Detection of Blood Flow in Healthy Gall Bladder Walls

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Abstract:

Background:

Detection of flow in gall bladder wall as a normal finding is still controversial .

Objectives: To detect mural flow in a healthy gall bladder & the pattern of such flow.

Subjects & methods: Examination of the gall bladder (using Siemens Versa Pro ultrasonic equipment, 3.5 MHz curved transducer) was performed on 50 healthy adult volunteers in Baghdad Teaching Hospital/Department of Radiology, to detect the morphological criteria (volume & wall thickness) by conventional sonography & the presence of flow within the gall bladder wall by color & power Doppler sonography. Sonography for all subjects was performed at both fasting & after eating a test meal .

Results: Doppler sonography showed either no mural flow or only solitary spotty signals of flow in the gall bladder of studied subjects. Enhanced flow was detected by both color & power Doppler after eating than at fasting with statistically significant difference. At each time point, flow was more conspicuous with power Doppler than with color Doppler with a very highly significant difference.

Conclusion: Flow in the gall bladder wall is a normal finding that is more apparent when the gall bladder is contracted.

Key words:

Gall bladder, mural flow, Doppler sonography, power Doppler.

Introduction:

The biliary tract consisting of the hepatic ducts, gall bladder (GB), common bile duct & sphincter of Oddi, stores & delivers bile to the duodenum during feeding to provide for the efficient digestion & absorption of lipids. The smooth muscle of the common bile duct contracts rhythmically & may enhance bile flow within the biliary tree.The sphincter of Oddi also undergoes rhythmic contractions. During fasting, bile flows predominantly into the GB because of pressure gradient created by the contracted sphincter of Oddi.The GB is a saccular organ with a capacity of 15-60 ml in adults.The bile collected in the GB during the interdigestive phase is concentrated predominantly by the reabsorption of water. When a meal is ingested the GB contracts (the wall thickens) and the sphincter of Oddi relaxes. The major hormone mediating GB contraction is cholecystokinin (CCK), released by duodenal mucosa due to stimulation by products of digestion especially fatty acids and amino acids. Circulating CCK causes strong contraction of GB and relaxation of sphincter of Oddi thus promoting the flow of bile to the upper small bowel (1).

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The arterial supply of the GB is from the cystic artery, a branch of the right hepatic artery, & by branches that supply it directly from the liver in the GB bed. Blood from the GB drains via small veins to the liver from the GB bed. Sometimes, a cystic vein is formed that drains to the portal vein (2).

Tessler & Tublin (3) found that blood flow in the healthy GB wall is a normal sonographic finding that is seen more easily when the GB is contracted (having thickened wall). They also added that this fact should be kept is mind when sonography is used in patients in whom acute cholecystitis is suspected , particularly if they do not fast before sonography .

Wall oedema & thickening are the best documented but relatively non-specific signs in acute cholecystitis, as GB wall thickening could be due to various other causes (4).

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During the last decade, several studies have appeared, with contradictory results, dealing with the role of color or power Doppler sonography or both techniques in detecting wall hyperaemia in acute cholecystitis (4-9) . This could be an important sign in revealing acute cholecystitis & differentiation from other causes of wall thickening such as chronic cholecystitis (6,8,9).

Color Doppler (CD) sonography depicts local flow by encoding an estimate of the mean Doppler frequency shift at a particular position in color. Power Doppler (PD) sonography is used to document the presence and characterization of flow in vessels that are poorly imaged with conventional CD.As PD has shown several key advantages over CD, including higher sensitivity to flow, better edge definition & depiction of continuity of flow (10).

The Aim of this study was to determine whether it is possible to detect blood flow within a normal GB wall & the pattern of this flow .

Subjects & methods:

This study was performed on 50 healthy adult volunteers (30 males & 20 females) who were 21-52 years old (mean age 36 years), & took no medication & none of them smoked on the morning of the examination. Each volunteer was examined sonographically after fasting overnight & the examination was repeated after 45 min. of consuming a mixed solid-liquid meal, consisting of one slice of bread, 10 gm butter, one boiled egg, 300 ml tea with 25gm sugar, which was finished within 5 min. (11).

Ultrasonic examination was performed in Baghdad Teaching Hospital/Department of Radiology, using 3.5 MHz curved transducer of a real time B-mode scanner "Siemens (Versa Pro)" ultrasonic equipment .

The GB lumen was measured in 3 orthogonal planes & its volume was estimated by multiplying the product of anteroposterior, transverse, & craniocaudal measurements by 0.5236 (3).

A representative thickness of the anterior wall of GB was measured in sagittal and transverse planes & the mean wall thickness was calculated (3).

Next, CD and PD sonography of the GB wall to detect mural flow was performed along the long & short axes with the subject in suspended respiration, using the highest sensitivity settings that could be obtained without introducing significant artifacts (3). The mural flow was graded using a modification of the scheme described by Uggowitzer et al. (7) & as follows:

Absence of flow : Grade 0
Spotty flow : Grade 1
Segmental flow : Grade 2
Continuous flow : Grade 3

Statistical Analysis:

Chi-square test was used for analysis of data related to PD and CD sonography, while T-test was used for analysis of data regarding GB wall thickness. $P< 0.05$ was considered to be statistically significant.

Results:

The GB volume in fasting subjects ranged from 7.5ml to 30ml (mean, 18.7ml). 45min. after eating the test meal, the GB volume decreased by a mean of 35.2%.The G.B. volume was smaller than at baseline (fasting) in 37 subjects, unchanged in 10 & larger in 3.

GB wall thickness measurements showed a statistically very highly significant increase ($p< 0.0001$) from baseline to 45 min. after the test meal, mean 2.32mm ± SD 0.35 to 2.7mm ± SD 0.05 respectively.

Doppler (color & power) sonographic examinations showed either no mural flow (Grade 0) or only solitary spotty signals of flow (Grade 1). No sign of (Grade 2) or (Grade 3) flow was detected in the GB of the studied subjects by both CD & PD sonography (Tables 1& 2).

On CD sonography, mean flow grades were 0.16 & 0.42 at baseline & at 45 min. after eating, respectively (Table 1). The corresponding grades on PD sonography were 0.58 & 0.86 (Table 2). The increase in flow at 45 min. after eating compared to that at baseline (fasting) was statistically significant ($P< 0.05$) on both CD & PD sonography .

Mural flow was more conspicuous with PD than CD sonography at fasting & at 45min. after eating (Table 3), with this difference being statistically very highly significant (P< 0.0001).

Table 1. Color Doppler sonographic results on four-point flow grading system

Grading	Grade 0	Grade 1	Grade 2	Grade 3	Mean flow grade
Fasting n=50	42	8	0	0	0.16
After eating n=50	29	21	0	0	0.42

P < 0.05 (Chi-square test).

Table 2. Power Doppler sonographic results on four-point flow grading system

Grading	Grade 0	Grade 1	Grade 2	Grade 3	Mean flow grade
Fasting n=50	21	29	0	0	0.58
After eating n=50	7	43	0	0	0.86

P < 0.05 (Chi-square test).

Table 3. Comparison of color Doppler & power Doppler sonographic flow grading results

	Fasting (n=50)		After eating (n=50)	
Grading	Grade 0	Grade 1	Grade 0	Grade 1
Color Doppler	42	8	29	21
Power Doppler	21	29	7	43
	P < 0.0001 (Chi-square test)		P < 0.0001 (Chi-square test)	

Discussion:

Thickening of the GB is a common though non-specific sonographic finding. Abnormal thickness can be attributed to diseases that are either intrinsic to the GB, such as acute or chronic cholecystitis, or extrinsic, such as congestive heart failure, hypoalbuminemia, pancreatitis, hepatitis, & renal failure. In patients with thickening of the GB wall, differentiating those with acute cholecystitis from those with other causes of wall thickening is important because cholecystectomy may be indicated. Pathologic examinations of specimens from patients with acute cholecystitis often show an increase in the size & number of vessels in the GB wall (5). Several investigators have attempted to enhance the diagnostic accuracy of sonography by detecting hyperaemia in acutely inflamed GB wall using color and power Doppler sonography. Schiller et al. (6), Soyer et al. (8), & Draghi et al. (9) reported that CD & PD sonography showed higher accuracy in revealing acute cholecystitis than conventional sonography. However, Paulson et al. (5), Jeffrey et al. (12), & Olcott et al. (13) found that the presence of flow in the GB wall was not a reliable indicator of acute cholecystitis.

On the other hand, several workers reported contradictory findings related to the ability of CD & PD sonography in revealing mural flow in healthy GB (3,7,8,13).

The present work was performed to detect flow in normal GB wall especially when it is thickened after contraction.

Out of the 50 healthy subjects examined sonographically, the GB showed contraction & decrease in volume after the test meal in 37, was unchanged in 10, & became larger in 2. These results are comparable to those obtained by Tessler & Tublin (3) who examined 10 volunteers, and after eating, the GB volume was smaller than at baseline in 6, unchanged in 2 & larger in 2.

Moreover, GB wall thickness in the present study, showed a very highly significant increase after the meal. This is in agreement with the findings of Tessler & Tublin (3).

Following conventional sonography, CD & PD sonography were performed on all subjects at fasting & after eating by 45 min.

Mural flow was detected (Grade 1:spotty signals) in only 8 & 29 subjects by CD & PD respectively, at fasting. While mural flow in the form of spotty signals (Grade 1) could be detected in 21 & 43 subjects by CD & PD respectively, after eating the test meal.

Uggowitzer et al. (7) detected mural flow (Grade 1) in 14 & 20 subjects by CD & PD respectively, out of their 72 fasting healthy volunteers. In contrast, Soyer et al. (8) were unable to detect flow in any of their 79 subjects without GB disease, using either CD or PD.

In agreement with Tessler & Tublin (3) the results in this study showed that mural flow was significantly greater 45 min. after eating than at fasting, on both CD & PD sonography. In addition, mural flow could be revealed by PD sonography in a larger number of the subjects studied at both fasting & after eating, in comparison with CD sonography, with very highly significant difference. These results are comparable with those obtained by Olcott et al. (13), whereas, Tessler & Tublin (3) found that although at each time point, flow was more conspicuous with PD than with CD sonography, but the difference was not statistically significant.

In conclusion, flow in the GB wall is a normal finding that is more apparent when the GB is contracted (i.e. after eating). Therefore, mural flow should be interpreted with caution, as a sign of acute cholecystitis, particularly when the GB is not distended.

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