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Original Article

Ultrasound imaging of gallbladder variants

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ABSTRACT

Introduction: This article examines the variations and anomalies of gallbladder. This study is highly useful for surgical purposes where there is always a lot of variations seen, to prevent misdiagnosis and to aid in evaluation of differential diagnostic possibilities.
Methods: Ultrasonography was used to perform this study.
Result: This study demonstrates wide array of variants including anomalies in location, number and configuration. The present study shows that there is double gallbladder found in 1%, kinking of posterior wall of gallbladder in 15%, Phrygian cap deformity in 7%, curved gallbladder found in 1%, intrahepatic gallbladder observed in 9%, transverse gallbladder detected in 7% and the gallbladder is located under the left lobe of liver in 2% of the cases. Normal location in right Hypochondrium is seen in 81 subjects.
Discussion: The present study shows various anomalies of gallbladder that can be diagnosed prior to the surgery, so as to avoid misdiagnosis that could cause any fatality.

1. Introduction

The gallbladder is an organ that stores and concentrates bile before it is delivered to the small bowels. It consists of fundus, body and neck. Shape is normally pear shape. It is situated on the undersurface of right lobe of Liver in the fossa for the gallbladder. Normally location is the right Hypochondrium. Our objective is to study the prevalence of variations in gallbladder and its morphology, locations, number and configuration, to compare findings with other group findings, to infer any factors or clues in gallbladder diseases and to alert the clinician of variations of the gallbladder that could result in fatality during procedures.

2. Materials and methods

Subjects include 100 normal, healthy adults who came for master health check with no known signs and symptoms of any disease clinically, biochemically and ultrasonographically. Subjects are picked up randomly from cosmopolitan urban upper to middle class population group. Subjects include 61 males and 39 females (Graph 1). Age ranges from 19 to 65 years. Prior consent was taken in all cases. Study is approved by the Local Ethical committee of Nitya Diagnostic Centre Study and performed at Nitya Diagnostic Centre.

3. Result

The present study shows that there is double gallbladder found in 1%, kinking of posterior wall of gallbladder in 15%, Phrygian cap deformity in 7%, curved gallbladder found in 1%, intrahepatic gallbladder observed in 9%, transverse gallbladder detected in 7% and the gallbladder is located under the left lobe of liver in 2% of the cases. Normal location in right Hypochondrium is seen in 81 subjects (Graph 2, Tables 1–3, Figs. 1–7).

4. Discussion

4.1. Variation in form and shape

Several variations in the ultrasonographic appearance of gallbladder shape were described. The so-called junctional fold is a kinking or folding of the gallbladder, usually of the posterior wall, but can occur anteriorly as well. Such junctional folds occur frequently, and are easily shown by ultrasonography as well as by other imaging techniques. The gallbladder may show gross folding or bending, occasionally forming a bizarre appearance or an unusual shape. Careful analysis usually excludes adjacent disease.

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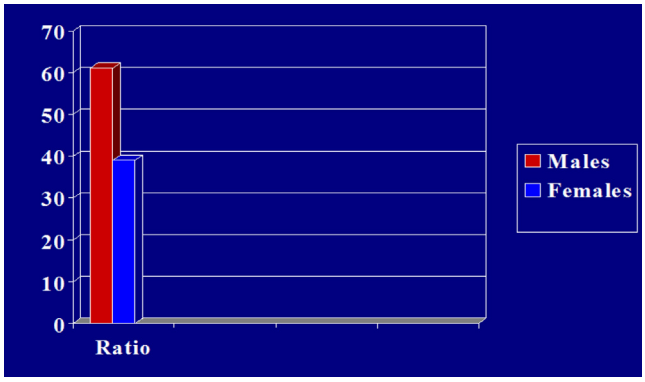
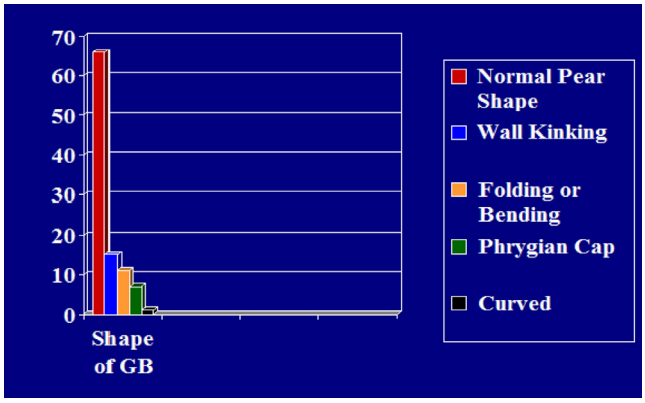


Graph 1. Male to female ratio in our study.



Graph 2. Variants of gallbladder.

The Phrygian cap is a common normal variation. The name is derived from ancient Greek headgear, descriptive of the asymptomatic folding of the gallbladder fundus.

Two most significant variations are the folded fundus and variations at neck of the gallbladder.[1] According to Khamiso Altaf, Phrygian cap variations are about 1 in 300 cases i.e. 0.33.[2,3] It is a rare cause of false positive diagnosis of stones. According to Williams B. Sutter and Phillips, variants in double gallbladder are 2.5 in 10,000. Due to inadequate drainage by any lobe it may be a predisposing factor for the development of cholelithiasis.[3] Meistrup et al., 1991[4] observed that gross bending of the gallbladder can occur posteriorly or anteriorly and lead to bizarre or unusual shapes when visualized by sonography and other

Table 1
Variants in form and shape.

S. no.	Variations	Subjects
1.	Normal gallbladder	66
2.	Posterior wall kinking	15
3.	Folding or bending	11
4.	Phrygian cap	7
5.	Curved (bizarre)	1

Table 2
Variation in location.

S. no.	Variation	Subjects
1.	Normal variation in right hypochondrium	81
2.	Intrahepatic	9
3.	Transverse	7
4.	Under the left lobe	2

Table 3
Variation in number.

S. no.	Variations	Subjects
1.	Single gallbladder	99
2.	Double gallbladder	1

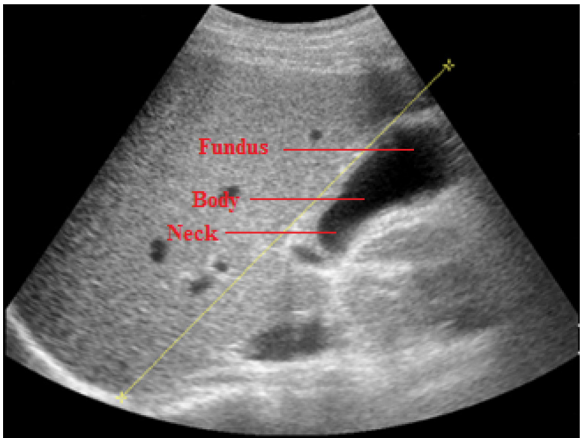


Fig. 1. Normal pear-shaped gallbladder.

Fig. 2. Gallbladder with folding or bending.

Fig. 3. Junctional fold in gallbladder.

Fig. 4. The tortuous cystic duct.

Fig. 6. Gallbladder in epigastrium.

imaging techniques. Gore et al., 2000[5] found it in 1–6% of population and observed a fold or septum between the body and the fundus.

Futura et al., 2001[6] observed that there was a significant higher prevalence of kinking of the gallbladder and Hartmann's pouch in the females than in male subjects which could be related to higher rate of gallstone formation and biliary tract diseases in females. Kinking of posterior wall of gallbladder is seen in 15% of cases in the present study. Phrygian cap was reported in 3–7.5% of the cases by Lichtenstein Nicosia 1955.[7] They considered it due to disproportion between the size of the gallbladder and that of the gallbladder bed, but without any pathological significance. Deutsch 1986 found this variation in 0.33% and considered it as non-developed form of congenital septum. Folded fundus – Phrygian cap was found in four i.e., 6.67% specimen. Folding of the neck over the body of the gallbladder is found in four specimens −6.67%, out of which one −1.67% was anteriorly folded.[8] In present study, it is about 7%.

Phrygian cap is a common deformity occurring in about 1–6% of population which was similar to that of Lichtenstein and Nicosia 1955[7] and Gore et al. in 2000.[5]

Septa of the gallbladder can be either partial or complete. These can lead to stasis and stone formation. Multiseptate gallbladder is a rare variation, having a multichambered lumen with multiple septa,[9] creating a honey-combed appearance. Presence of a septum was reported by De Csepel et al., 2003,[10] Chalkoo 2009[11] and Talpur et al., 2010.[12] Talpur found this variation in 0.33% of his cases. In 1963, Simon and Tandon described the clinical, radiologic and pathologic findings in a patient with multiseptate gallbladder.[13]

4.2. Variation in location

Gallbladder can be seen in any part of the abdomen. While variable positions are rare, the most common of these are:

1. Under the left hepatic lobe.
2. Intrahepatic.
3. Transverse.
4. Retro-placed (retro-hepatic or retroperitoneal).

Intra-operative ultrasonography may be helpful in establishing the diagnosis and in finding a completely intrahepatic gallbladder.[7]

An intrahepatic gallbladder is the one which is embedded partially or completely within the matter of liver.[14,15] It is the second most frequent ectopic location of the gallbladder.[16] Intrahepatic gallbladders have a sub-capsular location along the anterior inferior right lobe of the liver.[17] Present study shows that intrahepatic gallbladders are about 9%.

An aberrant gallbladder situated under the left liver, medial to falciform ligament, was first described by Hochstetler[18] in 1886 and was termed 'left-sided gallbladder'. 110 more cases were reported over the last 112 years. The method of detection was by anatomical dissection until 1930, by cholecystography and or laparotomy during the 1940s and 1950s and by laparoscopy more recently.

An aberrant gallbladder situated under the left lobe of liver may develop in two ways. Firstly, the gallbladder develops from a

Fig. 5. Phrygian cap gallbladder.

Fig. 7. Double gallbladder.

hepatic diverticulum at its normal place. It then migrates to the left of falciform ligament and attaches to the under-surface of the left liver.[19] This migration explains the entry of the cystic duct on the right side of the hepatic duct, as described in this and most other studies. In the other case, a left-sided gallbladder may develop directly from the left hepatic duct[20] accompanied by the failure of development of a normal gallbladder on the right side.[21] Here the cystic duct enters the common duct directly on the left side. Some left-sided gallbladders have been explained by Nagai and colleagues who found the variation associated with a right-sided falciform ligament in 3 of 1621 patients –0.2%, during operation[22] another 15 examples of this association were present.[19,23–27] The suggested explanation is that during early fetal growth to 6 mm size, both right and left-sided umbilical ligaments exist. By 7 mm embryo size, the right side normally atrophies and the left side becomes dominant.[28,29] In rare instances, the left ligament atrophies and the right ligament becomes dominant in 0.1–0.7%.[23] In such patients, the gallbladder is situated at the normal site but to the left of a right-sided falciform ligament, so it appears aberrant beneath the left lobe of liver. This anomaly should not be confused with a true left-sided gallbladder situated medial to the normal falciform ligament. Information on the falciform ligament is not usually available in reports, but in each of the cases, it is normally placed. 0.2% Gallbladder found under the left lobe according to Nagai.[22] The incidences of ectopic locations of the gallbladder are reported to be 0.1–0.7%.[30] Present study illustrates gallbladder under left lobe are about 2%.

4.3. Variation in number

Agenesis of the gallbladder is rare, as are duplication anomalies. Due to failure of development of the caudal division of the primitive hepatic diverticulum or failure of vacuolization after the solid phase of embryonic development agenesis of the gallbladder occurs.

Imaging of multiple gallbladders is challenging, since the duplicated gallbladder(s) are difficult to detect on sonography, Magnetic Resonance Cholangio-Pancreatography (MRCP) confirms the diagnosis. Atresia or hypoplasia of the gallbladder also represents aborted development of the organ.[13,31] Other congenital anomalies are represented in two-thirds of these patients, including congenital heart lesions, polysplenia, imperforate anus, absence of one or more bones, and rectovaginal fistula. There appears to be a genetic input as well, because several families with multiple individuals having agenesis are identified. This malformation was reported in 0.013–0.155% of autopsy series, but many of these cases are in stillborn and young infants. The surgical incidence of gallbladder agenesis is approximately 0.02%,[32,33] nearly 2/3rd of adult patients with agenesis of the gallbladder have biliary tract symptoms, and extrahepatic biliary calculi were found in 25–50% of these patients.

Preoperative diagnosis of gallbladder agenesis is difficult, and the absence of the gallbladder is often an intra-operative finding.[34–36] Ultrasound or CT may suggest the diagnosis, but this disorder is usually diagnosed during surgery when the gallbladder is not found in cholangiography.[37] No agenesis of gallbladder is found in present study.

Agenesis of gallbladder is a rare cause of false-positive hepatobiliary scintiscans. Gallbladder duplication occurs in about 1 in 4000 people.[4,38] Present study shows duplication in about 1 in 100 urban populations. Variations caused due incomplete revacuolization of the primitive gallbladder results in a persistent longitudinal septum that divides the gallbladder longitudinally. Another possible mechanism is the occurrence of separate cystic buds. To establish the diagnosis of two separate gallbladder cavities, each with its own cystic duct must be present.[39] These duplicated cystic ducts may enter the common duct separately or form a 'Y' configuration before opening in a common entrance.[40] Most reported cases of gallbladder duplication have a clinical picture of cholecystitis with cholelithiasis in at least one of the gallbladder. Sometimes one of the gallbladders appears normal in oral cholecystography, while the second, diseased non-visualized and unsuspected gallbladder produces symptoms.

5. Conclusion

Routine ultrasound imaging of the gallbladder demonstrates a wide array of imaging variants, including anomalies in location, number, and configuration.

An awareness of these normal variants may prevent misdiagnosis and will aid in evaluation of differential diagnostic possibilities.

Conflict of interest

The authors have none to declare.

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