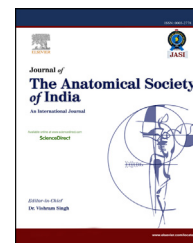


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Original Article

The gallbladder of human fetuses: A morphological and morphometric study

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ABSTRACT

Introduction: The study aims in analyzing the gross development of human gallbladder and its variations.

Methods: 92 fetuses, 59 males and 33 females, of different age groups were dissected for morphological analysis of gallbladder. The length and weight of foetal gallbladder, its relationship with the gallbladder fossa of liver and inferior hepatic margin, its lumen and wall, detection of bile and congenital anomalies are looked into the present study.

Results: In foetus, the gallbladder is short of inferior hepatic margin. A sudden increase in mean length and weight of the gallbladder is observed as foetal age advances from 26–30 weeks to 31–35 weeks. Bile staining of the wall of gallbladder is observed from 17-week old fetuses onwards. Double gallbladder with common cystic duct, intraparenchymal gallbladder, a gallbladder on the inferior surface of liver along the line of attachment of falciform ligament (which is attached on the anterior surface of liver), a gallbladder with dilated body and neck, Phrygian cap, an enlarged gallbladder with wide lumen, thin wall and absence of bile stain were the variations observed in the present study.

Discussion: From this study, the gross development of the gallbladder can be analyzed. The knowledge of the variations in development of human gallbladder will be helpful for clinical studies.

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1. Introduction

The gallbladder, a part of extrahepatic biliary tree is a blind pear shaped diverticulum. It lies in the gallbladder fossa on

the visceral surface of the right lobe of liver, just to the right of quadrate lobe. It is covered by peritoneum continued from liver surface. The gallbladder continues into the cystic duct.

At one extreme, the gallbladder can be intraparenchymal i.e., buried within the liver surface and at the other extreme,

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the gallbladder may hang from a short mesentery.¹ Congenital anomalies of the gallbladder include agenesis of gallbladder, double gallbladder with single or separate cystic duct, small ducts connecting gallbladder with liver, folded fundus part of gallbladder (Phrygian cap deformity), septate gallbladder.²

The gallbladder consists of three parts: fundus, body and neck. Fundus is the bulbous blind end of the gallbladder. It usually projects beyond the inferior margin of the liver to a variable length. The fundus is continuous with the body. The upper end of the body narrows into the neck. The neck is continuous with the cystic duct. At the lateral end, the neck widens out and this widening is referred to as Hartmann's pouch.¹

The liver primordium appears in the middle of the third week as an outgrowth of the endodermal epithelium at the distal end of foregut.³ By 26–28 days, the liver primordium is directed ventrally and begins to proliferate as a diverticulum. There are two parts: a caudal part which gives rise to the cystic duct and gallbladder and a cranial part which will form the biliary system.⁴ The ductal system becomes solid and the lumen of the gallbladder becomes re-established at the end of 12 weeks of gestation.⁵ The gallbladder lies in the midline initially but it becomes more peripheral later on.⁶

In the neonate, the gallbladder has a smaller peritoneal surface than in the adult, and its fundus does not extend to the liver margin. It is generally embedded in the liver and in some cases, it may be covered by bands of liver. After the second year, the gallbladder assumes the relative size that it has in the adult.⁴ Bile formation by hepatic cells begins approximately at 12th week of gestation. The study aims to analyse the gross development of human gallbladder and its variations.

2. Materials and methods

Ninety two foetuses, 59 males and 33 females of different age groups varying from 15 weeks to 40 weeks which were

products of terminated pregnancy under Medical Termination of Pregnancy (MTP) Act of India, 1971 and stillbirths were obtained from the Department of Obstetrics and Gynaecology, Regional Institute of Medical Sciences, Imphal. The ninety two foetuses were sorted out as being free from gross anatomical abnormality. The foetuses were immersed in a bucket of 10% formal saline. The age of the foetuses was calculated from obstetrical history and crown-rump length (CRL) and gross features. The specimens were categorized into five groups (Tables 1 and 2):

Group I: 15–20 weeks (CRL – 80 mm to 150 mm)

Group II: 21–25 weeks (CRL – 151 mm to 210 mm)

Group III: 26–30 weeks (CRL – 211 mm to 290 mm)

Group IV: 31–35 weeks (CRL – 291 mm to 370 mm)

Group V: 36–40 weeks (CRL – 371 mm to 450 mm)

3. Results

In foetus, the gallbladder was short of inferior hepatic margin. As foetal age advances, the distance between the fundus of gallbladder and inferior margin of liver gradually decreases. In younger foetuses (15–22 weeks), the gallbladder is completely embedded in the gallbladder fossa of liver. It descends from this position thereafter, which means that the gallbladder becomes subhepatic (Fig. 1). They are situated at the right side of falciform ligament. The distance of foetal gallbladder from umbilical vein is variable. Hartmann's pouch is an inconstant feature.

The maximum variation in length of the gallbladder is observed in the period of 21–25 weeks of foetal age (Table 1). The maximum variation in its weight is observed in 31–35 weeks of foetal age (Table 2). The least variation in length and weight of foetal gallbladder is observed in 15–20 weeks of foetal age. A sudden increase in mean length and weight of

Table 1 – Mean length of gallbladder and variations in the length of Gallbladder (as shown by standard deviation) at different foetal age groups.

Group	Foetal age (in weeks)	CRL (in mm)	No. of cases	Mean length of gallbladder (in mm)	Standard deviation of length (in mm)
I	15–20	80–150	23	11.1	1.85
II	21–25	151–210	29	17.1	3.9
III	26–30	220–286	17	19	3.1
IV	31–35	300–362	11	31.2	2.92
V	36–40	378–440	12	38.75	2.86

Table 2 – Mean weight of gallbladder and variations in the weight of gallbladder (as shown by standard deviation) at different foetal age-groups.

Group	Foetal age (in weeks)	CRL (in mm)	No. of cases	Mean weight of gallbladder (in mg)	Standard deviation of weight (in mg)
I	15–20	80–150	23	55.8	41.7
II	21–25	151–210	29	209.5	118.4
III	26–30	220–286	17	362.7	144
IV	31–35	300–362	11	874	163
V	36–40	378–440	12	1101	90.55

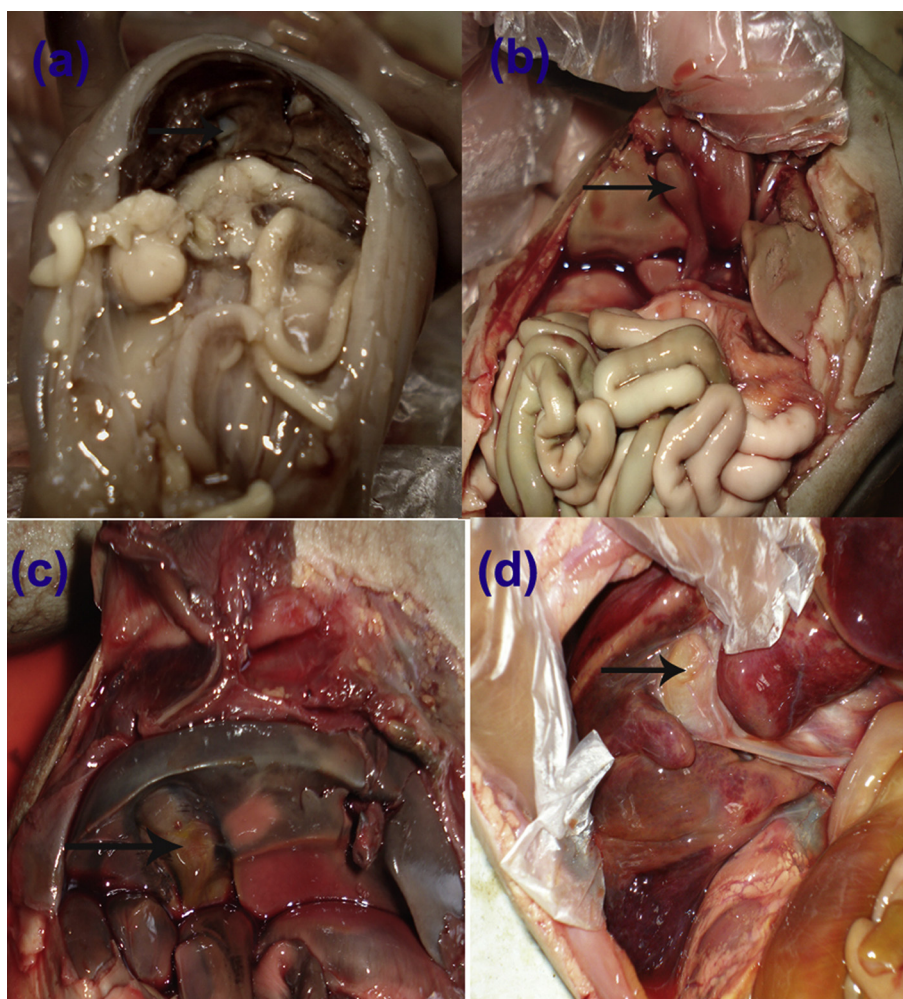


Fig. 1 – Foetal gallbladder (as indicated by arrow) at different foetal age-groups (a) 17 weeks (b) 24 weeks (c) 28 weeks (d) 40 weeks.

gallbladder is observed as age advances from 26–30 weeks to 31–35 weeks.

The wall of the gallbladder is very thick with narrow lumen in young foetuses. As the foetal age advances, the lumen of the gallbladder becomes wider and the wall thinner. The lumen of gallbladder is filled with solid debris in the foetal age period of 15–21 weeks. The debris is seen to be crumbly thereafter. Debris in lumen is detected up to 27 weeks of foetal age (Fig. 2). The wall of the gallbladder is double layered in the foetal age group of 22–27 weeks. Bile staining of the wall of the gallbladder as seen from external aspect is obvious from 25-week old foetuses onwards.

The variations observed in the foetal gallbladders of present study are as follows:

1. Double gallbladder with common cystic duct (Fig. 3a).
2. Intraparenchymal gallbladder (Fig. 3b).
3. A gallbladder on the inferior surface of liver along the line of attachment of falciform ligament (which is attached on the anterior surface of liver) (Fig. 3c).
4. A gallbladder with dilated body and neck (Fig. 3d).
5. Phrygian cap (Fig. 4a).

6. An enlarged gallbladder with wide lumen, thin wall and absence of bile stain (Fig. 4b).

4. Discussion

In the present study, the foetal gallbladders were found to be short of inferior hepatic margin till term though the distance between fundus of gallbladder to inferior margin of liver decreased as the foetal age advanced. The fundus of gallbladder crossed the inferior hepatic margin by 34 weeks of foetal age.⁷ Strandring et al⁴ mentioned that the fundus of the gallbladder did not extend to the liver margin in the neonate.

The present study favours the remark made by Haffajee⁷ that the distance of foetal gallbladder from umbilical vein is variable.

The transition between the neck and body of guinea pig's gallbladder is marked by a moderate constriction.⁸ This finding is faintly appreciated in foetal gallbladders of the present study.

The present study is in accordance with Haffajee⁷ who observed a descent of the gallbladder from an intra-hepatic

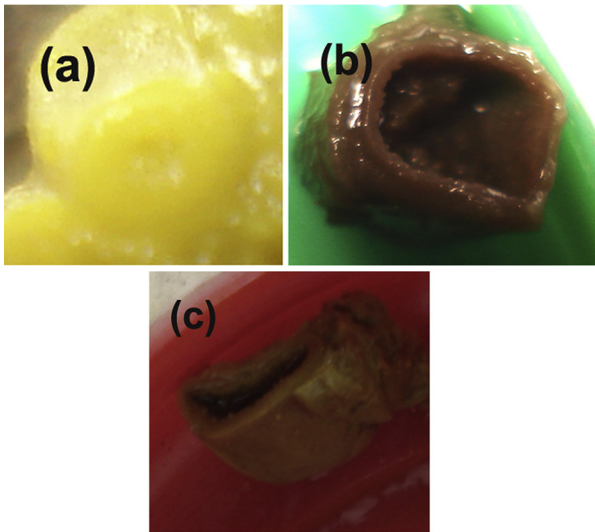


Fig. 2 – Lumen of foetal gallbladder at different foetal age-groups (a) 15 weeks (b) 22 weeks (c) 28 weeks.

position early in foetal life to a sub-hepatic position later on. On the contrary, Standring et al⁴ opines that the gallbladder is generally embedded in the liver and in some cases may be covered by bands of liver in the neonate.

In the present study, the mean length of gallbladder ranged from 11.1 mm (15–20 weeks of Gestational age) to 38.75 mm (36–40 weeks of Gestational age). In the present study, the least variation in the length and weight of foetal gallbladder was observed in 15–20 weeks of foetal age.

In the present study, the lumen of gallbladder was detected in all the foetuses in which the youngest foetus was 15-week old. The lumen of the gallbladder contains crumbly debris in 10–13 weeks of gestational age according to Haffajee.⁷ In the present study, the lumen of gallbladder was filled with solid debris in the foetal age group of 15–21 weeks. The debris was seen to be crumbly thereafter and it is detected up to 27 weeks of gestation. The present study also found the wall of the gallbladder to be very thick with narrow lumen in early foetal age. As foetal age advanced, the lumen of the gallbladder is seen to be wider and the wall thinner. The wall of the gallbladder was seen to be double layered in the foetal age group of 22–27 weeks.

Bile staining has been reported to occur from 14 weeks of foetal age.⁷ In the present study, bile staining of the wall of gallbladder was observed from 17-week old foetuses onwards.

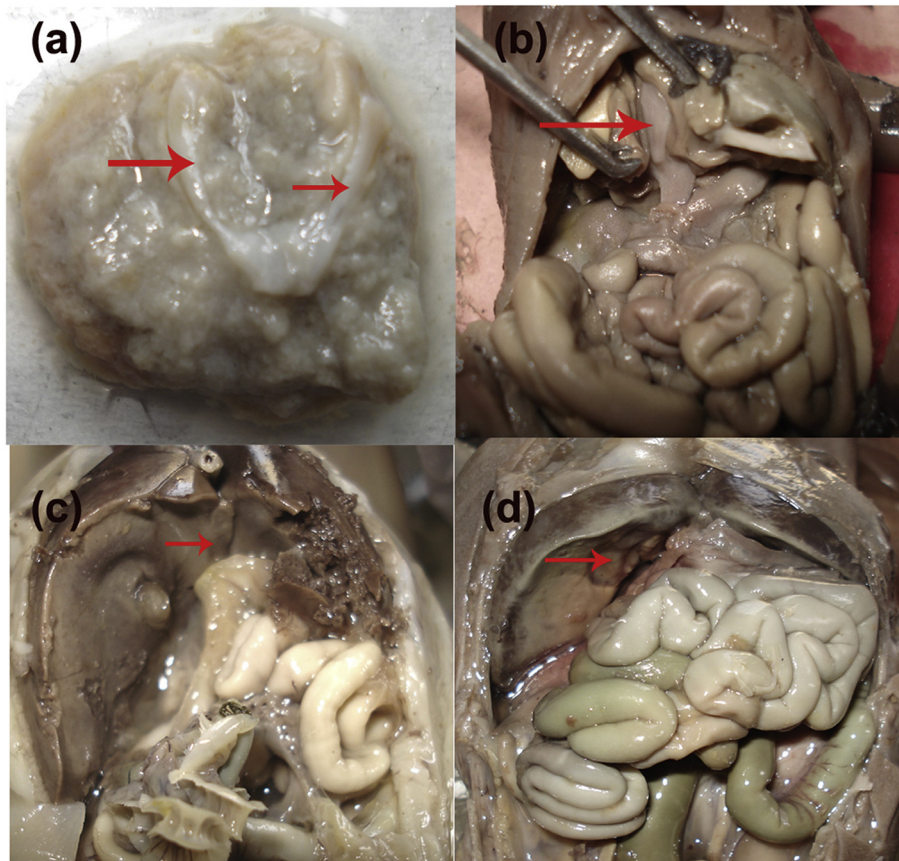


Fig. 3 – Variations (a) Double gallbladder with common cystic duct (b) Intraparenchymal gallbladder (c) Gallbladder along the line of attachment of falciform ligament. The falciform ligament is attached on the anterior surface of liver (d) Gallbladder with dilated body and neck.

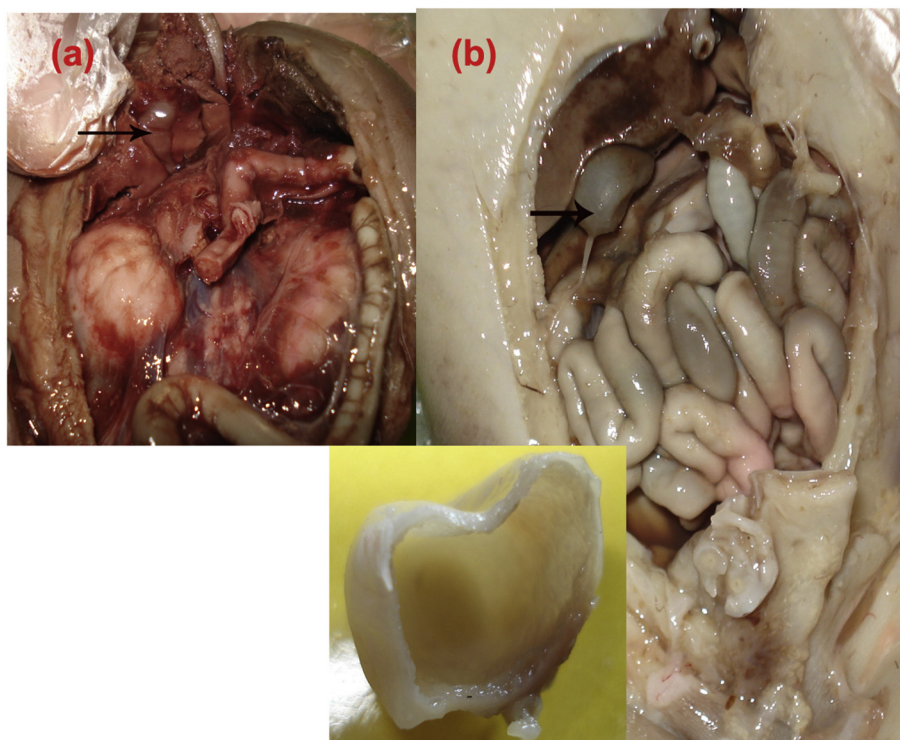


Fig. 4 – Variations (a) Phrygian cap (b) Enlarged gallbladder with its lumen.

The gallbladder Muller et al der sludge in the foetus is benign in nature and is similar to that of foetal gallstones.⁹ Muller et al¹⁰ found a foetal gallstone incidence of 0.07%. Foetal gallstones frequently undergo benign spontaneous resolution.¹¹

Prenatal detection of cholecystomegaly should prompt a search for associated anomalies and other markers of aneuploidy.¹² However, identification of an enlarged gallbladder at antenatal ultrasonography does not appear to associate with increased risk of chromosomal aneuploidy.¹³ In the present study, an enlarged gallbladder without bile is detected in a 26-week old male foetus. The absence of bile in this gallbladder probably depicts an obstruction in the biliary tract.

A case of agenesis of gallbladder which was diagnosed during surgery was reported.¹⁴ Agenesis of the gallbladder, with normal bile ducts, occurs in 13–65 people out of a population of 100,000.¹⁵

Phrygian cap which is the commonest congenital abnormality of the gallbladder has no pathological significance.² In the present study, 2 of the 92 foetal gallbladders studied exhibit Phrygian cap deformity.

Left-sided gallbladder has been reported.^{16,17} In the present study, an aberrant gallbladder in a 23-week old male foetus is detected on the visceral surface of the liver along the line of attachment of falciform ligament (which is attached on the anterior surface of liver). An aberrant placement of falciform ligament may give false impression of a left-sided gallbladder.¹⁸

Two cases of gallbladder duplication were reported.¹⁹ In the present study, a case of gallbladder duplication with common cystic duct is detected in a 15 week old male foetus.

Only eleven cases of triplication of the gallbladder have been reported to date.²⁰

The gallbladder may be of intraparenchymal pattern where it is almost completely buried within the liver surface. In the present study such an intraparenchymal gallbladder is detected in an 18-week old male foetus.¹

5. Conclusion

In foetus, the gallbladder is short of inferior hepatic margin. As the foetus grows older, the distance between the fundus of gallbladder and inferior margin of liver gradually decreases. Hartmann's pouch is an inconstant feature. A sudden increase in mean length and weight of the gallbladder is observed as foetal age advances from 26–30 weeks to 31–35 weeks. The wall of the gallbladder is very thick with narrow lumen in young foetuses. As the foetus grows older, the lumen of the gallbladder becomes wider and the wall thinner. Debris in lumen is detected up to 27 weeks of foetal age. The wall of the gallbladder is double layered in the foetal age group of 22–27 weeks. Bile staining of the wall of gallbladder is observed from 17-week old foetuses onwards. The knowledge of the variations in development of human gallbladder will be helpful for clinical studies.

Conflicts of interest

All authors have none to declare.

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