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Original Research Article

Morphometric study of adult human gall bladder in a cadaver and its clinical importance

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ABSTRACT

Background: Extrahepatic biliary apparatus comprises of gall bladder, cystic duct, hepatic ducts and common bile duct. Gall Bladder is a pear shaped hollow organ, which are situated in contact with the under surface of right lobe of liver. In adult the length is between 7-10 cm, maximum breadth being 3 cm and with a maximum capacity of 50 ml. The morphological and morphometric variations of gall bladder are common. These variations are well studied and documented by the earlier studies but its precise morphological types and its incidence are utmost important during diagnostic and therapeutic procedures. Hence, comprehensive knowledge of variations of gall bladder will be important to avoid complications during surgical procedures and radiological interventions.

Materials and Methods: The study was carried on 50 liver with Gallbladder specimens obtained from 10% formalin fixed cadavers of age group 50-60 years in the department of Anatomy. The gall bladder was observed, dissected carefully and studied for its parameters i.e. length and breadth using Vernier calipers. The variations in shape, its external morphological features and its position were also noted.

Results: 52% of the gall bladder specimens had length ranging between 7 – 10cms. 68% of the specimens had transverse diameter ranging between 3 – 5cms. Various shapes observed were Pear shape, Hourglass shape, Retort shape, Cylindrical shape and Flask or Irregular shaped. The commonest shape observed and recorded in this study was Pear shaped in 26 specimens (52%). Folded fundus (Phrygian cap) of gall bladder was found in 2 out of 50 specimens (4%) and Hartmann's pouch was found in 7 out of 50 specimens (14%).

Conclusion: The precise knowledge of the various morphological and morphometric variants of the gall bladder is important for the operating Surgeons and Radiologists. The preoperative diagnosis of these variations helps to reduce the complications like bleeding and biliary leaks.

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1. Introduction

Extrahepatic biliary apparatus comprises of gall bladder, cystic duct, hepatic ducts and common bile duct. The gallbladder is a slate-blue, pear-shaped sac, partly sunk in a fossa or depressed area in the right hepatic lobe's inferior surface. It extends forward from a point near the right end of porta hepatis to the inferior hepatic border.

Its superior or upper surface is attached to the liver by a connective tissue and elsewhere it is completely covered by peritoneum. It is a pouch like or blind ended diverticulum, leading to cystic duct and finally attaching itself to common bile duct. Gall bladder is 7-10 cm long, 3 cm broad at its widest part and has a capacity of 30-50 ml. It is described to have neck, body and fundus. The neck presents itself at the medial end close to porta hepatis and sometimes widens or dilates to form "Hartmann's Pouch". The body of gall bladder comes to lie in contact with liver surface.

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The fundus projects past the lower border of the liver to a variable length. The gall bladder varies in size and shape.¹ Sometimes gall bladder may be absent or double in number or bifurcated. A variation seen in the gall bladder with respect to its fundus is called Phrygian cap. Gall bladder varies in its position which includes intrahepatic, retrohepatic, retroperitoneal, suprahepatic, floating, anterior epigastric and transverse position.² The present study helps Surgeons and Radiologists in the better understanding of normal and variants of gall bladder.

2. Materials and Methods

The study was carried on 50 liver with gallbladder specimens obtained from 10% formalin fixed cadavers of age group 50-60 years in the department of Anatomy. The study was approved by Institutional ethics committee. Cadavers with abdominal surgeries, crush injuries of the abdominal organs and with a history of liver diseases were not included in the study.

The gall bladder was observed, carefully cleaned, dissected and studied. The following parameters were studied:

1. Its maximum length of gall bladder
2. Its maximum transverse diameter of gall bladder
3. Shape of gall bladder
4. External variants of gall bladder
5. Length of part of gall bladder below the lower border of the liver.

Its maximum length and maximum transverse diameter was measured using Vernier caliper and graduated in centimetres.

The recording of maximum length of gall bladder was measured from the porta hepatis to the mid-point of the fundus.

The recordings of maximum breadth were obtained at the site of maximal gallbladder width perpendicular to the long axis of the gall bladder and were noted.

The descriptive statistics recorded - minimum, maximum proportions, percentage and range. All the measurements were statistically analysed by using SPSS 21.0.

3. Results

3.1. Length of gall bladder

Gall bladder had length with range between 3 and 11cm. Average length of gall bladder recorded was 7 cm. The maximum length was 11 cm. The minimum length was 3cm. 52% of the specimens had length with range between 7 – 10 cm.

3.2. Transverse diameter of gall bladder

Gall bladder had a transverse diameter with range between 1.5– 5cm. Average breadth of gall bladder recorded was 2.9 cm. The maximum transverse breadth was 5.0 cm. The minimum transverse diameter recorded was found 1.5 cm. 68% of the specimens had transverse diameter ranging between 3 - 5 cm.

3.3. Shape of gall bladder

The classification of gall bladder was made in according to their shapes. Various shapes observed were Pear shape, Hourglass shape, Cylindrical shape, Retort shape, Flask and Irregular shaped. The commonest shape found were Pear shape – 26 specimens (52%).

3.4. External variants or appearance of gall bladder

Folding of fundus was observed with respect to anterior or posterior. Folding of fundus called as Phrygian cap was noted in 2 out of 50 specimens of gall bladder. Hartmann's pouch was found in 7 specimens.

3.5. Length of gall bladder below the inferior or lower border of the liver

The part of gall bladder below the inferior or lower border of liver varied between 0.5-4 cm.

Table 1: Length of gall bladder

S. No	Length	Number of specimens	Percentage (%)
1	3 – 7 cm	23	46 %
2	7 – 10 cm	26	52 %
3	>10cms	1	2 %

Table 2: Breadth of gall bladder

S. No	Breadth	Number of specimens	Percentage (%)
1	<3 cm	14	28 %
2	3 – 5 cm	34	68 %
3	>5 cm	2	4 %

Table 3: Various shapes of gall bladder

S. No	Shapes	Number of specimens	Percentage
1	Pear	26	52 %
2	Cylindrical	11	22%
3	Hourglass	7	14%
4	Retort	5	10%
5	Irregular	1	2%



Fig. 1: Pear shaped gall bladder



Fig. 4: Retort shaped gall bladder



Fig. 2: Cylindrical shaped gall bladder



Fig. 5: Irregular shaped gall bladder

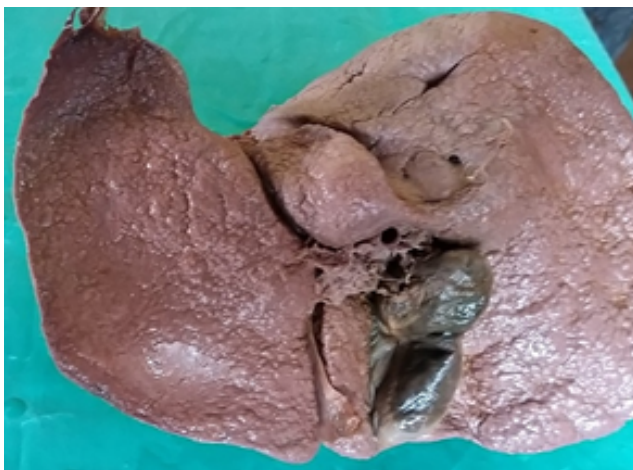


Fig. 3: Hourglass shaped gall bladder

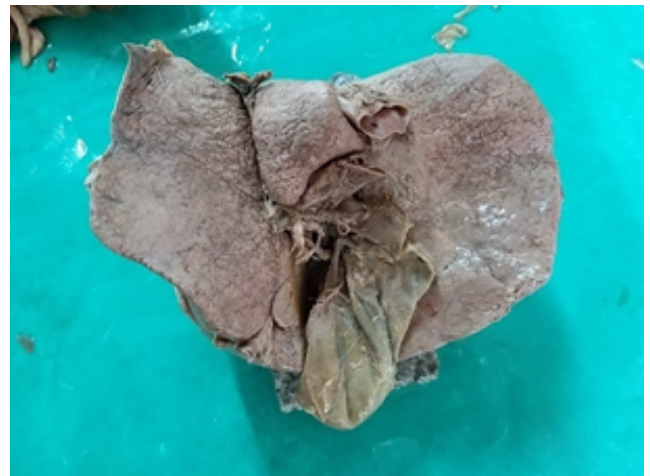


Fig. 6: Hartmann's pouch in gall bladder



Fig. 7: Folded fundus (Phrygian cap) of gall bladder

4. Discussion

At the beginning of the fourth week of normal human embryonic development, the liver, gall bladder, and its biliary ductal system starts developing from the hepatic endodermal diverticulum of the foregut. The diverticulum proliferates and projects into the septum transversum, which is a mesodermal plate present between the stalk of yolk sac and pericardial cavity. Later it divides into 2 parts – the cranial bud or part which give rise to liver and the bile ducts while its caudal bud or part gives rise to gall bladder and the cystic duct. Any malformation in the extrahepatic biliary system or apparatus may be caused due to some alterations in the normal embryonic development.³

The gall bladder varies extensively in its size and shape. The size of gall bladder may vary in different pathological and physiological conditions. The gall bladder with its increased size was observed and noted in diabetic conditions due to autoimmune neuropathy, pregnancy, sickle cell diseases, cystic duct or may be of common bile duct obstructed conditions, after truncal or selective vagotomy and in extreme obesity.⁴

The increase in size of gall bladder is termed as cholecystectomegaly, whereas size of gall bladder may decrease in cystic fibrosis.²

According to our study, the gall bladder had length ranging between 3 – 11cms which is similar to the study done by Prakash et al,⁵ Desai,⁶ Rajendra et al⁷ and Nadeem.⁸

The commonest shape recorded in this study was Pear shaped, noted in 26 specimens (52%) similar to the observations of Rajendra et al⁷ and Suman,² followed by Cylindrical shaped in 11 specimens (22%) closely corresponding to the study done by Rajendra et al,⁷ Suman,² Purvi et al⁹ and Stuti,¹⁰ Hourglass shaped in 7 specimens (14%), Retort shaped in 5 specimens (10%) and least common being Irregular shaped in 1 specimen (2%) in which the fundus was ‘V’ shaped.

The common variants of gall bladder are the folded fundus also known as Phrygian cap and variations at the level of neck of the gall bladder. Phrygian cap, a deformity in fundus of gall bladder, wherein the fundus is folded on the body which results in separation of the fundus from the body in partial is considered to be normal anatomical variants of gall bladder. It was first described by Bartel¹¹ in the year 1916 who documented and recorded 43 cases at autopsy. Boyden¹² in the year 1935 found this deformity to be present in 7.5% of the 80 autopsy specimens and 3.6% of the studied cholecystograms. In 1937, Lichtenstein¹³ reported 3% out of 212 specimens. It was reported to have been precipitated by a local thickening of the gall bladder wall and may be of little importance as the gallbladder function is usually normal. They also explained that it can be due to a disproportionate size of the gall bladder with that of the gallbladder bed, but with no pathological significance.¹³ This variant is usually symptomless and are diagnosed on ultrasonography or on x-ray.¹⁴ These types of variants can be mistaken for stones.¹⁵

Hartmann’s pouch is a dilatation or widening at the level of the neck of gall bladder. It is of two types—developmental and acquired types. In congenital / developmental type, all the layers of gall bladder wall are present, but in the acquired variety / type it may result from some other disease process and has got little or there may be absence of smooth muscle in its wall. In these cases, patients may present with clinical symptoms and also signs and are usually associated with cholelithiasis (stones in gall bladder) and carcinoma of gall bladder. This can conceal or cover the cystic duct and calot’s triangle which may lead to a condition like mucocele and Mirizzi’s syndrome, in which the compression of the ducts can be caused by the gall bladder stones impacted within the Hartmann’s pouch.¹⁶ Futara et al. observed and recorded that there was a higher prevalence of kinking of the gallbladder and Hartmann’s pouch in the females than in male subjects which may be related to the higher cases of gall bladder stone formation and biliary tract diseases in females.¹⁷ In this study, we found the Hartmann’s pouch in 7 specimens (14%), which is higher than the observations noted by Nadeem⁸ 7% and Bharathi et al¹⁸ noted in 2 specimens (3.33%). Hence preoperative diagnosis of presence of dilatation at the level of neck of gall bladder should be done to avoid post-operative and intraoperative complications.

Among all the different types and shapes of gall bladder, the rarely observed abnormal variant of gall bladder is intrahepatic gallbladder, which may present as partial type or complete type. In case of partial type, a part of the gall bladder may be seen as projecting outside from within the substance of liver. Whereas in complete type, the gall bladder is completely embedded within the parenchyma or the substance of the liver. It is a developmental anomaly and is caused due to congenital arrest in the movement of gall

bladder from its intrahepatic position in the 2nd month of gestation to its normal superficial location. These types of variants can be diagnosed by ultrasonographic techniques or by Computed Tomography scan.

Due to incomplete emptying of the gall bladder caused by stasis, subjects with intrahepatic gall bladder are more prone for cholelithiasis.¹⁹ The preferred treatment of choice for cholelithiasis in patients with intrahepatic gall bladder is cholecystostomy rather than cholecystectomy as cholecystectomy is threatening in persons with such anomaly.²⁰ Intrahepatic gallbladder has been reported by Suman² as 1 in 50 specimens (2%). This was not observed in our present study.

The part of gall bladder below the inferior border of the liver is the most susceptible length of gall bladder that may get injured or damaged in various laparoscopic procedures.¹⁰ Stuti et al.¹⁰ reported it as being between the range of 0.46 -3.93 cm and Prakash et al⁵ reported between 0.4 -2.5 cm. In our study it was between 0.5 - 4 cm which was similar to these studies.

Gallbladder size and its volume are the key determinants of gallbladder contraction and function. These parameters get altered with age and can be explained of the age-related reduction in gallbladder contractility and its association with gallstone formation. The gallbladder volume shows a statistically significant increase with age and there is a marked increase in these parameters after the 5th decade. This explains the exponential increase in prevalence of cholelithiasis and cholecystitis by 4 to 10 times after the 5th decade of life. Individuals with a higher resting gall bladder volume and a higher residual volume after meals would have less post prandial fractional emptying. It is also observed and established that larger gallbladder volumes in older individuals are the predictors of impaired gallbladder motility and bile stasis which may predispose the normal subjects to further gall stone and biliary sludge formation.²¹

These findings may suggest the clinicians that measurements obtained from cadaveric specimens can be compared with those from the ultrasonographic measurements done in vivo are comparable. The measurements obtained from cadaveric studies can be used as a baseline data to interpret ultrasonographic parameters and may advise the asymptomatic individuals for their further prevention of predisposing factors and may avoid complications of the gallbladder.

5. Conclusion

The reporting and documentation of various congenital anomalies and morphological variations of extrahepatic biliary apparatus are not common. However, the detailed study of morphological variations and morphometric knowledge helps Surgeons, Radiologists to reduce morbidity. Awareness of these variations may help them to relook at the pathological conditions while performing

interventional procedures. Failure to recognise can lead to iatrogenic injuries. The common complications encountered during surgical procedures are intraoperative bleeding and also biliary leaks. Nowadays most of the surgical procedures like cholecystectomies (removal of gall bladder) is done laparoscopically and it is important as well as necessary to have a precise awareness of morphological variations of gall bladder in an attempt to perform safe cholecystectomy and to avoid re-exploration of the patients.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

References

1. Standring S. The anatomical basis of clinical practice in gall bladder and biliary tree. In: Gray's Anatomy. Philadelphia: Elsevier Churchill Livingstone; 2008. p. 1177–81.
2. Tiwari S. Study of anatomic variations of human gall bladder and its clinical importance. *Indian J Clin Anat Physiol*. 2018;5(1):124–8.
3. Hollinshed WH. The Liver and the Gall bladder. In: Anatomy for Surgeons. Philadelphia: Harper and Row publishers; 1983. p. 334.
4. Rajguru J, Khare S, Jain S, Ghai R, Singla M, Goel P. Variations in The External Morphology of Gall Bladder. *J Anat Soc India*. 2012;61(1):9–12.
5. Prakash AV, Panshewdikar PN, Joshi DS, Anjaankar AP. A cadaveric study involving variations in external morphology of gall bladder. *IntJMedResHealth*. 2013;2(2):239–42. doi:10.5958/j.2319-5886.2.2.029.
6. Desai J, Bhojak N. 2015.
7. Rajendra R, Makandar UK, Tejaswi HL, Patil BG. Morphometric Study of Gall Bladder in South Indian Population(cadaveric study). *Indian J Forensic Community*. 2015;2(1):35–42.
8. Nadeem G. A study of the clinico-anatomical variations in the shape and size of gallbladder. *J Morphol Sci*. 2016;33(2):62–7.
9. Purvi M, Anant F, Kseersagar DD. A study of variations in the external morphology of gall bladder. *World J Pharm Med Res*. 2018;4(3):276–8.
10. Stuti S, Abeer ZK. Morphology of gall bladder-A Cadaveric study. *J Curr Med Res Opin*. 2019;2(10):293–8.
11. Bartel J. Cholelithiasis und Körperkonstitution cholelithotripsie. *Frankfurt Z Pathol*. 1916;p. 206.
12. Boyden EA. The accessory gall bladder - an embryological and comparative study of aberrant biliary vesicles occurring in man and the domestic mammals. *Am J Anat*. 1926;38:177.
13. Lichtenstein M, Nicosia AJ. The Clinical Significance of Accessory Hepato-Biliary Ducts. *Annals*. 1955;141(1):120–4.
14. Gore RM, Fulcher AS, Taylor AJ, Ghahremani GG. Anomalies and Anatomic Variants of the Gallbladder and Biliary Tract. In: Textbook of gastrointestinal Radiology . Philadelphia, PA: B Saunders Co; 2000. p. 1305–20.
15. Dundareddy R, Sumana R. Comparative study of Human Gall Bladder variations in south Indian population. *Int J Sci Res*. 2017;6(4):36–8.
16. Choudhury P. Relevant Biliary Anatomy during cholecystectomy. *J Evol Med Dent Sci*. 2014;3(35):9332–42.
17. Futura G, Kinfu Y. Anatomical variations of Gallbladder and biliary ducts among Ethiopians. *Ethiop Med J*. 2001;39(3):173–84.
18. Bharathi D, Jyothilakshmi GL, Shruthi BN. Morphometry and morphology of variations of gall bladder: A Cadaveric study. *Int J Anat Res*. 2020;8(2.1):7413–7.

19. Khalsa MS, Hari JP, Dutta A. Cholecystectomy for intrahepatic gall bladder with incidental sub hepatic appendix: a challenge for the surgeon. *Int J Res Health Sci.* 2017;5(2):16.
20. Hassan A, Zargar SA, Malik A, Shah P. Surgical significance of variations in the anatomy in the biliary region. *Int J Res Med Sci.* 2013;1(3):183–7.
21. Kariuki BN, Saidi H, Ndung'u B, Kaisha W, Ogeng'o J. Influence of age on gallbladder morphometry. *Anat J Afr.* 2017;6(2):987–94.

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