



## An Ultrasonographic Study of Morphometric and Incidence of Anatomical Variations in the Gallbladder, Cysticduct & Common Bile Duct

### KEYWORDS

Common Bile Duct (CBD), Cystic Duct (CD), Gall Bladder (GB), Extra Hepatic Biliary Apparatus (EHBA).

\* **Dr. R. JITENDRA**

Assistant Professor of Anatomy, , Osmania Medical College , Hyderabad, Telangana State, India,  
\*CORRESPONDING AUTHOR

**Dr. B.MAHITHA**

Assistant Professor of Anatomy, Osmania Medical College , Hyderabad , Telangana State, India.

**Dr.V.JANAKI**

Assistant Professor of Anatomy, , Osmania Medical College , Hyderabad, Telangana State, India

**Dr.T.NAVAKALYANI**

Associate Professor of Anatomy, , Osmania Medical College , Hyderabad, Telangana State, India

**ABSTRACT** **INTRODUCTION:** *The liver is the largest gland of digestion and occupies the right hypochondria and epigastric regions of the abdomen. The ductular or transport system comprises intra and extra-hepatic biliary systems of which the latter forms the subject of our study. Awareness of "morphometric and incidence of anatomical variations in the Gall Bladder (GB), Cystic Duct (CD) & Common Bile Duct (CBD) " is important to surgeons, radiologists, and clinicians in general. Ultrasound is widely available, easy-to-use and less expensive than other imaging methods, that is the reason we choose this method for this study.*

**MATERIAL AND METHODS:** *This study was conducted with 225 patients (The number of adult patients is 159 and the pediatric age group patients are 66)*

*at the department of Radiology, Osmania General Hospital, Hyderabad who attended the Gastroenterology outpatient unit. All the patients were included in the study particularly morphometric and incidence of anatomical variations in the Gall Bladder (GB), Cystic Duct (CD) & Common Bile Duct (CBD).*

**OBSERVATIONS AND RESULTS:** *The visibility in the adult patients (159) was 100% for Gallbladder i.e.159 cases: 3.77% for CD, number of cases being 6: and 89.94% for CBD, the number of cases being 143. The diameter of these visualized components is in the range of 0.8mm to 12mm(CD,CBD). Out of the total 225 patients included in this study the author diagnosed only one case of Double Gallbladder which comes to the percentage of 0.4%.*

**CONCLUSION:** *The sample comprised 107 males and 118 females in the ratio of 0.9 to 1.0. The author could visualize the ductal system in only 40% of the cases and gallbladder in 100% of cases. Visualization of Extra Hepatic Biliary Apparatus (EHBA) component parts was better in the pediatric group than in the adult group In our study we could not report any congenital anomaly in the pediatric group. However there was a double gallbladder in the adult group.*

### INTRODUCTION:

The liver is the largest gland of digestion and occupies the right hypochondria and epigastric regions of the abdomen. The ductular or transport system comprises intra and extra-hepatic biliary systems of which the latter forms the subject of our study. Most of the variations are asymptomatic in nature and are detected during the routine ultrasound examination of the person or may be detected when the patient has presented with symptoms related to the digestive system. Congenital anomalies and normal variants of the biliary tree are not common but may be of significance during laparoscopic surgery as failure to recognize them leads to iatrogenic injuries and inadvertent ductal ligation, biliary leaks and strictures after laparoscopic cholecystectomy, can increase morbidity and mortality. Awareness of "morphometric and incidence of anatomical variations in the Gall Bladder (GB), Cystic Duct (CD) & Common Bile Duct (CBD) " is important to surgeons, radiologists, and clinicians in general. Ultrasound is widely available, easy-to-use and less expensive than other imaging methods. In view of the above factors the author is inspired to study the morphometric and incidence of variations in the extra-hepatic biliary apparatus particularly lowerpart which include gallbladder (the major variations may be anomalies in location, number, and form, persistence of intra-hepatic gallbladder) , Anatomic Variations of the Cystic Duct and varia-

tions in the common bile ducts by ultrasonography .

### MATERIAL AND METHODS

This study was conducted with 225 patients at the department of Radiology, Osmania General Hospital, Hyderabad who attended the Gastroenterology outpatient unit. All the patients were included in the study. All the patients had ultrasonography of the abdomen for the study of extra-hepatic biliary apparatus. To perform the ultrasound of the EHBA for better visualization, the technique and equipment specifications vary little for gallbladder and biliary tree. variations in gallbladder -the major variations may be anomalies in location, number, and form, persistence of intra-hepatic gallbladder , Anatomic Variations of the Cystic Duct , variations in the common bile ducts were noted

**Type of study:** Random Prospective Study

**Place of study:** Osmania General Hospital, Hyderabad.

**Sample size:** 225.

**Sample source:** Patients attending the gastroenterology outpatient department.

**Sample:** Sonograms

**Preparation of patient:-**

The patient was fasted for 6 – 12 hours and with comfortable, loose-fitting clothing and all clothing and jewelry removed in the area to be examined. The patient. was asked to wear a gown during the procedure and with the patient positioned lying face-up on an examination table that can be tilted or moved. A clear water-based gel was applied to the area of the body being studied to help the transducer make secure contact with the body and eliminate air pockets between the transducer and the skin. The transducer was pressed firmly against the skin in various locations, sweeping over the area of interest or angling the sound beam from a farther location to better see an area of concern.

**For gallbladder:-**

Ultrasound was performed using the high frequency probe to gain adequate penetration. This was between 2-7 MHz range curved linear array probe with colour doppler capabilities and the Patient looking supine/left lateral decubitus and erect. Patient was asked to take an inspiration; so that the distending abdomen can push the bowel gas out of the way. Assessed the pancreas and visualized the Common Bile Duct (CBD) in the head of pancreas. Liver was used as a window especially when rolling the patient on to their left side. Measurements of the Cystic Duct (CD) and Gall Bladder (GB) were taken.

**OBSERVATIONS AND RESULTS**

A total of 225 cases were studied at the Department of Radiology of the Osmania General Hospital, Hyderabad. All the cases included are the patients from the Department of Gastroenterology. The analysis of the observations and results are given below.

**1. Table Showing the Sex Wise Distribution of Cases.**

Sl.no.	Sex	Number	Percentage (%)
1	Male	107	47.55
2	Female	118	52.45
3	Total	225	100

**2. Table Showing the Age Wise Distribution of Cases**

Sl.no.	Age (year)	No. of cases	Percentage (%)
1	0 - 1	11	4.88
2	1 – 10	44	19.55
3	11 – 20	26	11.55
4	21 – 30	27	12
5	31 – 40	28	12.44
6	41 – 50	38	16.88
7	51 – 60	28	12.44
8	61 – 70	16	7.11
9	71 – 80	07	3.11
10	Total	225	100

In our study of 225 patients the age of the patients ranged from 0 to 80 years. The highest incidence being in the age of 1 to 10 years followed by 41 to 50 years and minimum number of cases are in the age group of 71 to 80 years. The number of adult patients is 159 and the pediatric age group patients are 66.

**3. Table showing the visualization of EHBA (Gallbladder, Cystic duct, Common bile duct) by USG in adults**

Sl.no.	Part	Sonographically visualized		Sonographically not visualized	
		No.	%	No.	%
1	Gall-bladder	159	100	0	0
2	Cystic duct	6	3.77	153	96.23
3	Common bile duct	143	89.94	16	10.06

1	Gall-bladder	159	100	-	-
2	Cystic duct	6	3.77	153	96.23
3	Common bile duct	143	89.94	16	10.06

Of the total number of 225 patients who underwent ultrasonographic study of the extra-hepatic biliary apparatus, the visibility of the EHBA varied for different parts. The visibility in the adult patients (159) was 100% for Gallbladder i.e.159 cases: 3.77% for CD, number of cases being 6: and 89.94% for CBD, the number of cases being 143.

**4. Table Showing sonographic size range of EHBA ducts in adults.**

	0 -1mm	1.1 -2mm	2.1 -3mm	3.1 -4mm	4.1 -5mm	5.1 -11mm
CD	0	2	1	1		2
CBD	1	3	49	58	16	16

The data obtained regarding the diameters of the visible components of the EHBA was also measured and tabulated. The diameter of these visualized components (Fig-1) &(Fig-2) is in the range of 0.8mm to 12mm. The CD was measuring 1.1-2mm (2 cases), 5.1-6mm (2 cases), 2.1-3mm(1 case) and 3.1-4mm(1 case). The CBD was measuring 3.1-4mm(58 cases), 2.1-3mm(49 cases), 4.1-5 mm(16 cases) , 5.1-6mm(16 cases), 1.1-2mm(3 cases) and 0-1mm(1 case). The overall mean for all measurements of duct diameter was 2.05mm.

**5. Table Showing the Pediatric Group – Sex Wise Distribution**

Sl.no.	Sex	Number	Percentage (%)
1	Male	32	48.48
2	Female	34	51.52
3	Total	66	100

The number of pediatric cases are 66 (29.33%), out of the total number of 225 cases. The percentage of pediatric male patients is 48.48% (32 cases) and female pediatric patients is 51.52% (34 cases). The ratio of M:F :: 0.94:1.

**6. Table Showing the Pediatric Group – Age Wise Distribution**

Sl.no.	Age	Number	Percentage (%)
1	0 -1	15	22.72
2	1 -5	26	39.39
3	6 -12	25	37.87
4	Total	66	100

In our study of 225 patients the age of the patients ranged from 0 to 80 years. The pediatric age group patients constitute 29.33% i.e.66 cases. The highest incidence being in the age of 1 to 12 years followed by 0 to 1 year.

**7. Table Showing the Visualization of EHBA by USG in Pediatric Age Group**

Sl.no.	Part	Sonographically visualized		Sonographically not visualized	
		No.	%	No.	%
1	Gall-bladder	66	100	0	0
2	Cystic duct	41	62.12	25	37.88
3	Common bile duct	66	100	0	0

Of the total number of 225 patients who underwent ultra-

sonographic study of the extra-hepatic biliary apparatus, the pediatric age group constitute 29.33% (66 cases), and among this group, the visibility of the EHBA varied for different parts. The visibility was 100% for Gallbladder i.e.66 cases: 62.12% for CD, number of cases being 41: and 100% for CBD, the number of cases being 66.

#### 8 Table showing sonographic size range of EHBA ducts in pediatric age group

	0 -1mm	1.1 -2mm	2.1 -3mm	3.1 -4mm	4.1 -5mm	5.1 -11mm
CD	2	34	3	2		
CBD		9	38	16	2	1

The measurements of visible components of the EHBA in pediatric age group were tabulated separately. The diameter of these parts is in the range of 0.8mm to 11mm and in most of the cases the diameter is below 3mm. The CD was measuring 1.1-2mm (34 cases), 2.1-3mm (3 cases), 0-1mm (2 cases) and 3.1-4mm (2 cases). The CBD was measuring 2.1-3mm (38 cases), 3.1-4mm (16 cases), 1.1-2 mm (9 cases), 4.1-5mm (2 cases) and 5.1-6 mm (1 case).

#### 9 Table Showing the Congenital Anomalies and Anatomical Variations seen during USG

Sl. no.	Site of anomaly	Type of anomalies	No. of Patients	%
1	Gallbladder	Double Gall-bladder	One (1)	0.4
2	Cystic duct	-	Nil	-
3	Common bile duct	-	Nil	-

Out of the total 225 patients included in "AN ULTRASONOGRAPHIC STUDY OF MORPHOMETRIC AND INCIDENCE OF ANATOMICAL VARIATIONS IN THE GALLBLADDER, CYSTIC DUCT & COMMON BILE DUCT " the author diagnosed only one case of Double Gallbladder (Fig-3) which comes to the percentage of 0.4%.

#### DISCUSSION

The liver is the largest gland of digestive system and occupies the right hypochondriac and epigastric regions of the abdomen. The ductular or transport system comprises intra and extra-hepatic biliary systems (EHBA). The EHBA consists of right and left hepatic ducts (RHD & LHD), common hepatic duct (CHD), gallbladder (GB), cystic duct (CD), and common bile duct (CBD).

**Reliability of Ultrasonography to study EHBA:** According to **E A Deitch,(1981)<sup>[1]</sup>** "The Reliability and Clinical Limitations of Sonographic scanning of the Biliary Ducts" a major limitation of sonographic scanning of the biliary tree was the fact that 38% of the patients did not have their extra-hepatic ducts adequately visualized.

**Sex Wise Distribution of Cases:**The author has studied 225 patients. There were 107 male patients and 118 female patients at the ratio of 0.9 to 1.0. Despite the male population being more in general, in our study the number of female patients is more. This could be due to a predilection of the female sex for hepatobiliary related complaints.

**Age Wise Distribution of Cases:**The highest number of patients was in the age group of 1 -10 years (19.55%) followed by 41 to 50 years (16.88%) of age and minimum being in the range of 71 to 80 years (3.11%). The increased incidence of the first decade could be representation of the increased incidence of infections of the respiratory and gastrointestinal tracts in children. The raised incidence in

the fifth decade is probably related to a combination of aetiologies –stress and lifestyle related (irregular habits, smoking, drinking) upper gastrointestinal complaints (gastriitis, hepatitis, cholecystitis etc.). Early degenerative conditions could also present with a similar picture (eg; fatty liver, cholelithiasis).

**Visualization of EHBA by USG in adults:** In general overall Visualization of the EHBA varies for different parts of the EHBA. **Deitch (1981)<sup>[1]</sup>** noted that overall visualization of EHBA by USG was 62%. In our study the overall visualization was 40%. This may be due to presence of many important organs lying close together in the upper abdomen. The visualization for CBD in 94% of case (**Dewbury -1980**)<sup>[2]</sup>.The percentage of visibility in our study for CBD it was 90% which is coinciding with the **Dewbury (1980)<sup>[2]</sup>**.

The measurements of CBD was in the range of 1 mm to 11mm.**Wu (1984)<sup>[3]</sup>** obtained similar readings for CBD and were in the range 1mm to 11mm.This is also coinciding with our study. A standard US text states, "A simple rule of thumb is to consider as normal a 4 mm mean duct diameter at age 40 , a 5 mm mean duct diameter at age 50 , a 6 mm mean duct diameter at age 60,and so on". **Horrow et al (2001)<sup>[4]</sup>**.

**Pediatric Group – Sex Wise Distribution** The number of pediatric cases is 66 (29.33%), There were 32 male patients and 34 female patients at the ratio of 0.94 to 1.0. Despite the male population being more in general, in our study the number of female patients is more. This could be due to a predilection of the female sex for hepatobiliary related complaints.

**Visualization of EHBA by USG in Pediatric Age Group :** In general overall Visualization of the EHBA varies for different parts of the EHBA. **Deitch (1981)<sup>[1]</sup>** noted that overall visualization of EHBA by USG was 62%. In our study the overall visualization in pediatric cases was 73.74%. Visualization is more in pediatric cases, because the subject is thinner and the girth of the abdomen is also small when compared to adult population. The visualization for CBD in 94% of case (**Dewbury -1980**)<sup>[2]</sup>.The percentage of visibility in our pediatric cases for CBD it was 100%.This is almost coinciding with results of **Dewbury (1980)<sup>[2]</sup>**.

**Sonographic size range of EHBA ducts in pediatric age group :** On ultrasonography the diameters of the EHBA ductular components was in a range of 0.8 to 11mm depending on the part studied. **Deitch (1981)<sup>[1]</sup>** obtained the similar readings. **Hernanz-Schulman (1995)<sup>[5]</sup>** found an average diameter of the extra-hepatic bile duct less than 3.3 mm in all patients and less than 1.2 mm in children aged 3 months or younger. The diameter of the RHD, LHD and CHD was in the range of 0.8mm to 5mm. **Dewbury (1980)<sup>[2]</sup>** also obtained similar readings for the said ducts. His range of ductular diameter was shown to lie between 2mm to 5mm. This is coinciding with our study. The measurements of CBD was in the range of 1.1 mm to 11mm. **Wu (1984)<sup>[3]</sup>** obtained similar readings for CBD and were in the range 1mm to 11mm.This is coinciding with our study.

**Congenital Anomalies and Anatomical Variations seen during USG:** Congenital anomalies occur due to any aberration in the process of development. In general incidence of commonly occurring congenital anomalies is more in males (8.4%) when compared to females (5.5%) in pediatric age group as well as in adult population.However,the literature says that congenital anomalies for the EHBA are more common in female children.

Talpur et al (2010)<sup>[6]</sup> in his study "Anatomical variations and congenital anomalies in extra-hepatic biliary system encountered during laparoscopic cholecystectomy" revealed the operative findings that the variations in cystic duct – 4.33%, gallbladder in 2% cases.

According to Banu Alicioglu, (2007)<sup>[7]</sup>, the ultrasound may demonstrate the number of gallbladders and normal anatomy grossly but cannot define the exact anatomy of the biliary tree and these techniques should be supplemented with MRCP or ERCP to detail biliary tract anatomy and its variations. The author could demonstrate only two gallbladders of the triple gallbladder with ultrasound and the third gallbladder was found at surgery. Foster.D.R. (1981)<sup>[8]</sup> has demonstrated the Triple gallbladder by Oral cholecystography.

William B. Sutter et al (1991)<sup>[9]</sup> has presented the first case of prenatal diagnosis of double gallbladder by ultrasonography at 24 weeks of gestation.

Desolneux. G. et al (2009)<sup>[10]</sup> and Amit Goel et al (2003)<sup>[11]</sup> have presented a rare congenital anomaly of double gallbladder, occurring in about one per 4000 births (0.025%) which are thought to be due to exuberant budding of the developing biliary tree when the caudal bud of the hepatic diverticulum divides. They diagnosed double gallbladder by ultrasonography.

Ronald A. Bergman et al<sup>[12]</sup> has mentioned in his "Illustrated Encyclopedia of Human Anatomic Variation: Opus IV: Organ Systems: Digestive System and Spleen" that the incidence of absent gallbladder is 0.065%, and the incidence of double gallbladder is 0.026%.

This author also in his study could find only one case of double gallbladder by ultrasonography and no other variations could be demonstrated in USG, with the percentage being 0.4%. This high percentage could be attributed to the small sample size. A larger study is required to corroborate the findings definitively.

## CONCLUSION

In this project "AN ULTRASONOGRAPHIC STUDY OF MORPHOMETRIC AND INCIDENCE OF VARIATIONS IN THE CD, GB AND CBD IN PATIENTS ATTENDING THE GASTROENTEROLOGY OUTPATIENT DEPARTMENT" the modality of ultrasound imaging was employed to locate variations in the CD, GB and CBD. The range of age groups varied from less than one year to eighty years.

1. The sample comprised 107 males and 118 females in the ratio of 0.9 to 1.0.
2. The author could visualize the ductal system in only 40% of the cases and gallbladder in 100% of cases.
3. As the ultrasonography can visualize only the gross anatomy, like gallbladder thickness, size of the GB and ductal diameter, the exact variations in anatomy of the biliary tree could not be seen by ultrasonography with certainty in most patients.
4. As expected the sizes of the components of the ductular system varied from pediatric to adult age group. The concerned diameter measurements were smaller in the pediatric group as compared to adult group.
5. Within the pediatric age group the ductal diameter varied from 0.8 to 0.11 mm.
6. The ductal diameter varied from 0.8 to 0.12 mm in the adults.
7. Measurements obtained in our study correlated well

with the known literature.

8. Male: Female ratio in the pediatric sample was 0.94: 1.0.
9. Male: Female ratio in the adult sample was 0.90: 1.0.
10. Visualization of EHBA component parts was better in the pediatric group than in the adult group.

In general, our findings correlated well with those reported in the literature. In our study we could not report any congenital anomaly in the pediatric group. However there was a double gallbladder in the adult group.

**Fig-1 : Transverse USG scan showing the GB with Cystic Duct and Liver.**



**Fig-2: Transverse USG scan showing the CBD anterior to the PV,GB and Liver**



**Fig-3 : Longitudinal USG showing the Double Gallbladder (GB 1 & GB 2)**



## REFERENCES:

1. Edwin Deitch. A. (1991), The reliability and clinical limitations of sonographic scanning of the biliary ducts. *Ann Surg.* 1981 August; 194(2): 167-170.
2. Dewbury.K.C.(1980), Visualization of normal biliary ducts with ultrasound, *British Journal of Radiology*, 1980; 53, 774-780; )
3. Wu Cc, Ho YH, Chen CY.(1984) Effect of aging on common bile duct diameter: a real time ultrasonographic study. *J Clin Ultrasound* 1984; 12: 473-478.
4. Horrow MM, Horrow JC, Niakosari A, et al(2001). Is age associated with size of the adult Extra-hepatic Bile Duct: sonographic study. *Radiology* 2001; 221: 411-414.
5. Hernanz-Schulman M, Ambrosino MM, Freeman PC, Quinn CB (1995). Common Bile Duct in Children: sonographic dimensions. *Radiology* 1995; 195:193-195.
6. Talpur.K.H, Abdul Aziz Laghari, Sikandar Azam Yousfani, Arshad Mahmood Malik,Aamir Iqbal Memon, Sangrasi Ahmed Khan, (2010), Anatomical variations and congenital anomalies of Extra-Hepatic Biliary System encountered during Laparoscopic Cholecystectomy *J Pak Med Assoc* pages 89 -93 Vol. 60, No. 2, February 2010
7. Banu Alicioglu, (2007), An incidental case of triple gallbladder, *World J Gastroenterology* 2007 April 7; 13(13): 2004-2006
8. Foster.D.R. (1981), Triple gall bladder, *British Journal of Radiology*, 54, 817-818.
9. William B. Sutter and Philippe Jeanty, (1991), Gallbladder duplication ;*SonoWorld* 1991-04-06-08 Gallbladder, duplication © Sutter [www.thefetus.net/](http://www.thefetus.net/);
10. Desolneux.G, S. Mucci, J. Lebigot, J. P. Arnaud, and A. Hamy (2009), Duplication of the Gallbladder. A Case Report, *Gastroenterology Research and Practice*, Volume 2009, Article ID 483473, 3 pages doi:10.1155/2009/483473.
11. [My pa Amit Goel, Keshav Narain Srivastava and Anil Kumar Rana, (2003), Double gallbladder – a laparoscopic management. *Surg Laparosc Endosc Percutan Tech.* 2003 Oct ;13 (5):348-9 14571174 Cit:7
12. Ronald A. Bergman, Adel K. Afifi and Ryosuke Miyauchi (2006), Gallbladder, *Anatomy atlases, Illustrated Encyclopedia of Human Anatomic Variation: Opus IV: Organ Systems: Digestive System and Spleen: 2006*;