

# UC Irvine

## UC Irvine Previously Published Works

### Title

Sonographic measurements of normal gallbladder sizes in children

### Permalink

<https://escholarship.org/uc/item/9xd7x0b9>

### Journal

Journal of Clinical Ultrasound, 31(2)

### ISSN

0091-2751

### Authors

Yoo, Jeong-Hyun  
Kwak, Hyun-Joo  
Lee, Myung-Jun  
[et al.](#)

### Publication Date

2003-02-01

### DOI

10.1002/jcu.10136

### Copyright Information

This work is made available under the terms of a Creative Commons Attribution License, available at <https://creativecommons.org/licenses/by/4.0/>

Peer reviewed

# Sonographic Measurements of Normal Gallbladder Sizes in Children

Jeong-Hyun Yoo, MD, Hyun-Joo Kwak, MD, Myung-Jun Lee, MD, Jeong-Soo Suh, MD, Chung-Sik Rhee, MD

Department of Radiology, Dongdae-Mun Hospital, Ewha Womans University, 70 Chongro 6-ga, Chongro-gu, Seoul 110-126, South Korea

Received 27 July 2001; accepted 14 October 2002

**ABSTRACT:** *Purpose.* Our goal was to establish the range of sonographic measurements of normal gallbladders in children.

*Methods.* Six hundred ten children aged 0–16 years (male:female ratio, 1.5:1) with normal clinical and laboratory findings were included in this study. The sonographic parameters were the length, width, and calculated volume of the gallbladder, and the clinical parameters were the age, height, weight, and body surface area of the children. Statistical significance was determined through correlation and regression analyses.

*Results.* The length of the gallbladder showed significant positive correlations with age ( $r = 0.65$ ), height ( $r = 0.67$ ), weight ( $r = 0.63$ ), and body surface area ( $r = 0.65$ ;  $p < 0.01$ ). The calculated volume of the gallbladder also showed moderate correlations with age ( $r = 0.53$ ), height ( $r = 0.55$ ), weight ( $r = 0.61$ ), and body surface area ( $r = 0.57$ ;  $p < 0.01$ ). The gallbladder width showed modest but significant correlations with age ( $r = 0.48$ ), height ( $r = 0.53$ ), weight ( $r = 0.53$ ), and body surface area ( $r = 0.55$ ;  $p < 0.01$ ). The highest correlation coefficients were found between the gallbladder length and subject age ( $r = 0.65$ ;  $p < 0.01$ ) and between the gallbladder length and subject height ( $r = 0.67$ ;  $p < 0.01$ ). For all correlations, statistical significance remained after regression analysis ( $p < 0.01$ ).

*Conclusions.* Values for the size of the normal pediatric gallbladder are defined and will be helpful in the diagnosis of gallbladder abnormalities. © 2003 Wiley Periodicals, Inc. *J Clin Ultrasound* 31:80–84, 2003; Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/jcu.10136

**Keywords:** gallbladder; ultrasonography; children

Although reports of gallbladder disease are common, few published reports detail the sonographic appearance of normal gallbladders in children.<sup>1–7</sup> Because of this lack of information, it is often difficult to determine whether a child's gallbladder is diseased. In neonates, a small gallbladder may be the result of biliary atresia, and a condition such as Kawasaki disease can lead to gallbladder enlargement accompanied by hydrops. It is therefore very important to decide whether the gallbladder size is normal.

We know of only 3 references in which the sonographic sizes of gallbladders in children are addressed,<sup>4,8,9</sup> and only 1 of those concerns normal gallbladders in healthy children.<sup>8</sup> We therefore decided to measure normal gallbladders sonographically in children to establish the range of normal sizes in this population.

## PATIENTS AND METHODS

This prospective study, carried out as part of a health screening program, involved 610 children aged 0–16 years (male:female ratio, 1.5:1). Written informed consent was obtained from the parents for the prospective health screening program. Physical findings concerning the upper abdomen and laboratory findings pertaining to the gallbladder were all negative, and the children were therefore considered healthy.

All subjects fasted before sonographic examination. A real-time ultrasound scanner (128XP; Acuson, Mountain View, CA) was used, with either a 3.5- or 5.0-MHz convex-array transducer. During the procedure, the subjects were usually supine, although occasionally the left lateral de-

Correspondence to: J.-H. Yoo

© 2003 Wiley Periodicals, Inc.

## NORMAL GALLBLADDER SIZES IN CHILDREN

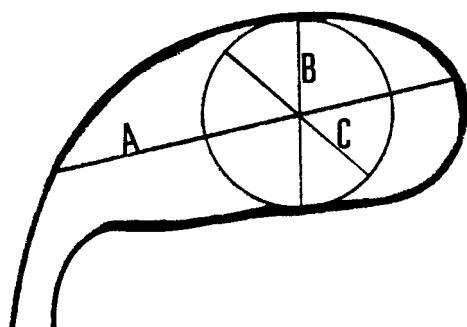
**TABLE 1**  
**Sonographic Measurements of Normal Gallbladders in Children by Age Group**

Age, years	No. Subjects	Length, cm				Width, cm				Volume, cm <sup>3</sup>			
		Mean ± SD	95% CI	Median	Observed Range	Mean ± SD	95% CI	Median	Observed Range	Mean ± SD	95% CI	Median	Observed Range
<1	41	3.3 ± 0.8	3.1–3.6	3.5	2.8–4.7	0.9 ± 0.4	0.6–1.0	0.9	0.1–1.8	1.8 ± 1.7	1.2–2.3	1.4	0.3–7.9
1	35	4.2 ± 0.6	4.0–4.4	4.2	2.5–6.0	1.4 ± 0.3	1.3–1.5	1.4	0.7–2.1	4.6 ± 2.6	3.7–5.5	4.1	0.5–12.4
2	30	4.5 ± 0.6	4.3–4.8	4.6	3.5–6.0	1.5 ± 0.3	1.4–1.6	1.5	1.1–2.3	5.9 ± 2.4	4.9–6.5	5.6	2.8–12.6
3	31	4.3 ± 0.6	4.1–4.5	4.4	3.0–5.8	1.5 ± 0.2	1.4–1.5	1.6	0.9–1.8	4.9 ± 1.7	4.3–5.6	4.9	1.5–8.4
4	24	4.7 ± 1.3	4.2–5.3	4.6	2.9–7.5	1.5 ± 0.3	1.4–1.6	1.7	0.7–1.9	5.9 ± 2.6	4.7–7.0	5.2	0.7–13.1
5	36	5.0 ± 1.0	4.7–5.4	5.0	3.4–7.2	1.7 ± 0.4	1.6–1.8	1.6	0.9–2.8	7.8 ± 4.8	6.2–9.4	7.4	2.2–29.3
6	47	4.9 ± 1.0	4.6–5.2	4.7	3.0–7.5	1.6 ± 0.3	1.5–1.7	1.5	1.1–2.5	7.0 ± 3.6	5.9–8.1	5.9	2.6–17.2
7	43	5.1 ± 0.9	4.9–5.4	5.0	3.5–7.7	1.6 ± 0.4	1.5–1.7	1.7	1.0–2.6	7.2 ± 3.8	6.0–8.4	6.6	2.7–21.0
8	45	5.3 ± 1.0	5.0–5.6	5.3	3.3–8.7	1.7 ± 0.4	1.6–1.8	1.8	0.9–2.9	8.5 ± 4.8	7.0–9.9	7.7	1.3–26.2
9	44	5.5 ± 1.0	5.2–5.8	5.5	3.4–7.7	1.8 ± 0.5	1.7–1.9	1.9	0.9–2.8	10.0 ± 5.9	8.2–11.8	8.1	2.4–25.2
10	54	5.6 ± 0.8	5.4–5.8	5.6	3.9–7.4	1.9 ± 0.4	1.8–2.0	1.9	1.0–2.9	11.5 ± 5.3	9.6–12.5	9.8	2.3–23.9
11	53	6.0 ± 1.0	5.7–6.3	6.0	3.9–8.0	1.9 ± 0.4	1.8–2.1	1.9	1.1–3.1	12.6 ± 6.6	10.7–14.4	10.7	4.2–38.4
12	47	6.1 ± 0.8	5.8–6.3	6.1	4.7–8.2	1.8 ± 0.6	1.7–2.0	1.9	0.9–3.4	12.1 ± 7.8	9.7–14.4	11.8	3.0–42.0
13	27	6.6 ± 1.3	6.1–7.1	6.7	3.3–8.9	1.9 ± 0.6	1.7–2.2	1.9	0.9–2.8	14.0 ± 8.4	10.7–17.4	13.7	1.3–31.7
14	17	6.8 ± 1.1	6.3–7.4	6.8	5.2–8.4	2.0 ± 0.6	1.7–2.3	1.9	1.1–3.3	15.2 ± 8.1	11.0–19.4	14.1	3.2–31.7
15	26	6.3 ± 1.3	5.8–6.8	6.1	4.1–8.9	1.9 ± 0.6	1.7–2.1	1.9	0.9–3.2	13.3 ± 9.5	9.4–17.1	10.9	3.2–42.0
16	10	5.9 ± 1.1	5.1–6.7	5.7	4.2–7.8	1.9 ± 0.6	1.5–2.3	1.8	1.1–2.8	11.9 ± 6.6	7.1–16.6	11.1	2.6–23.2
Total	610	5.3 ± 1.3	5.2–6.4	5.2	2.5–8.9	1.7 ± 0.5	1.6–1.7	1.7	0.1–3.4	8.0 ± 6.1	8.3–9.3	6.9	0.3–42.0

Abbreviations: SD, standard deviation; CI, confidence interval.

cubitus position was also used. The sonographic parameters for gallbladder size that were measured were the greatest length (L) and the greatest transverse diameter (W). It was assumed that the shape of the gallbladder was a prolate ellipsoid and that the width and anteroposterior diameter were similar. Therefore, the formula used for volume calculation was  $0.52 \times L \times W \times W$  (Figure 1). We also evaluated the relationships between gallbladder size and subject age, height, weight, and body surface area.

All study data were collected in the Excel program (Microsoft, Redmond, WA) and processed using the SPSS program (SPSS Inc., Chicago, IL). For gallbladder length, width, and volume, we



**FIGURE 1.** Method of sonographic measurement of gallbladders. The gallbladder volume was measured using the prolate ellipsoid volume formula:  $V = 0.52 \times L \times W \times W$ . A is the greatest length (L), B is the anteroposterior dimension (W) and C is the transverse width (W). B and C were assumed to be equal.

calculated the mean ± standard deviation, median, range, and 95% confidence interval. Correlation and regression analyses were performed. A *p* value below 0.05 was considered statistically significant.

### RESULTS

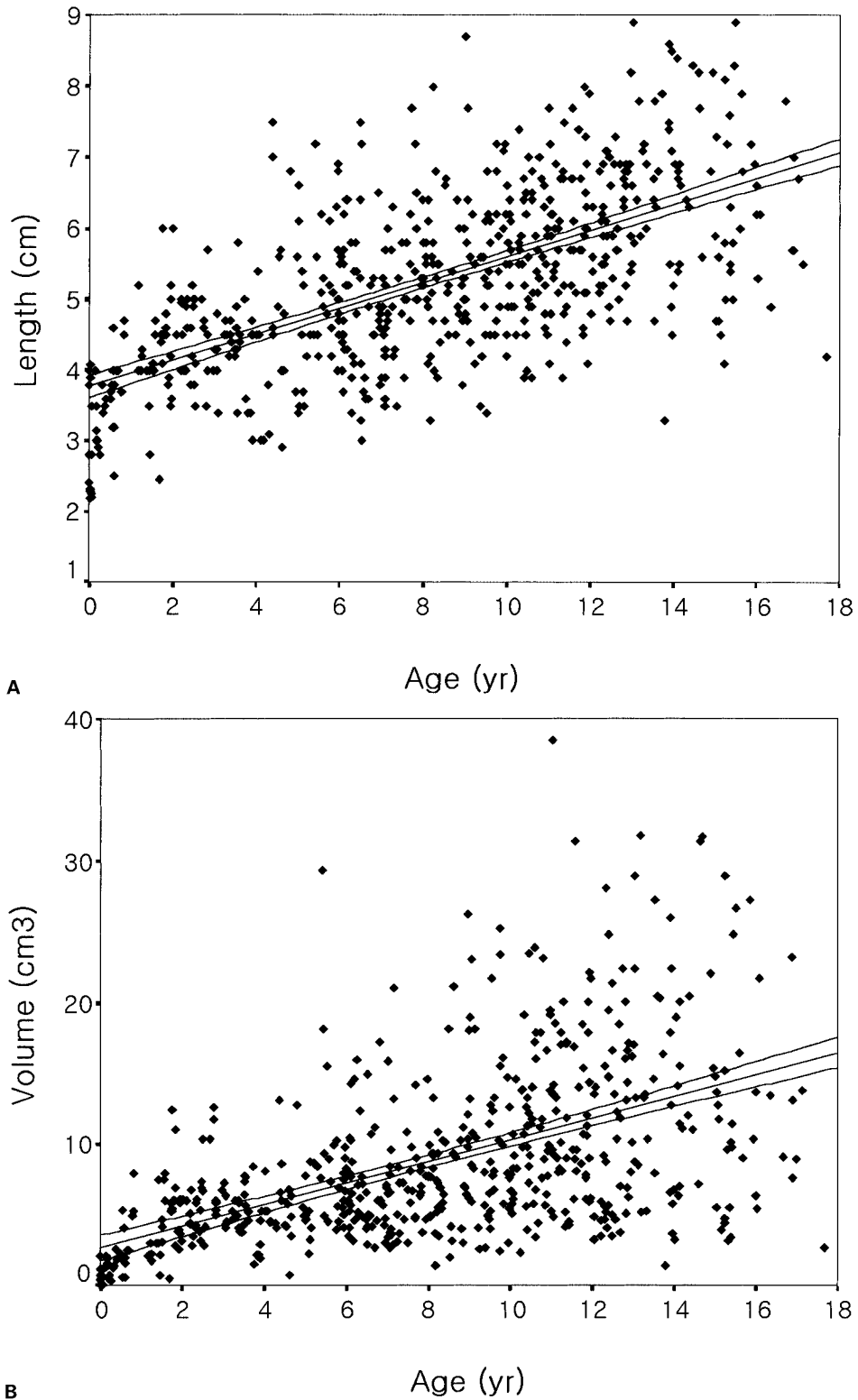
Table 1 shows the measurements of the gallbladder size parameters by age group. Gallbladder length ranged from 2.5 to 8.9 cm (mean,  $5.3 \pm 1.3$  cm), gallbladder width from 0.1 to 3.4 cm (mean,  $1.7 \pm 0.5$  cm), and gallbladder volume from 0.3 to 42.0 cm<sup>3</sup> (mean,  $8.0 \pm 6.1$  cm<sup>3</sup>).

The gallbladder size parameters showed a significant positive correlation with age and all body parameters ( $p < 0.01$ ) (Table 2). The length and volume of the gallbladder showed moderate correlations with age, height, weight, and body sur-

**TABLE 2**  
**Coefficients of Correlation between Body Parameters and Gallbladder Measurements\***

Gallbladder Measurement	Age	Height	Body Weight	Body Surface Area
Length	0.65	0.67	0.63	0.65
Width	0.48	0.53	0.53	0.55
Volume	0.53	0.55	0.61	0.57

\*Data are Pearson correlation coefficients. All correlations were significant ( $p < 0.01$ ).



**FIGURE 2.** Linear regression plots between gallbladder measurements and age (after verification of fitness by analysis of variance). **(A)** Maximal length versus age: length (in cm) = 1.9 × age (in years) + 3.8. **(B)** Volume versus age: volume = 7.7 × age (in years) + 0.2. **(C)** Width versus age: width = 5.5 × age (in years) + 1.2. All correlations showed statistical significance ( $p < 0.01$ ).

NORMAL GALLBLADDER SIZES IN CHILDREN

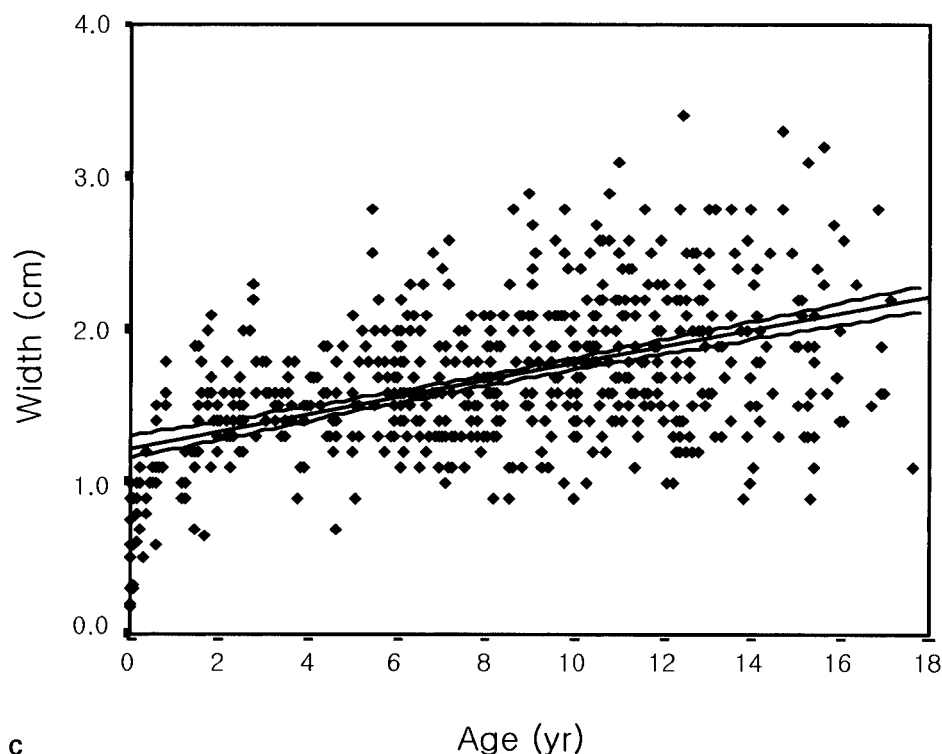


FIGURE 2. Continued.

face area. Correlation coefficients between the gallbladder width and body parameters were low compared with coefficients for other factors but were still significant. The greatest correlation coefficients were between gallbladder length and subject age ( $r = 0.65$ ;  $p < 0.01$ ) and between gallbladder length and subject height ( $r = 0.67$ ;  $p < 0.01$ ).

Regression plots also demonstrated significant linear correlations between age and gallbladder size parameters ( $p < 0.01$ ) (Figure 2). Again, gallbladder width had the lowest correlation with age of the 3 size parameters.

Because of the strong correlation between gallbladder size and subject height (a simple clinical measurement), we have also presented normal gallbladder length by subject height in Table 3.

**DISCUSSION**

Studies of normal gallbladders in children have been few,<sup>4,8,9</sup> and the resulting lack of information means that decisions about whether gallbladder disease is present can be difficult. We were able to locate only 1 report, by McGahan et al,<sup>8</sup> in which normal pediatric gallbladder measurements are detailed. The study's sample size was small, however, totaling only 51 cases, and the clinical data were also limited. Slovis et al,<sup>4</sup> in a

study of gallbladder hydrops in Kawasaki disease, included findings for 42 healthy children who served as the control group. And a report by Sarnaik et al<sup>9</sup> described the sonographic findings of some normal gallbladders in patients with sickle-cell anemia.

In the present study, we documented normal gallbladder measurements in 610 healthy children, thus establishing normal ranges that can be used in clinical settings. Since there was no pathologic proof that the gallbladders were completely normal in our study, we relied on normal

**TABLE 3**  
Length of Gallbladder by Subject Height

Subject Height, cm	No. Subjects	Gallbladder Length, cm			
		Mean ± SD	95% CI	Median	Range
<90	77	3.8 ± 0.9	3.6-4.0	4.0	2.8-6.0
90-99	49	4.3 ± 0.5	4.1-4.4	4.3	3.4-5.7
100-109	49	4.7 ± 1.1	4.4-5.0	4.6	2.9-7.5
110-119	57	4.8 ± 0.9	4.6-5.0	4.8	3.0-7.5
120-129	88	5.2 ± 0.9	5.0-5.4	5.2	3.4-7.7
130-139	81	5.4 ± 0.8	5.3-5.6	5.5	3.3-8.0
140-149	86	5.8 ± 1.0	5.6-6.1	5.9	3.5-8.7
150-159	65	6.5 ± 1.0	6.2-6.7	6.6	4.2-8.5
160-169	37	6.3 ± 1.2	5.9-6.7	6.6	3.3-8.9
≥170	21	6.4 ± 1.2	5.8-6.9	6.0	4.5-8.9

Abbreviations: SD, standard deviation; CI, confidence interval.

**TABLE 4**  
**Normal Gallbladder Lengths Reported by Other Researchers**

McGahan <sup>8</sup>				Slovis <sup>4</sup>				Sarnaik <sup>9</sup>		
Age, years	No.	Mean, cm	Range, cm	Age, years	No.	Mean ± SD, cm	Range, cm	Age, years	No.	Mean ± SD, cm
0-1	8	2.5	1.3-3.4	2-4	10	4.14 ± 0.20	3.1-5.3	2-4	29	4.27 ± 1.14
2-5	10	4.2	2.9-5.2	5-10	10	5.36 ± 0.34	4.1-8.0	5-9	67	5.46 ± 1.20
6-8	11	5.6	4.4-7.4	10-14	12	5.91 ± 0.33	4.3-7.5	10-14	44	6.24 ± 1.25
9-11	12	5.5	3.4-6.5	14-18	10	6.19 ± 0.22	5.2-7.2	15-19	23	7.15 ± 1.8
12-16	10	6.1	3.8-8.0							

Abbreviation: SD, standard deviation.

standard laboratory data to rule out any abnormality of the hepatobiliary system.

To establish guidelines on gallbladder size, we selected the greatest length and width and calculated the volume of the gallbladder, analyzing the relationships between these measurements and several body parameters (height, weight, and body surface area) and age. Our results demonstrated gradual but significant increases in gallbladder measurements with increases in age, height, weight, and body surface area. As in other reports, our data suggest that length is a more useful parameter than width or volume. Width, despite its significance in our study, showed a low correlation coefficient. Furthermore, an equation must be used to determine volume, making this parameter more difficult to use in clinical practice.

The relationship between gallbladder length and subject age was 1 of the strongest in our study, as most authors have reported. Our findings with regard to mean length are not greatly different from those of other authors, despite different sample sizes and the involvement of different age groups (Table 4).

It was interesting that the correlation between gallbladder length and subject height was greater than that between length and age. We therefore believe that in clinical settings, variations in gallbladder length according to subject height can also provide valuable guidance.

In conclusion, gallbladder length, width, and volume correlate significantly with subject age,

height, weight, and body surface area. In particular, the length of the gallbladder is highly significantly correlated with a subject's height.

#### REFERENCES

- Greenberg M, Kangaroo H, Cochran ST, et al. The ultrasonographic diagnosis of cholecystitis and cholelithiasis in children. *Radiology* 1980;137:747.
- Chen PA, Aliapoulos MA. Acute acalculous cholecystitis. Ultrasonic appearance. *Arch Surg* 1978; 113:1461.
- Kumari S, Lee WJ, Baron MC. Hydrops of the gallbladder in a child: diagnosis by ultrasonography. *Pediatrics* 1979;63:295.
- Slovis TL, Hight DW, Philippart AI, et al. Sonography in the diagnosis and management of hydrops of the gallbladder in children with mucocutaneous lymph node syndrome. *Pediatrics* 1980;65:789.
- Magilavy DB, Speert DP, Silver TM, et al. Mucocutaneous lymph node syndrome: report of two cases complicated by gallbladder hydrops and diagnosed by ultrasound. *Pediatrics* 1978;61:699.
- Robinson AE, Erwin JH, Wiseman HJ, et al. Cholecystitis and hydrops of the gallbladder in the newborn. *Radiology* 1977;122:749.
- Haller JD. Sonography of the biliary tract in infants and children. *AJR Am J Roentgenol* 1991;157:1051.
- McGahan JP, Phillips HE, Cox KL. Sonography of the normal pediatric gallbladder and biliary tract. *Radiology* 1982;144:873.
- Sarnaik S, Slovis TL, Corbett DP, et al. Incidence of cholelithiasis in sickle cell anemia using the ultrasonic gray-scale technique. *J Pediatr* 1980;96:1005.