High Accuracy Sonographic Recognition of Gallstones

Paul C. Hessler[1]
Donald S. Hill[1]
Frank M. Detorie[2]
Albert F. Rocco[1]

Recent advances in the imaging capabilities of gray scale sonography have increased the accuracy with which gallstones may be diagnosed. Since the sonographic diagnosis of gallstones is often followed by surgery without further confirmatory studies, the avoidance of false-positive diagnoses assumes major importance. In an attempt to improve diagnostic accuracy, 420 gallbladder sonograms were evaluated for gallstones. Positive diagnoses were limited to cases in which the gallbladder was well visualized and contained densities that produced acoustic shadowing or moved rapidly with changes in position. Gallstones were diagnosed in 123 cases and surgery or autopsy in 70 of these patients confirmed stones in 69. There was one false-positive, an accuracy rate for positive diagnosis of 98.6%. Five cases were called indeterminate for stones; one of these had tiny 1 mm stones at surgery. The other four cases had no surgery. Of 276 cases called negative for stones, two were operated. One contained tiny 1 mm stones; the other had no stones. None of the 146 cases with negative sonograms and oral cholecystography or intravenous cholangiography had stones diagnosed by these methods. Because of its ease and simplicity, sonography is attractive as the initial study in patients suspected of having gallstones. With the criteria used here, a diagnosis of gallstones in the gallbladder can be offered with great confidence.

Since 1974, the imaging capabilities of gray scale sonography have improved steadily, with corresponding increases in its accuracy in gallstone recognition. In 1974, Goldberg et al. [1] reported an accuracy rate for positive diagnoses of 88%, and subsequent studies have reported between 84% and 100% accuracy [2–9]. These results compare favorably with the accuracy of gallstone diagnosis by both oral cholecystography and intravenous cholangiography [9–11]. Because of its reliability, convenience, and safety, sonography is fast becoming the initial examination in patients suspected of having gallstones. Since the diagnosis of gallstones by sonography is often followed by cholecystectomy without further confirmatory studies, the avoidance of false-positive diagnoses assumes major importance. In an attempt to improve diagnostic accuracy, the following scanning methods and diagnostic criteria were applied.

Materials and Methods

During a 15 month period, 420 patients had gallbladder sonograms in our ultrasound department.

Technique

Sonograms were obtained on a Rohé (Santa Ana, Cal.) commercial gray scale contact scanner. Most examinations were performed with a 3.5 MHz transducer, although some patients required a 2.25 MHz transducer for adequate penetration. Very superficial gallbladders were scanned with a 5 MHz transducer. Patients were routinely scanned in

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[1] Department of Radiology, John E. Fogarty Memorial Hospital, Eddie Dowling Highway, North Smithfield, RI 02895. Address reprint requests to P. C. Hessler.

[2] Department of Surgery, John E. Fogarty Memorial Hospital, North Smithfield, RI 02895.

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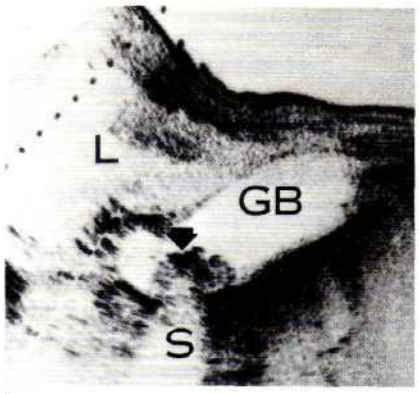

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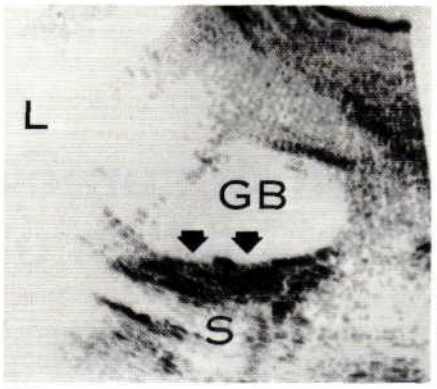
Fig. 1.—Longitudinal scan. 3 cm shadowing stone (*arrow*). GB = gallbladder, L = liver, S = acoustical shadowing.



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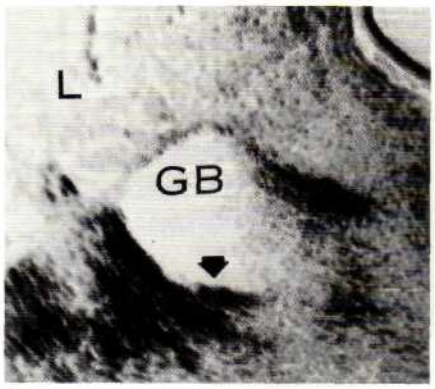

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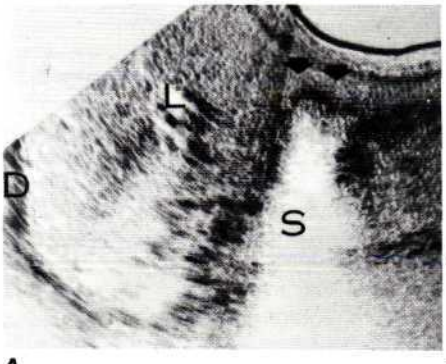
Fig. 2—**A**, Longitudinal scans. Small faintly shadowing densities (*arrows*). Densities move into gallbladder fundus in left lateral decubitus position (**B**). L = liver, D = diaphragm, GB = gallbladder, S = acoustical shadowing.



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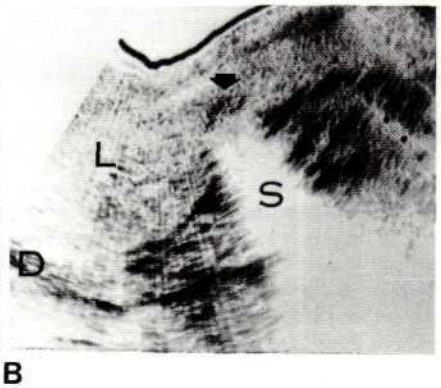

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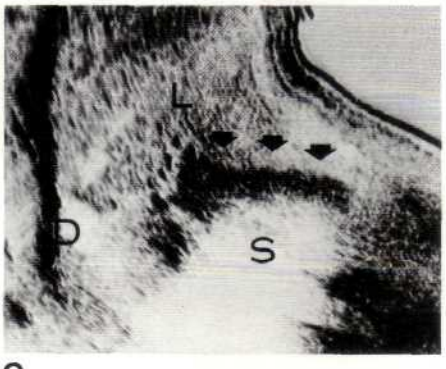

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Fig. 3.—Longitudinal (**A**), transverse (**B**), and left lateral decubitus (**C**) scans. Gallbladder packed with stones (*arrows*) differentiated from bowel gas. D = diaphragm, L = liver, S = acoustical shadowing.

longitudinal and transverse positions. The left lateral decubitus position was used to separate the gallbladder from adjacent bowel gas and observe movement of nonshadowing densities within the gallbladder, as described by Foster and McLaughlin [12]. The cystic and common bile ducts were visualized segmentally along their long axes in most cases.

Interpretation

The diagnosis of gallstones was restricted to sonograms meeting the following criteria: (1) the gallbladder was well visualized in at least two projections; (2) intraluminal densities were well defined; and (3) the densities either produced acoustic shadowing (fig. 1) and/or removed rapidly with changes in position (fig. 2).

Densities that did not move or shadow were further evaluated when feasible by repeating the examination 1 day after ingestion of a fatty meal. If the densities could not be found on this second examination, they were assumed to have been gallbladder sludge, and the examination was called negative for stones. If the densities persisted or if a second examination could not be obtained, the examination was called indeterminate and an oral cholecystogram was recommended.

The only exception to the above criteria occurred when the gallbladder lumen was packed with stones (fig. 3). In these cases, a positive diagnosis was permitted if the pattern of acoustic shadowing in longitudinal, cross sectional, and left lateral decubitus positions was characteristic of gallstones and could be differentiated from bowel gas. In selected cases, the chance that a calcified right upper quadrant mass might mimic a cluster of gallstones was eliminated by obtaining a plain radiograph of the abdomen.

Results

Of 420 patients, the gallbladder was well visualized in 404, a scanning success rate of 96.5%. Inability to see the gallbladder was attributed to overlying gas in 11 cases, ascites in three, an overlying hepatoma in one, and bandages in one. Gallstones were diagnosed in 123 cases, and surgical or autopsy follow-up was obtained in 70 cases. Of

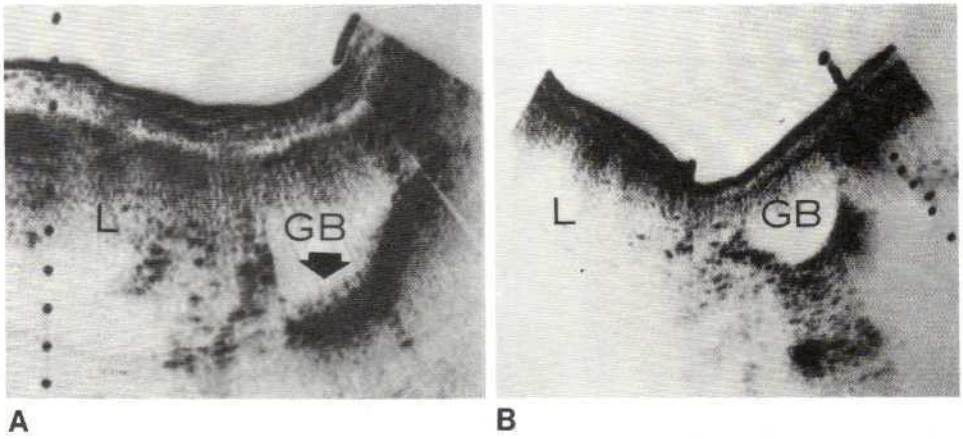

Fig. 4.—Fatty meal and delayed scanning technique. A, Day 1. Small, nonshadowing, nonmobile densities (*arrow*). B, After fatty meal. Densities disappeared. L = liver, G = gallbladder.

these, 69 had gallstones, an accuracy rate for positive diagnoses of 98.6%. The single known false-positive proved to be chronic cholecystitis in which thickening and irregularity of the posterior gallbladder wall was mistaken for tiny, nonshadowing stones. The diagnostic criteria were applied prospectively; the single diagnostic error was made by a radiologist unfamiliar with our scanning criteria.

In six cases, the gallbladder contained several tiny densities that neither shadowed nor moved rapidly with changes in position. In one case, reexamination 24 hr after a fatty meal failed to reveal the densities, and it was called negative for stones (fig. 4). No oral cholecystogram, intravenous cholangiogram, or surgery was obtained in this case. In the other five cases, postfatty meal examinations could not be performed, and they were diagnosed as indeterminate for stones. One of these cases was operated, and multiple 1 mm stones and chronic cholecystitis were found. No oral cholecystogram or intravenous cholangiogram was obtained preoperatively. The other four cases had no surgery. Two of these cases had normal oral cholecystograms; the other two had neither oral cholecystography nor intravenous cholangiography.

Of the 276 cases called negative for stones, two were operated. Of these, one had been diagnosed as acalculus cholecystitis by sonography, but multiple 1 mm stones in addition to chronic cholecystitis were found at surgery. No oral cholecystogram or intravenous cholangiogram was obtained in this case. The other case appeared entirely normal by sonography, but mild chronic cholecystitis was found at surgery. Several oral cholecystograms were attempted in this case, but the gallbladder could not be visualized. No intravenous cholangiogram was attempted. The other 274 cases received no surgery. Of these, 146 had oral cholecystograms, of which 111 were normal, 18 showed poor visualization of the gallbladder, and 17 failed to visualize the gallbladder at all. Of the 146 cases having oral cholecystograms, four also had intravenous cholangiograms, of which only one adequately visualized the gallbladder, and no stones were seen in this case. The rest of the nonoperated cases called negative for stones by sonography had neither oral cholecystograms nor intravenous cholangiograms. In summary, no cases called negative or indeterminate for stones by sonography were discovered to have stones by oral cholecystography or intravenous cholangiography.

Discussion

In the sonographically well visualized gallbladder, stones 3 mm or larger always shadow [13, 14] or move rapidly with changes in position [8]. Stones smaller than 3 mm often fail to shadow and may be visualized as irregular thickening of the posterior wall of the gallbladder, an appearance often mimicked by the inflammatory changes seen in acalculus cholecystitis. Consequently, small numbers of tiny stones and acalculus cholecystitis may be mistaken for one another. Using our restrictive criteria, we expected to miss most stones smaller than 3 mm, but we considered it preferable to risk false-negative and indeterminate results rather than to make false-positive diagnoses. Symptomatic patients with stones not visualized by sonography will presumably have oral cholecystography or other diagnostic studies, and the correct diagnosis will ultimately be reached in nearly all cases. Our single false-positive diagnosis in 70 proven cases resulted from an isolated inconsistency in the application of our diagnostic criteria. Our results compare favorably with others (table 1).

Gallbladder sonography is rapid, noninvasive, and easily performed in the acutely ill patient. It is reliable in both acutely and chronically ill patients, and there is no risk of contrast reaction or limitation by impaired liver function, as occurs in oral cholecystography and intravenous cholangiography. A conclusive diagnosis can often be obtained in a few minutes, compared with the 1 or 2 day delay inherent in oral cholecystography. Intravenous cholangiography can be performed rapidly enough, but the gallbladder is often poorly visualized and the examination often fails entirely in the jaundiced patient.

Our restrictive criteria have increased our confidence in accurately recognizing gallstones by sonography. We now

TABLE 1: **Accuracy of Positive Diagnosis of Cholelithiasis in the Gallbladder**

Reference No.	Year	No. Cases			Accuracy of Positive Diagnoses (%)
		Total	Diagnosed as Gallstones with Follow-up	False-Positives	
[1]	1974	195	66	8	88
[2]	1974	50	25	4	84
[3]	1976	50	21	0	100
[4]	1976	123	31	1	97
[5]	1976	75	27	1	96
[6]	1977	81	56	1	98
[7]	1977	76	23	2	91
[8]	1978	145	116	2	98
[9]	1978	108	88	1	99
This report	1980	420	70	1	99

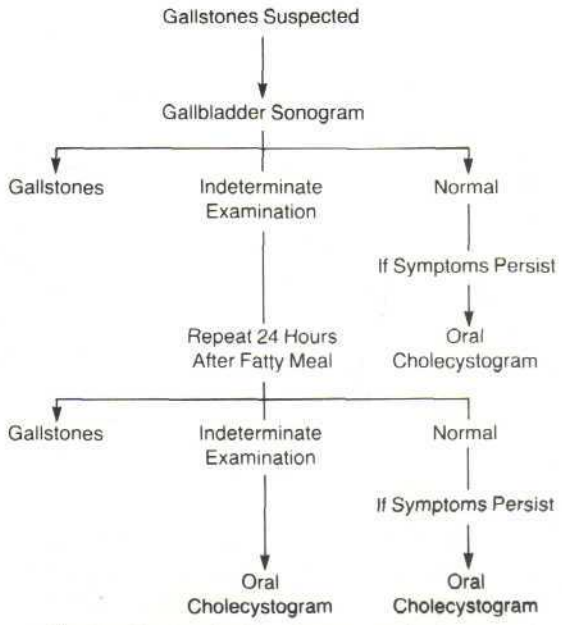

Fig. 5.—Algorithm for detecting suspected gallstones.

believe that gallbladder sonography should be the initial study in patients suspected of having gallstones. If the sonogram reveals stones, the physician can proceed confidently with treatment. If sonography does not provide a definitive diagnosis, and if the patient's symptoms persist, we recommend oral cholecystography (fig. 5).

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