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Original Article

Anatomy Section

A Study of Variations in the Position of Fundus and Peritoneal Reflections of Gall Bladder

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ABSTRACT

Introduction: Various positions of fundus and peritoneal reflections of Gall bladder are of significance as it is a common site of medical and surgical pathologies.

Aim: To study the position and length of fundus of gall bladder and the peritoneal relations of the gall bladder.

Materials and Methods: An observational cadaveric study was done on 58 adult human liver specimens obtained from cadavers between the age of 20 to 68 years over a period of five years between October 2012 to September 2017 from the Department of Anatomy, Shri Sathya Sai Medical College and Meenakshi Medical College, Kancheepuram, after obtaining ethical committee clearance for studying the different positions and length of fundus along with the peritoneal reflections of gall bladder.

Results: The position of fundus of gall bladder was observed to be inframarginal in 25 specimens (43.1%), marginal in 13 specimens (22.4%) and supramarginal in 20 specimens (34.48%). For the 25 inframarginal type of gall bladders, the length of the fundus varied between 1.8 to 4 cm. A total of 31 out of 58 gall bladders showed differential peritoneal reflection. The remaining 27 specimens showed normal peritoneal reflection.

Conclusion: Knowledge about the different positions of gall bladder and its peritoneal relations is important, as peritoneum extending onto the superior surface can often be related to torsion and also may get injured being a common site of laparoscopic surgeries.

Keywords: Biliary tract, Cholecystectomy, Laparoscopy, Liver

INTRODUCTION

Gall bladder is flask shaped and is usually firmly attached by connective tissue to the inferior surface of the right lobe of the liver. It is located on the inferior surface of liver and is covered by peritoneum [1]. Its upper surface is attached to the liver by connective tissue, elsewhere it is completely covered by peritoneum continued from the hepatic surface. Occasionally it is completely invested by peritoneum and even connected to the liver by a short mesentery [2]. Rarely the gall bladder itself may be embedded within the liver [3]. The reflection of peritoneum varies widely. At one extreme, the gall bladder may be intrahepatic having no peritoneal covering, whereas on the other end, it may hang freely by a mesentery [4,5].

The gall bladder consists of the fundus, body, infundibulum and neck. The fundus is a bulbous blind end, which usually projects a little beyond the sharp inferior border of the liver and touches the parietal peritoneum of the anterior abdominal wall at the tip of the ninth costal cartilage, where the transpyloric plane crosses the right costal margin, at the lateral border of the right rectus sheath [3]. The fundus of the normal gall bladder is not palpable but may become so if distended by biliary tract obstruction. The body passes backwards and upwards and tapers towards the neck, which lies in the porta hepatis [3,6].

The biliary tract is one of the most frequent sites of operative intervention, with an estimated 8,50,000 biliary tract procedures performed every year in India [7]. Cholecystectomy is the most common operative procedure performed on biliary tract [8]. It is the single most common intra abdominal operative procedure and it is estimated that about 4,50,000 cholecystectomies were performed annually [9]. Few studies state that the extra hepatic biliary tract does not have a normal anatomy and instead presents with a common pattern of variations [10,11].

While doing routine dissection for undergraduate teaching we came across liver and gall bladder specimens with different positions of the fundus and varying peritoneal reflections with free hanging gall bladders. As, a free hanging gall bladder can lead to surgical emergencies, study aimed at observing the occurrence of this variation along with the position and extent of the fundus. Hence, this study was undertaken to observe various positions of the fundus and length in relation to and beyond the inferior border of liver. Also various peritoneal relations of the gall bladder were studied.

MATERIALS AND METHODS

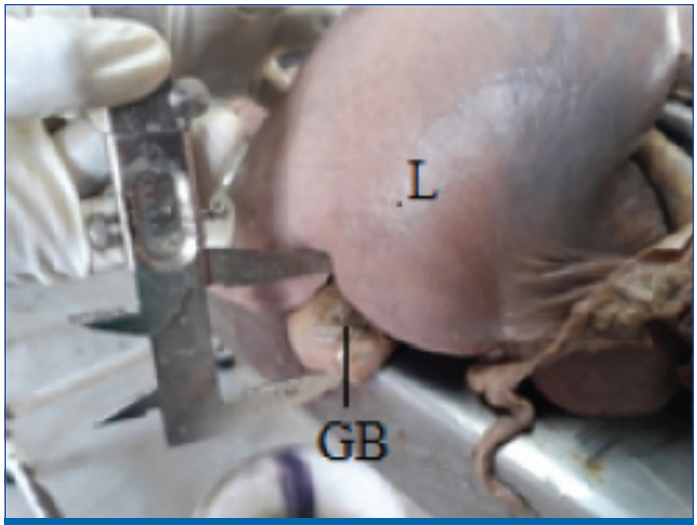
This is a descriptive, observational cadaveric study done on 58 adult human liver specimens. The sample size was obtained during routine dissection from cadavers between the age of 20 to 68 years over a period of five years from October 2012 to September 2017 from the Department of Anatomy, Shri Sathya Sai Medical College and Meenakshi Medical College, Kancheepuram, after obtaining ethics committee clearance (Institutional ethical committee, Shri Sathya Sai Medical College and Research Institute. IEC No: 2012/07). The 58 liver specimens taken in the study were removed from cadavers during routine dissection after excluding the cadavers with abdominal surgery, any pathologies and absent gall bladder.

The relationship of the fundus of the gall bladder to the inferior margin of the liver was noted and grouped as supramarginal, marginal and Inframarginal types [12].

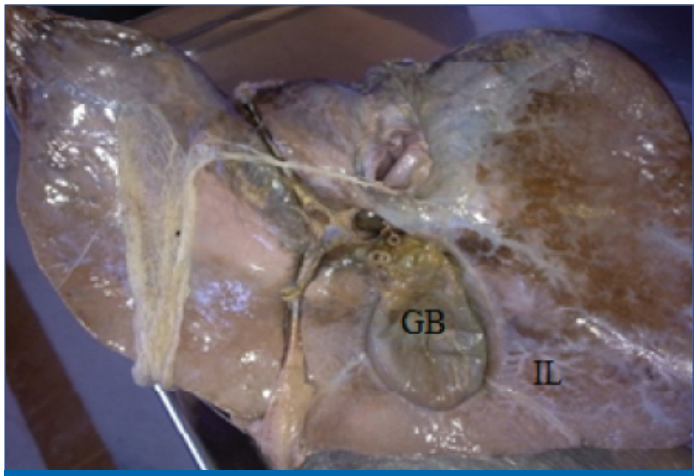
The length of the fundus in inframarginal type of gall bladder was measured using a Vernier caliper from cystic notch on the inferior margin of the liver to the point farthest from of the mouth of the gall bladder [Table/Fig-1]. The variations in the peritoneal relation of the gall bladder were noted. The images were taken in the dissection hall with an 8 MP, 750*1334 pixels camera. No statistical parameters were considered in the present study.

RESULTS

Out of 58 specimens studied, the position of fundus of the gall bladder to the inferior margin of liver was observed and classified into supramarginal, marginal and inframarginal types. Supramarginal type [Table/Fig-2] was seen in 20 specimens (34.5%), marginal type [Table/Fig-3] was seen in 13 specimens (22.4%) and inframarginal type [Table/Fig-4] was seen in 25 specimens (43.1%).



[Table/Fig-1]: Measurement of length of fundus in inframarginal type of gall bladder (L: Liver, GB: Gall Bladder).



[Table/Fig-2]: Supramarginal type seen in 20 specimens (IL: Inferior surface of Liver, GB: Gall Bladder).

[Table/Fig-3]: Marginal type seen in 13 specimens (IL: Inferior surface of Liver, GB: Gall Bladder).

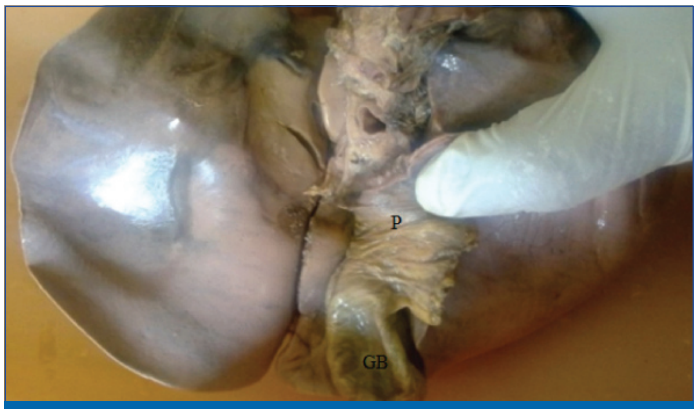
For the 25 inframarginal type of gall bladders, the length of the fundus extending beyond the inferior border of the liver ranged between 1.8-4 cm (Mean: 2.70 cm)

Peritoneal relations: The peritoneal reflections of all the 58 gall bladder specimens were observed [Table/Fig-5]. Of the 25 inframarginal type, three specimens showed variation in the peritoneal reflection. In one specimen [Table/Fig-6], the peritoneal reflection extended from the neck of the gall bladder to the first part of the duodenum. In two specimens [Table/Fig-7], except the neck region, the remaining part of the gall bladder was covered by peritoneum and was free and hanging.

[Table/Fig-4]: Inframarginal type seen in 25 specimens (IL: Inferior surface of Liver, GB: Gall Bladder).

Type	No. of GB's	No. of GB's showing variable peritoneal reflections
Inframarginal	25	3
Marginal and supramarginal	33	28

[Table/Fig-5]: Peritoneal reflections of all the three types of gall bladders.



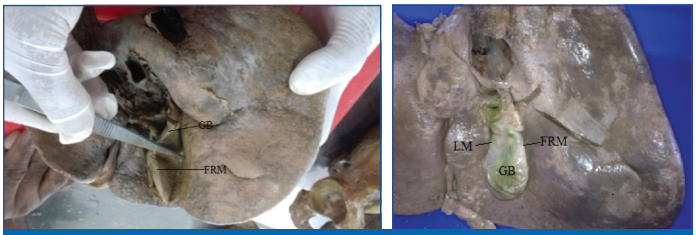
[Table/Fig-6]: Peritoneum extending from the neck of gall bladder to first part of duodenum (P: Peritoneum extending on to duodenum, GB: Gall Bladder).

[Table/Fig-7]: In 2 inframarginal type, the entire gall bladder was covered by peritoneum and was free and hanging, except at the neck region.

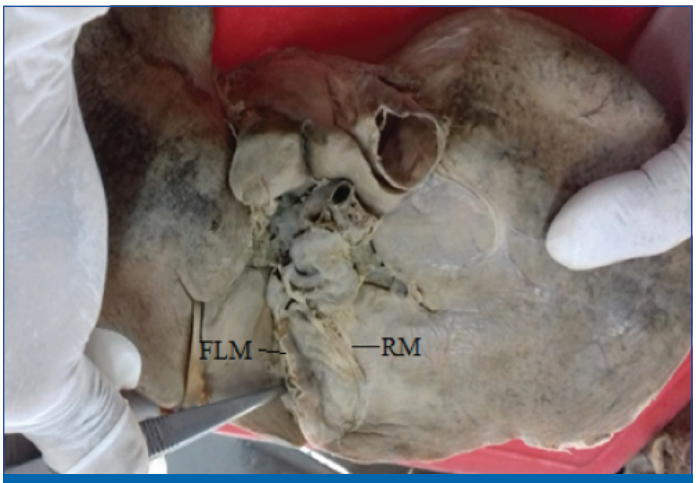
Of the 33 marginal and supramarginal types, 28 specimens showed variations in the peritoneal reflection: In 24 specimens [Table/Fig-8], the left margin was plastered to the liver and the right margin was free and covered by peritoneum. In three specimens [Table/Fig-9], the right margin was plastered to the liver and the left margin was free and covered by peritoneum. In one specimen [Table/Fig-10], the fundus, right and left margins were free and the peritoneum was covering the entire fundus and a small part of the body of the gall bladder over the superior surface and finally attached to the inferior surface of the liver, giving the appearance of folded gall bladder.

DISCUSSION

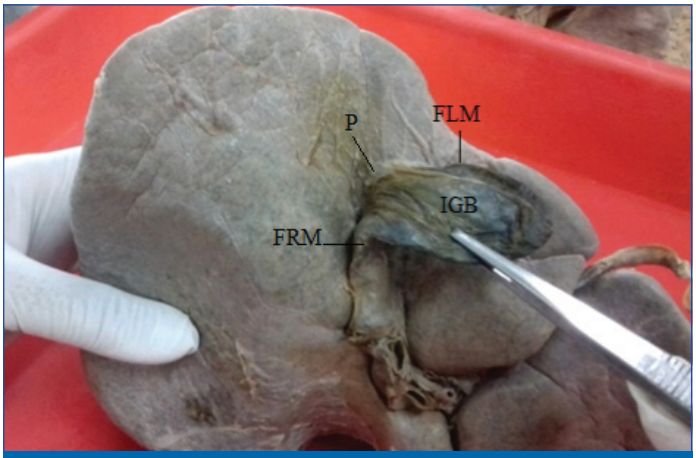
The gall bladder, liver and the biliary ductal system develop from the hepatic endodermal diverticulum of the foregut, at the beginning



[Table/Fig-8]: Left margin was plastered to the liver. Right margin was free and covered by peritoneum and was separated from the fossa.
GB: Gall Bladder; LM: Left Margin; RM: Right Margin; FRM: Free Right Margin



[Table/Fig-9]: Right margin was plastered to the liver. Left margin was free and covered by peritoneum and was separated from the fossa.
RM: Right Margin; FLM: Free Left Margin



[Table/Fig-10]: 1 Specimen with free right and left margins, covered by peritoneum and was attached to the inferior surface of the liver giving the appearance of folded GB.
FLM: Free left margin; FRM: Free right margin; IGB: Inferior surface of gall bladder; P: Peritoneum

of the fourth week of development. This diverticulum rapidly proliferates into the septum transversum and divides into two parts-pars hepatica and pars cystica respectively. Any arrest or deviation from the normal embryological developmental process may result in some sort of malformation of the gallbladder and of the biliary system [5].

The relationship of the fundus of the gall bladder to the inferior margin of the liver has been reported by several authors. Lurje A et al., studied 194 cadavers and classified the relation of fundus to the edge of the liver into supra marginal, marginal and infra marginal. He reported 33% (64 cadavers) to be supramarginal, 13.9% (27 cadavers) to be marginal, and 53.1% (103 cadavers) to be inframarginal type [12]. Rajguru J et al., studied the relation of fundus of gall bladder to the inferior border of liver in 100 specimens and stated that supra marginal type was seen in a total of eight (8%) specimens, marginal type in five (5%) specimens and inframarginal in 87 (87%) specimens [Table/Fig-11] [8].

In the present study, out of 58 specimens, supramarginal type was seen in 20 specimens, contributing to 34.48%, marginal type was seen in 13 specimens, contributing to 22.4% and inframarginal type was seen in 25 specimens contributing to 43.1%. The result of the present study is similar to all the previous studies [8,12], as the inframarginal type was found to be the commonest (43.1%) in previous studies as well [Table/Fig-11].

S.No	Author	Supramarginal	Marginal	Inframarginal
1	Jaba Rajguru J et al., [8]	8%	5%	87%
2	Lurge [12]	33%	13.9%	53.1%
3	Present study	34.5%	22.4%	43.1%

[Table/Fig-11]: Comparison of the findings of present study with previous studies.

According to a study done by Lurje A et al., out of 194 cadavers observed, 103 cadavers showed inframarginally placed fundus of gall bladder ranging between 0.5 to 4 cm [12]. Anjankar VP et al., reported the length of gall bladder below the inferior border of liver to be varying between 0.4 and 2.5 cm [13]. According to a study done by Sreekanth C et al., he concluded that the length of gall bladder below the inferior border of the liver was found to be ranging between 0.4 and 2.5 cm. This is the most susceptible part of gall bladder that can be damaged in laparoscopic procedures [14]. In the present study, the length of the fundus of the gall bladder in the inframarginal type varied between 1.8 to 4 cm which was similar to the observations of Lurje A et al., [12].

In the present study, there were two specimens which had mesentery and was free and hanging. Pamidi N et al., reported a case of gall bladder to be suspended from the undersurface of the right lobe of liver by a fold of peritoneum. The line of attachment of this fold was observed along the upper 2/3rd of the left margin of fossa for the gall bladder. The rest of the fossa was noted to be completely covered by peritoneum. The peritoneal fold when traced carefully became continuous with the transverse colon and transverse mesocolon in the sub hepatic region. This fold also extended to the second part of duodenum from the transverse colon [15]. However, in the present study, in one specimen, it varied from that reported by Pamidi N et al., in that, the peritoneum extended from the neck of the gall bladder to the 1st part of duodenum [15].

Rajguru J et al., studied 100 liver and gall bladder specimens and noted that in 93 specimens the hepatic surface of the gall bladder was closely adherent to the gall bladder fossa. Of the remaining seven specimens in which differential peritoneal reflections were noted, in three specimens the gall bladder fossa was adherent only to one or both margins of the fossa, two specimens showed free margins with only hepatic surface of lower half of the body adherent to the fossa and in another two specimens the gall bladder was free from the fossa and its margins [8]. The findings in the present study were similar to that of Rajguru J et al., with respect to the peritoneal reflections along the margins of the gall bladder to the fossa and also in two specimens of the inframarginal type, where the gall bladder was completely free and hanging.

The inframarginal fundus of gall bladder lies at a critical point during cholecystectomy. According to a study the incidence of mesentery of gall bladder is much higher in general population than diagnosed and could be associated with anomalies of the liver and gall bladder fossa [8].

Knowledge about the positions of fundus of gall bladder and its peritoneal relations is important as inframarginal types with peritoneum extending onto the superior surface can often be related to torsion of gall bladder.

Torsion of the gall bladder can only occur in patients with anatomic variation of gall bladder fixation to the liver, which could be a complete long and wide mesentery or an incomplete mesentery covering only the cystic duct and artery. In these anatomic variations, there is a free-floating gallbladder. Another possibility is that relaxation

and atrophy of a previously normal mesentery in the elderly cause visceroptosis [16,17].

The above findings supported by previous works might help the surgeons in their differential and early diagnosis of acute pain abdomen and also provides an insight, before planning a sugary, into the possible anatomical variations that they may encounter intraoperatively.

LIMITATION

The present cadaveric study findings are not supported by age specific factors and past history. Hence, further clinical and radiological studies may be done to assess the cause and incidence of inframarginal type of GB, free and hanging gall bladders and the early detection of risk of developing torsion of gall bladder.

CONCLUSION

The present study showed that, of the 58 specimens observed, inframarginal type was the most common constituting 43.1% and the fundus was seen covered by peritoneum. Peritoneal variations were seen in 31 specimens of which two gall bladders were attached only at the neck and were free and hanging. The study shows a high occurrence of variations in the peritoneal reflections. Surgically torsion of the gall bladder is a rare condition and an indication for emergency urgent cholecystectomy. In the present study two out of 58 specimens showed a free hanging gall bladder which is a predisposing factor leading to torsion. Hence the present findings warrant further studies with a larger sample size and also useful clinically for radiologists to be aware of the importance in screening individuals who are susceptible to develop torsion of the gall bladder.

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