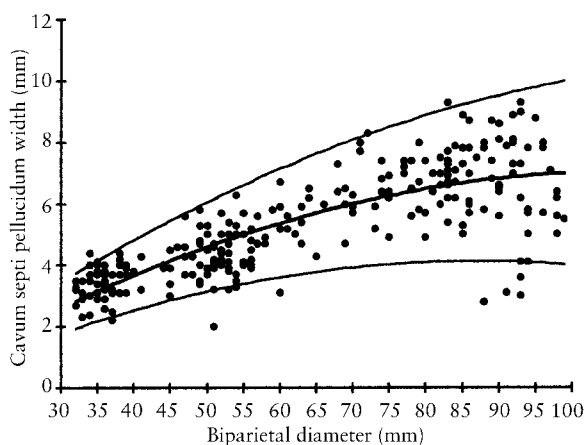


Figure 6 Relationship between cavum septum pellucidum width (mm) and biparietal diameter (mm) ± 2 SD.

proximity with the distal corpus callosum. This normal variant is commonly referred to as the cavum vergae. The universal presence of the CSP during fetal life is well established. However, the cavity undergoes progressive reabsorption around term gestation or soon after birth, to become a virtual space during adult life.

In a previous study of fetuses between 19 and 42 weeks of gestation, the CSP was identified in all cases with the exception of one fetus at 38 weeks of gestation. The CSP width was found to increase with gestational age from 19 to 27 weeks, and to plateau between 28 weeks and term. Its diameter varied from 2 to 10 mm¹².

Our study indicates that the CSP is frequently impossible to visualize prior to 18 weeks of gestation, or with a BPD of less than 44 mm, if using transabdominal sonography. Between 18 and 37 weeks, or with a BPD between 44 and 88 mm the CSP is always seen, after which it disappears in about 30% of cases. Our observations correlate well with postnatal neurosonographic studies that suggest that the CSP is seen in most premature infants and only in about 50% of term neonates^{1,2}. We confirm that the CSP width increases with gestational age, with a slight decrease close to term.

In pediatric diagnostic imaging studies, the absence of the CSP is documented with many cerebral anomalies, including agenesis of the corpus callosum, holoprosencephaly, septo-optic dysplasia and schizencephaly¹³. Similarly, failure to visualize the CSP sonographically during fetal life has been described in association with the same group of anomalies⁴⁻⁸. Filly and colleagues¹⁴ have suggested that the sonographic visualization of the lateral ventricles and cisterna magna is adequate to diagnose most fetal central nervous system anomalies. In their study, failure to observe the CSP did not enhance sensitivity over and above the observations of the ventricular atrium and the cisterna magna. However, the selection of cases in this specific series probably favored the inclusion of cases with ventriculomegaly or neural tube defects. The number of midline anomalies in the study group was relatively small. We have previously reported that failure to visualize the CSP when using standard axial views of the brain may be the only sign of complete agenesis of the corpus callosum, one of the most frequent cerebral malformations⁴. Bennet and colleagues¹⁵ later reported failure to diagnose agenesis of the corpus callosum between 16 and 22 weeks in all the 10 cases examined using a protocol of investigation that did not include visualization of the CSP. In all these 10 cases, the atrium of lateral ventricle together with the cisterna magna were normal at mid-gestation.

Our experience suggests that the CSP should always be seen at gestations between 18 and 37 weeks, or with a BPD greater than 43 mm. Failure to visualize the CSP should alert the sonologist to possible agenesis of the corpus callosum, which would be easily demonstrated by multiplanar neurosonography. Bronshtein and Weiner⁹ have suggested a possible association between an enlarged (> 5 mm) CSP and other malformations and chromosomal aberrations. Conversely, in a later study, all fetuses with a

Table 1 Mean values and ± 2 SD of the cavum septum pellucidum width (mm) from 15 to 41 weeks of gestation

Gestational age (weeks)	- 2 SD	Mean	+ 2 SD
15	1.8	2.8	3.7
16	2.1	3.2	4.2
17	2.4	3.5	4.6
18	2.7	3.9	5.0
19	2.9	4.2	5.5
20	3.2	4.5	5.8
21	3.4	4.8	6.2
22	3.6	5.1	6.6
23	3.7	5.3	6.9
24	3.9	5.5	7.2
25	4.0	5.8	7.5
26	4.1	5.9	7.8
27	4.2	6.1	8.0
28	4.3	6.3	8.3
29	4.3	6.4	8.5
30	4.3	6.5	8.7
31	4.4	6.6	8.8
32	4.3	6.7	9.0
33	4.3	6.7	9.1
34	4.3	6.7	9.2
35	4.2	6.7	9.3
36	4.1	6.7	9.4
37	4.0	6.7	9.4
38	3.8	6.6	9.4
39	3.7	6.6	9.5
40	3.5	6.5	9.4
41	3.3	6.4	9.4

large CSP were found to be normal¹⁶. Further studies in this area are therefore warranted.

High frequency vaginal probes allow a much greater resolution of fetal anatomy than abdominal probes¹⁷. Using vaginal sonography, it should be possible to increase the visualization rate of the CSP in early gestation, at least in vertex fetuses. As the majority of second and third trimester sonographic examinations of the fetus are performed transabdominally, the aim of our study was to evaluate the capability of this standard technique to recognize the CSP. Vaginal sonography is certainly the technique of choice for the evaluation of difficult cases or those in which an abnormal CSP is suspected.

In conclusion, our experience indicates that, in normal fetuses, the CSP should always be visualized by standard transabdominal ultrasound between 18 and 37 weeks, or with a BPD of 44–88 mm. Failure to demonstrate the CSP within these parameters, or possibly the demonstration of a large CSP, suggests the likelihood of a fetal anomaly and the need for further investigation.

ACKNOWLEDGMENTS

Presented at the Eighth World Congress of ISUOG, Edinburgh, 1–5 November 1998, abstract #124. This investigation was supported by the University of Bologna (funds for selected research topics).

Table 2 Mean values and ± 2 SD of the cavum septum pellucidum width (mm) according to biparietal diameter (BPD)

BPD (mm)	- 2 SD	Mean	+ 2 SD
32	1.9	2.8	3.7
33	2.0	2.9	3.9
34	2.1	3.1	4.0
35	2.2	3.2	4.2
36	2.2	3.3	4.3
37	2.3	3.4	4.4
38	2.4	3.5	4.6
39	2.5	3.6	4.7
40	2.5	3.7	4.8
41	2.6	3.8	5.0
42	2.7	3.9	5.1
43	2.7	4.0	5.2
44	2.8	4.1	5.3
45	2.9	4.2	5.5
46	2.9	4.2	5.6
47	3.0	4.3	5.7
48	3.0	4.4	5.8
49	3.1	4.5	5.9
50	3.1	4.6	6.1
51	3.2	4.7	6.2
52	3.2	4.8	6.3
53	3.3	4.8	6.4
54	3.3	4.9	6.5
55	3.4	5.0	6.6
56	3.4	5.1	6.7
57	3.5	5.2	6.8
58	3.5	5.2	6.9
59	3.6	5.3	7.0
60	3.6	5.4	7.1
61	3.6	5.4	7.2
62	3.7	5.5	7.3
63	3.7	5.6	7.4
64	3.7	5.6	7.5
65	3.8	5.7	7.6
66	3.8	5.8	7.7
67	3.8	5.8	7.8
68	3.9	5.9	7.9
69	3.9	5.9	8.0
70	3.9	6.0	8.1
71	3.9	6.1	8.2
72	4.0	6.1	8.3
73	4.0	6.2	8.3
74	4.0	6.2	8.4
75	4.0	6.3	8.5
76	4.0	6.3	8.6
77	4.1	6.4	8.7
78	4.1	6.4	8.7
79	4.1	6.4	8.8
80	4.1	6.5	8.9
81	4.1	6.5	8.9
82	4.1	6.6	9.0
83	4.1	6.6	9.1
84	4.1	6.6	9.2
85	4.1	6.7	9.2
86	4.1	6.7	9.3
87	4.1	6.7	9.3
88	4.1	6.8	9.4
89	4.1	6.8	9.5
90	4.1	6.8	9.5
91	4.1	6.8	9.6
92	4.1	6.9	9.6
93	4.1	6.9	9.7
94	4.1	6.9	9.7
95	4.1	6.9	9.8
96	4.1	7.0	9.8
97	4.1	7.0	9.9
98	4.0	7.0	9.9
99	4.0	7.0	10.0

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