The Fetal Gallbladder

A Study of Sonographic Visualization Rate and Dimensions in the Second and Third Trimesters

KAREN HAVING, MS Ed, RT, RDMS

LYNN FLAMM, BS, RT, RDMS

DEANNA MCAULIFFE, BS, RT, RDMS

In a study of 113 routine transabdominal fetal OB exams with estimated gestational age ranging from 14 to 38 weeks, the fetal gallbladder was identified in 93.8% of the examinations. Fetal gallbladder size, shape, and pathologies associated with nonvisualization are discussed.

Key words: ultrasound, fetal survey, gallbladder

A second trimester OB patient was recently referred for a targeted fetal ultrasound evaluation for possible fetal cystic abdominal mass, which was determined to be a normal-appearing gallbladder. This occurrence prompted the authors to conduct a study of the fetal gallbladder on patients presenting for a routine fetal screening exam. The purpose of this study was to answer the following questions:

1. What was the percentage of gallbladders sonographically visualized in the population of fetuses scanned?
2. What was the gestational age of those fetuses whose gallbladders were sonographically visualized?
3. What was the gallbladder length and width, according to fetal age?
4. Were there any abnormal findings in the visualized fetal gallbladders?

Materials and Methods

The study involved women referred to an outpatient obstetrical practice for a routine fetal anatomic survey sonogram during their second or third trimester of pregnancy. Permission was obtained by the researcher's University Human Subjects Committee to obtain and collect data on the fetal gallbladder. Consent was obtained from all women who participated in the study. Data were collected from 24 July 2001 to 28 August 2001. There were 117 participants ranging from 14 to 39 weeks gestational age (GA). Gestational age was determined by initial dating ultrasound measurements. The

From Southern Illinois University, Carbondale, Illinois. Correspondence: Karen Having, MS Ed, RT, RDMS, College of Applied Sciences and Arts, Mailcode 6615, Southern Illinois University, Carbondale, IL 62901. E-mail: khaving@siu.edu.

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FIG. 1. Sonogram of a teardrop-shaped fetal gallbladder in the transverse view of the fetal abdomen. GB = gallbladder; SP = spine; UV = umbilical vein.

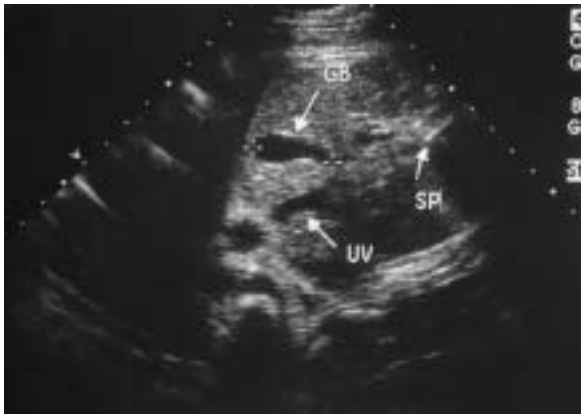

FIG. 2. Sonogram of a teardrop-shaped fetal gallbladder demonstrating the transverse view of the fetal abdomen. Calipers are placed on gallbladder walls indicating maximum length. GB = gallbladder; SP = spine; UV = umbilical vein.

FIG. 3. Sonogram demonstrating fetal gallbladder width. This image is obtained by rotating the transducer 90 degrees from plane demonstrating the maximum gallbladder length. Calipers are placed on gallbladder walls indicating maximum width. GB = gallbladder.

scans were performed using Ultramark 9 and HDI 3000 ATL machines (Bothell, WA) with curved 5 MHz transducers. The fetal gallbladder was located by scanning the fetal abdomen in transverse orientation. Upon identifying the site of umbilical cord insertion, the sonographer followed the course of the umbilical vein in a cranial direction to obtain an abdominal circumference measurement. After obtaining the abdominal circumference measurement, the sonographer angled the transducer in a caudal direction until the cord insertion site was viewed. The fetal gallbladder was then identified to the right of the umbilical vein (Fig. 1). Upon identification of the fetal gallbladder, the scan plane was adjusted to document the greatest length of the gallbladder (Fig. 2). The transducer was then rotated 90 degrees and the greatest width was documented (Fig. 3). This information was recorded on each exam, along with the shape of the gallbladder. Gallbladder shapes were classified as teardrop, oval, round, or disc-like.

Results

Of the 117 exams, 4 revealed abnormal maternal/fetal findings (duodenal atresia, 2 vessel cord, gestational diabetes, and preeclampsia with oligohydramnios). The gallbladder was identified in each of the abnormal maternal/fetal exams with exception of the duodenal atresia finding.

Because the purpose of the study was to describe fetal gallbladder visualization in the routine scan, these 4 exams were excluded from the study. Data from the remaining 113 exams were stored on computer utilizing the Microsoft Excel spreadsheet. There were no fetal gallbladder abnormalities found in the observed population. Consequently, there were no data regarding contributing maternal factors available for consideration.

Ratio of Fetal Gallbladders Observed

Of the 113 participants included in the study (GA 14-38 weeks), 106 (93.8%) fetal gallbladders were visualized.

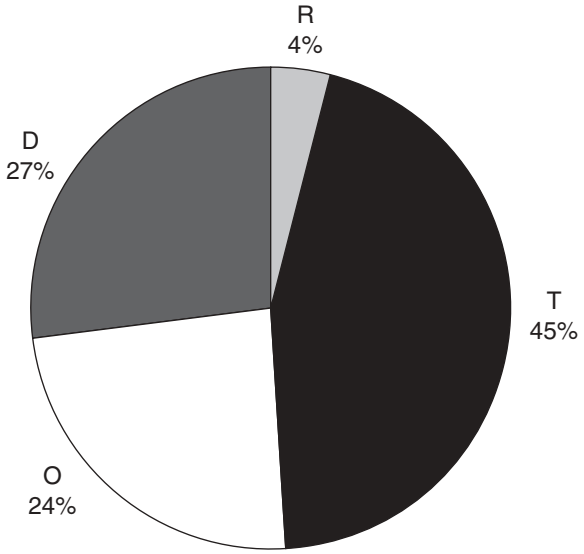

FIG. 4. The shape of all fetal gallbladders observed classified as teardrop (T), disc (D), oval (O), or round (R).

Shape of Fetal Gallbladders Observed

The majority (45%) of the fetal gallbladders observed were characterized as teardrop shaped (n = 48) (Fig. 1). There were approximately the same numbers of disc- (n = 29, 27%) and oval- (n= 25, 24%) shaped fetal gallbladders. Only 4 (4%) of the fetal gallbladders were characterized as round shaped (Fig. 4).

Correlation of Fetal Gestational Age to Gallbladder Length and Width

The relationship between fetal GA, gallbladder length (GBL), and width (GBW) was analyzed using Pearson's product moment correlation coefficient technique. A statistically significant correlation was found between GA and GBL (r = .76; $P \leq .001$) (Fig. 5) and GB and GBW (r = .63; $P \leq .001$) (Fig. 6).

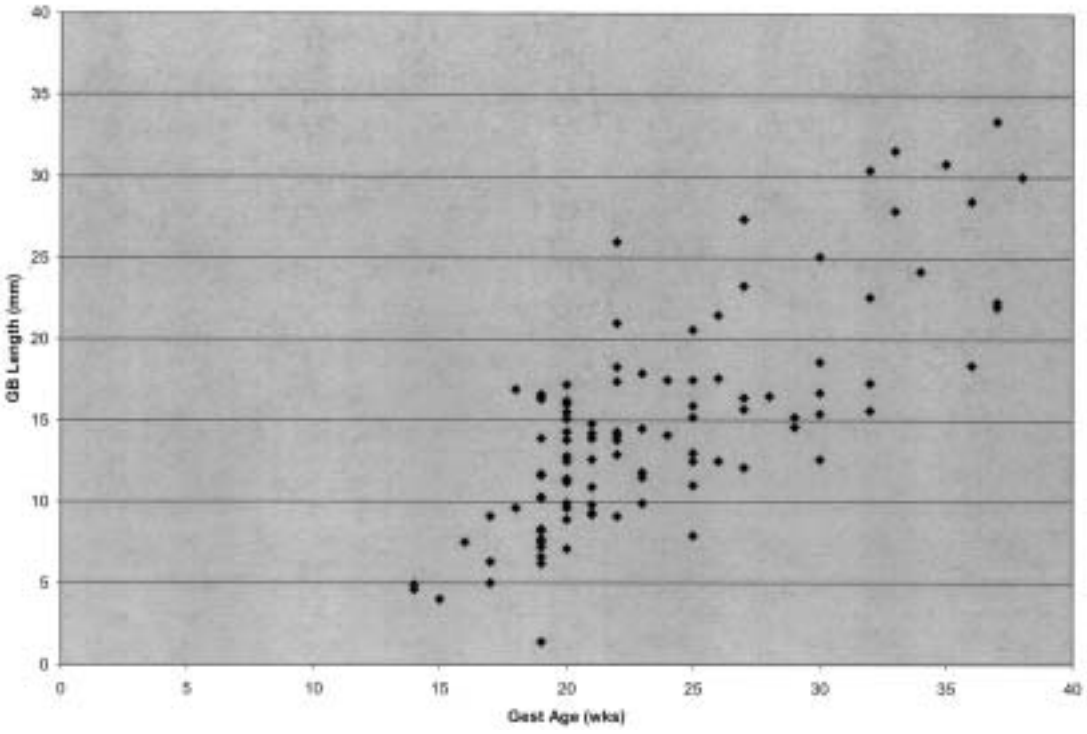

FIG. 5. Scatter graph demonstrating correlation between the estimated gestational age and fetal gallbladder length.

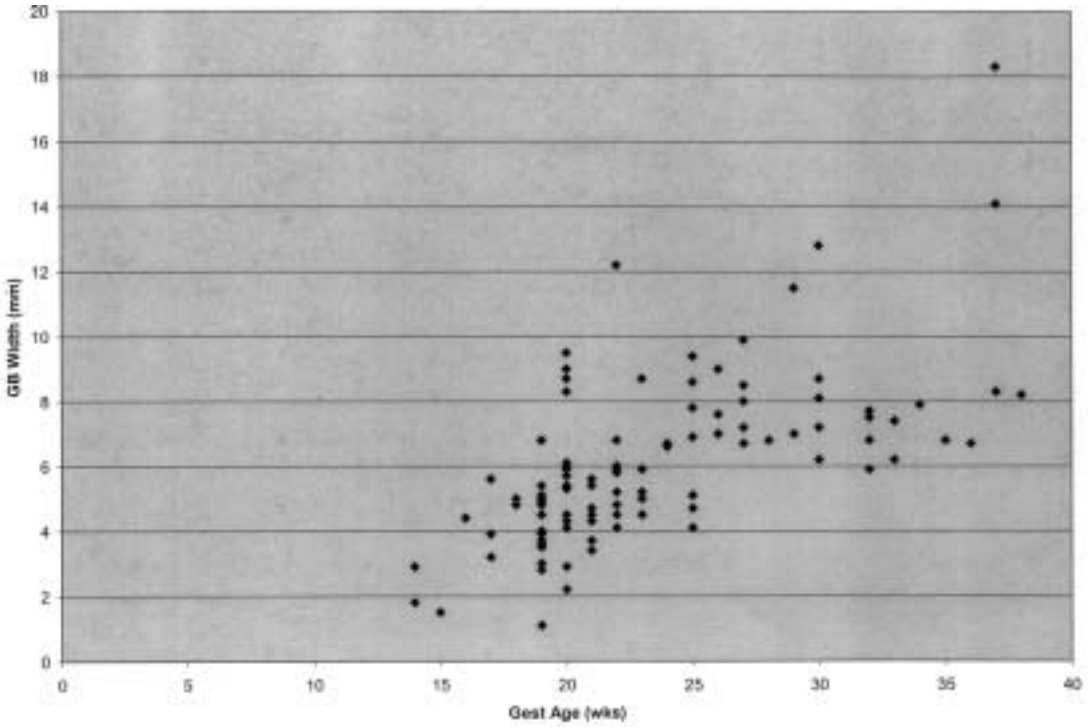

FIG. 6. Scatter graph demonstrating correlation between the estimated gestational age and fetal gallbladder width.

Literature Review

The fetal gallbladder evolves from a ventral outpouching off the caudal portion of the embryonic foregut during the fourth week of gestation. At approximately 12 weeks gestation, the hepatic cells begin to produce bile, which passes through the bile duct to the duodenum by 13 weeks GA.[1] Although the physiologic mechanism of the adult gallbladder is well documented, little has been published regarding in-utero function. Recent studies have reported that fetal gallbladder contraction does occur.[2–5] Furthermore, maternal fasting, nonfasting, and fat or glucose ingestion does not appear to correlate with either contraction or dilation of the fetal gallbladder.[2–4,6] The causative factors for apparent gallbladder function remain unknown.

The earliest sonographic fetal gallbladder study found in the literature was published by Hata et al in 1987. The fetal gallbladder visualization rate of the 149 fetuses scanned was 36.5% of those who were 20 to 23 weeks GA and 64.7% for the 24 to 27 weeks GA range.[2] In 1993, Wei et al conducted a study of 70 subjects and reported a visualization rate of 84.3% in fetuses ranging from 15 to 39 weeks GA.[6] Goldstein (1994) stated that the gallbladder can be sonographically demonstrated in virtually all fetuses with a GA beyond 20 weeks.[5] A 100% visualization rate was also reported by Chan et al (1995) when surveying fetuses from 15 to 40 weeks gestation.[7] However, Hertzberg et al (1996) reported gallbladder visualization in 477 of 578 (82.5%) sonographic studies, with a decline in frequency of visualization after 32 weeks GA.[8] The decline in gallbladder visualization after 32 weeks may be supported by a study of preterm infants revealing that functional gallbladder contraction was not observed before approximately 32 weeks GA.[9]

Chan et al (1995) collected 300 normal fetal gallbladder measurements for the purpose of establishing normative dimensions throughout pregnancy. Findings indicated a linear relationship from 15 to 30 weeks gestational age. The measurements were reported to plateau at 30 weeks gestational age.[7] Similar growth findings were reported

by Hata et al, with an apparent plateau occurring at 35 weeks GA.[2] These differences in findings spurred Tanaka et al (2000) to closely monitor the gallbladder size of fetuses ranging from 20 to 40 weeks GA. Fetal gallbladder measurements were obtained every 30 minutes for a period of 10 hours on 54 subjects. A sinusoidal contractility pattern was discovered, which became more pronounced with gestational age. Maternal eating patterns did not affect the function of the fetal gallbladders.[3] Therefore, a greater difference in fetal gallbladder dimensions may indeed be anticipated with advanced gestational age.

The fetal gallbladder shape is most commonly described as oval or teardrop shaped.[2,5,6,10,11] Other descriptors of the fetal gallbladder include pear, round, oblong, disc, and cystic.

Sonographic visualization of sludge or stones in the fetal gallbladder has also been reported.[6,11–15] This finding is rare and generally resolves relatively soon after birth, perhaps due to postnatal hydration. In cases where the findings did not resolve postnatally, the neonate remained asymptomatic.

Because the fetal gallbladder can be sonographically visualized in most cases, researchers continue to study the correlation between gallbladder nonvisualization and/or visualized gallbladder anomalies with other fetal anomalies. A rather large study done in 1993 found only 17 anomalies out of 10,016 (0.15%) studies performed. Although the percentage of anticipated anomalies is small, the likelihood of associated fetal malformations is increased when fetal gallbladder anomalies are detected.[16]

Discussion

There appears to be a continual historical increase in the reported visualization rate of the fetal gallbladder.[2,5–8] The increasing success rate is most likely attributable to the improved image resolution made available with technological advancement in sonographic equipment. Of the 113 exams included in this study, 7 exams were unsuccessful for confident visualization. By chance, 1 of the women returned 3 weeks later for a follow-up exam (not related to the nonvisualized gallbladder). The gallbladder was visualized at that time. Two of the 7 exams were technically difficult owing to maternal obesity. Management of these 7 patients was not affected by inability to visualize the gallbladder. It is interesting to note that two thirds of the nonvisualized gallbladders in our study occurred within the first 3 days of data collection. This would seem to indicate that given a few days practice, the sonographer may quickly increase the confidence rate and ease of identification.

The authors contend that the sonographer should attempt to identify the gallbladder on each fetal screening exam. Consistently identifying the gallbladder immediately after obtaining the abdominal circumference measurement would only add a few seconds to the total exam time. Findings other than the expected cystic structure located to the right of the umbilical vein should be noted.

The literature states that the most common shape is teardrop. In our study, only 45% were described as teardrop. The sonographer needs to be aware that the gallbladder can have various shapes, especially in the third trimester, due to the previously described sinusoidal contractility. The size of the fetal gallbladder also increases with gestational age.[17] However, normal variance in size due to functional contractility would preclude the utility of assessment of gallbladder dimensions for biometric purposes.

The incidence of anomalies is admittedly a low percentage, but when documented, careful attention must be given to possible associated anomalies.[16] Agenesis (failure of the embryonic buds to form) or atresia (abnormal occlusion/absence of an opening) of the gallbladder will result in a nonvisualization. Prominent bile ducts may be associated with agenesis or an atretic gallbladder. Associated anomalies have been reported with agenesis.[18,19] Alternatively, the gallbladder could be undergoing a normal sinusoidal contraction. A second observation before ending the exam may prove beneficial.

Another reason for the nonvisualizing gallbladder is an ectopically placed gallbladder. A left-sided gallbladder may be visualized in the case of complete or partial situs inversus. Although the fetal outcome with complete situs inversus is good, partial situs (asplenia and polysplenia syndrome) is usually associated with heart defects resulting in a poor fetal outcome.[20] The sonographer may quickly

determine the proper arrangement of abdominal organs when viewing the abdomen in transverse orientation. When a fetus in cephalic presentation is viewed in a transverse plane, the spine, stomach, umbilical vein, and gallbladder will appear in clockwise order. Conversely, when the fetus is in breech presentation, the spine, stomach, umbilical vein, and gallbladder will appear in counterclockwise order.

Biliary atresia (sclerosing of the intrahepatic and extrahepatic bile ducts) also results in nonvisualization of the gallbladder. This condition is of uncertain etiology and, while life-threatening, has not been detected prenatally.[21]

An abnormally shaped gallbladder may warrant closer investigation. Although the shape will vary due to normal sinusoidal contraction, an abnormally large gallbladder may result from abnormalities within the bile ducts. A dysmorphic gallbladder has been associated with intrauterine growth retardation and other anomalies.[15] Alternatively, the gallbladder may simply be bilobed or duplicated.

Although echogenic sludge or shadowing stones have been documented prenatally, the general postnatal prognosis is good. On the other hand, nonvisualization of the gallbladder may be associated with cystic fibrosis.[22,23] Cystic fibrosis is an autosomal recessive disorder more commonly found in Caucasians. Another sonographic finding associated with cystic fibrosis is dilated or echogenic bowel. The sonographic findings in combination with hereditary factors could be of grave diagnostic importance.

Conclusion

Improved image resolution allows successful imagery of the fetal gallbladder with a greater than 90% success rate. When obtaining transverse abdominal measurements, it takes little time or effort to identify the fetal gallbladder. Although specific imaging and measurement is not endorsed, the sonographer should expect the size to increase with gestational age and the shape to vary. The nonvisualizing or abnormal appearing gallbladder may be associated with other anomalies and should warrant a thorough fetal survey. Perhaps more important, routine identification of the fetal gallbladder can reduce the possibility of mistaking the gallbladder for an abdominal cystic mass.

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