DOI: https://doi.org/10.22516/25007440.136

What is the normal size of the common bile duct?

Martín Alonso Gómez Zuleta, MD,[1] Óscar Fernando Ruiz Morales, MD,[2] William Otero Regino, MD.[3]

1 Internist and Gastroenterologist, Professor at the National University of Colombia. Gastroenterologist at National University of Colombia Hospital in Bogotá, Colombia
2 Internist and Gastroenterologist at Hospital Nacional Universitario and Kennedy Hospital in Bogotá, Colombia
3 Internist and Gastroenterologist, Professor of Gastroenterology at the National University of Colombia in Bogotá, Colombia

Received: 05-11-15
Accepted: 21-04-17

Abstract

Traditionally, the common bile duct (CBD) has been said to measure up to 6 mm in patients with gallbladders and up to 8 mm in cholecystectomized patients. However, these recommendations are based on very old studies performed with trans-abdominal ultrasound. Echoendoscopy has greater sensitivity and specificity for evaluating the bile duct, but studies had not yet been done in our population to evaluate the normal size of the CBD by this method.

Objective: The objective of this study was to evaluate the size of the CBD in patients with gallbladders and patients without gallbladders.

Materials and Methods: This is a prospective descriptive study of patients who underwent echoendoscopy at the gastroenterology unit in the El Tunal hospital, Universidad Nacional de Colombia. Patients had been referred for diagnostic echoendoscopy to evaluate subepithelial lesions in the esophagus and/or stomach. Once the lesion had been evaluated and an echoendoscopic diagnosis had been established, the transducer was advanced to the second duodenal portion to perform bilio-pancreatic echoendoscopy. The size of CBC at the hepatic artery was measured to avoid altering the size of the CBC. These data were collected in online forms in Google drive that were filled out during the echoendoscopic procedure. A scatter plot was graphed and analyzed to assess the size of the common bile duct in the entire study population.

Results: The study took place between January 2013 and September 2013 during which time 100 echoendoscopies were performed for subepithelial lesions in the upper digestive tract. The average patient age was 55.6 years, 65% of the patients were women, 18% of the patients had had previous cholecystectomies and 50% of these patients were women. The average common bile duct size was 4.88 mm (range: 2.6 to 7 mm). In the group with intact gallbladders (88%) the average CBC was 4.16 mm (range 2.6 to 6 mm), among women with intact gallbladders the average CBC was 3.9 mm (range 2.6 to 5 mm) and among men with intact gallbladders the average CBC was 4.42 mm (range 3 to 6 mm). In the group of cholecystectomized patients the average CBC was 4.88 mm (range 3 to 7 mm), in the group of cholecystectomized women the average was 4.84 mm (range 4.6 to 7 mm), and among cholecystectomized men the average was 4.92 mm (range: 3 to 7 mm).

Conclusions: Our study shows that the normal size of the common bile duct is 4.16 mm. This is smaller than the size accepted by the literature and than the 4.88 mm in cholecystectomy patients. This is interesting, since if the common bile duct is indeed larger following cholecystectomy, we could discard biliopancreatic pathology with diagnostic echoendoscopy.

Keywords

Common bile duct, echography, echoendoscopy, choledocholithiasis.

INTRODUCTION

Diseases and biliary disorders associated with obstruction affect a significant portion of the world's population. The size of the common bile duct (CBD) is a predictor of biliary obstruction and, therefore, measurement is an important component of biliary system evaluation. (1)

As time has passed, the development of modern medical imaging technology has enabled better and more accurate measurement of the bile duct. (1, 2) The availability of diagnostic tests that allow appropriate evaluation and measurement of the CBD and correlation with parameters of normality has allowed us to distinguish between cholestasis secondary to obstruction and non-obstructive cholestasis. (1, 3) Although a plethora of literature related to the normal size of the CBD has been published, there is great diversity in the design and measurement technique. Currently, the most frequently used techniques are transabdominal ultrasound [TU], computed tomography scans [CT], magnetic resonance cholangiopancreatography [MRCP], endoscopic ultrasonography [EUS] and endoscopic retrograde cholangiopancreatography [ERCP]). (4-16) These measuring techniques have allowed the normal upper limit to be fixed conventionally at 6 mm. Nevertheless, this is somewhat arbitrary and dependent on a variety of factors including measurement technique and the patient's sex, weight, postprandial measurement and medications. (17-19)

Since its introduction into clinical practice in the 1980s, EUS has been used to diagnose and stage benign and malignant gastrointestinal and pancreatobiliary disorders. Comparative studies have shown that EUS is more accurate than TU, CT, and MRI for detection and staging of extraluminal lesions and lesions of the gastrointestinal tract (GIT). (20-22) EUS combines endoscopic visualization with ultrasonographic imaging, and - given the proximity of the extrahepatic biliary tract to the proximal duodenum - it allows better evaluation of this area than do other methods. Two metaanalyses, each covering more than 25 trials and more than 2,500 patients, have reported a sensitivity of 89% to 94% and a specificity of 94% to 95% for EUS detection of choledocholithiasis (23, 24). Both used ERCP and intraoperative cholangiography as the gold standard of detection. However, despite the demonstrated usefulness of EUS as a diagnostic method, there have been no previous studies in the Americas and Europe that have evaluated the normal parameters of CBD diameter with this diagnostic technique. For this reason, we decided to carry out the study presented here.

MATERIALS AND METHODS

This is a prospective descriptive study that was conducted between January 2013 and September 2013. During this period, a total of 100 patients between the ages of 19 and 80 years old underwent EUS in the gastroenterology unit of Universidad National of Colombia's El Tunal Hospital. The patients underwent EUS diagnosis for evaluation of subepithelial lesions in the esophagus or stomach. Patients with known biliary pathologies, diagnostic suspicions of biliary pathologies, and stenoses of the duodenum were excluded. After explaining the procedure and potential complications, informed consent forms were signed. Procedures were done under sedation by an anesthesiologist who administered drugs in accordance with prior evaluation by the anesthesiology service and the hospital's protocol. Patients' vital signs (arterial blood pressure, arterial oxygen saturation [Sat O_2] and electrocardiographic tracings) were continuously monitored. Procedures were conducted with patients in the left lateral decubitus position using an EU-M60 EU-ME1 ultrasonic processor and an Olympus manufactured ultrasound model number GF-UM160 with an insertion tube diameter of 10.5 mm, a tip diameter of 12.7 (mm), mechanical radial ultrasonic orientation, 360 ° scanning, 5-20 MHz frequencies, and an oblique front view angle. Once the lesion had been evaluated and a diagnosis arrived at, the transducer was advanced to the second duodenal portion. There, it was located to allow evaluation of the CBD from its origin in the hilum to its convergence with the hepatic bile duct. This method can display between 95% and 100% of the CBD. (25) Procedures were performed at frequencies between 7.5 and 12 MHz by an expert echoendoscopist (MG) who has logged more than 3,000 EUS hours. Procedures met the quality standards of the American Society for Gastrointestinal Endoscopy (ASGE) for 2015. (26) The CBDs were identified and measured at the portal vein where the hepatic artery crosses perpendicularly. The exterior walls were taken as the boundaries using electronic gauges. All procedures were attended by at least two nurses with endoscopy training. These data were collected in online forms in Google drive filled out during the echoendoscopic procedure. Frequency calculations were performed with Microsoft Excel, and nominal data were described as frequencies and percentages.

RESULTS

Average patient age was 55.6 years, 65% of the patients were women and 18% had had a previous cholecystectomy.

In order of frequency, indications for endoscopic procedures were gastric submucosal lesions (58%), esophageal submucosal lesions (34%), mediastinal lymphadenopathy (5%) and thickened gastric folds (3%) (Table 1).

Table 1. Characteristics of the population

Characteristic	Percentage
Age (years)	55.6
Male	35
Female	65
History of cholecystectomy	18
Indication	
Submucosal gastric lesions	58
Submucosal esophageal lesions	34
Study of mediastinal lymphadenopathy	5
Thickened gastric folds	3

Of the 100 patients who met the inclusion criteria, 18% had previous cholecystectomies. Of this group, 50% were women. The average size of the bile duct as measured by the transducer located in the second duodenal portion was 4.88 mm (range 2.6 to 7 mm). In the group of patients with no surgical history related to the CBD (88%), the mean choledochal size was 4.16 mm (range 2.6 to 6 mm). In the subgroup of women with intact gallbladders, the mean CBD was 3.9 mm (range 2.6 to 5 mm), and in men with intact gallbladders, the mean CBD size was 4.42 mm (range 3 to 6 mm). In the group of cholecystectomized patients, the mean choledochal size was 4.88 mm (range 3 to 7 mm). In the group of cholecystectomized women, the mean was 4.84 mm (range 4.6 to 7 mm), and in the group of cholecystectomized men, the mean was 4.92 mm (range 3 to 7 mm) (Figure 1). We found no variations of the CBD measurement by EUS related to the age of the patients evaluated (Figure 2).

DISCUSSION

TU is the initial diagnostic method of choice for assessment of the biliary tract, particularly if an obstruction is suspected. It can provide real-time assessment of the intrahepatic and extrahepatic biliary tract and gallbladder which allows measurement of these structures in most cases. In addition, it is a non-invasive, low-cost and easily accessible procedure. Nevertheless, it is operator dependent and the quality of the images obtained depends largely on interposed intestinal gas, tissues and abdominal fat. It can also be difficult to visualize the distal part of the CBD and papillary area clearly, and diagnosis of calculi in the CBD is limited by its low sensitivity of 77%. (27-30)

CT scans, although not invasive, involve exposure to radiation and contrast medium and have low sensitivity for detection of biliary diseases. (30) The visualization of gallstones in CT scans varies with the chemical composition of the calculi. Most calculi are radiopaque, but some have only soft tissue density and may be difficult to visualize. Ten to twenty percent of gallstones are composed of pure cholesterol. (31)

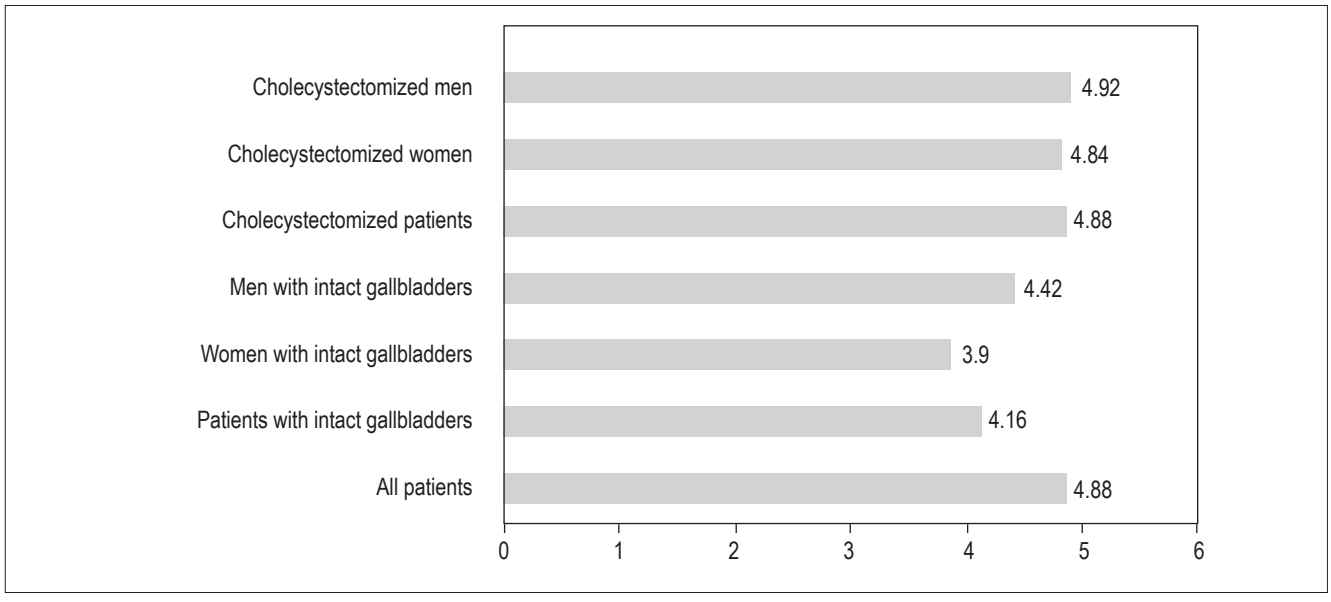

Figure 1. CBD size in millimeters according to gender and histories of cholecystectomies.

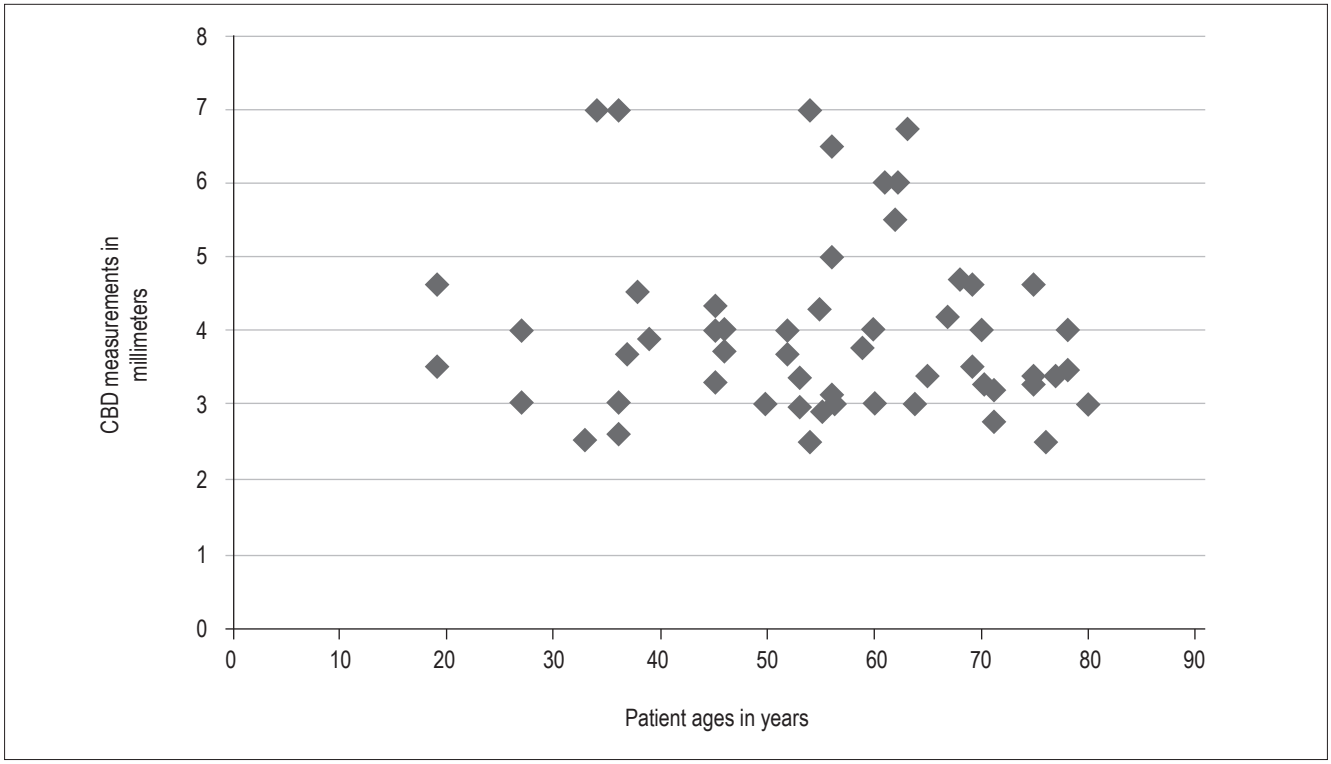

Figure 2. Scatter diagram of variation of CBD size compared to age

ERCP is often considered to be the gold standard of diagnostic methods for evaluating patients suspected of having biliary tract disease. However, this procedure should be reserved for cases requiring therapeutic intervention since the document risks inherent to this procedure include acute pancreatitis (2.4% to 4%), bleeding (0.3% to 1.4%), ascending biliary infections (1.4%), perforations (0.6%), and a mortality rate of 0.2% to 0.9%. (2, 18, 32, 33)

MRCP offers advantages over CT scans and ERCP for evaluating the common bile duct: visualization of gallstones is not affected by their internal compositions, does not require sedation and provides an accurate image of the bile duct and the pancreatic duct plus there is no radiation risk. Nevertheless, decision-making models based on MRCP results have not reduced the number of ERCPs in patients with choledocholithiasis and other biliary diseases. (18) In addition, its accuracy decreases when fatty planes are inadequate and when there is little liquid contained in the CBD plus MRCP is contraindicated for patients with claustrophobia and for those with implanted electronic devices. (34)

Like ERCP, EUS provides a direct endoscopic view of the periampullary area and offers an excellent echographic evaluation of the extrahepatic biliary tract, pancreas, and duodenal wall. It has advantages over MRCP in the detection of small stones (up to 0.1 mm) and, in theory, if EUS demonstrates gallstones, therapeutic ERCP can be performed immediately after a single session of sedation. This reduces the risk inherent in the anesthetic procedure and has been shown to be cost-effective, with high sensitivity and specificity, and low morbidity (35-38). It has also been shown to reduce unnecessary therapeutic ERCP by 60% to 73%. However, there are drawbacks related to EUS including inaccessibility (even more marked in our environment), requirements for sedation, and the fact that it is dependent on the operator. For patients with anatomical alterations such as prior surgery involving the upper digestive tract, acquisition of images may be limited by the absence of anatomical references. (2, 34, 35, 37) Operator experience plays an important role in the procedure's sensitivity: when the examination is performed by an expert operator, the sensitivity is almost double (77% to 90%) that of an operator with little experience (37% to 47%). (28, 39) When MRCP has failed to find a clear cause for extrahepatic biliary dilatation, EUS allows the cause to be diagnosed with certainty. (40)

Despite the large amount of information available regarding CBD diameter and various useful techniques, there is very little EUS information available on normal CBD measurement in patients with biliopancreatic disease who are asymptomatic. We verified this through a search of

PubMed, Embase, Ebsco, Tripdatabase, Ovidsp, Springer, Science Direct, and ProQuest using the following Mesh terms: endosonography [Mesh] and common bile duct [Mesh]). One of the studies that was found was conducted in Israel. It included 647 patients grouped according to age and surgical histories of cholecystectomy. The study found that the average CBD diameter for the 18-49 year old group with gallbladders intact was 4.4 (± 1.2) while the average CBD diameter for the 18-49 year old group who had undergone cholecystectomies was 5.1 (± 1.8). Similarly, the average CBD diameter for the 50-59 year old group with gallbladders intact was 4.9 (± 1.6) while the average CBD diameter for the 50-59 year old group who had undergone cholecystectomies was 5.8 (± 1.5). For the 60-69 year old group with gallbladders intact, it was 5.4 (± 1.6) while for the 60-69 year old group who had undergone cholecystectomies, it was 6.6 (± 2). For the 70-79 year old group with gallbladders intact, it was 5.7 (± 1.7), while for the 70-79 year old group who had undergone cholecystectomies, it was 6.6 (± 1.7). For those over 80 years with intact gallbladders, average CBD diameter was 6 (± 1,6) and for those in this age group who had undergone cholecystectomies, it was 9.6 (± 0.7). The study concluded that the diameters of CBD increase proportionally with each decade and that there is an additional increase in diameter in patients with a history of cholecystectomy. (41)

These results do not correlate with our study's findings.

In our results, the CBD measurement did not show any significant correlation with age or history of cholecystectomy. The overall mean diameter of the CBD was 4.89 mm, the proximal and distal diameter was not measured considering that the normal CBD is a tubular structure with a constant diameter. (42-44), The mean CBD diameter that we found was also less than that found in a study by JS Park et al. (45) Using multidetector computed tomography (MDCT) and multiplanar reconstruction, they found that the mean CBD diameter among 2 different observers of 398 Korean patients was 6.7 mm. (42) A recent study in Taiwan used MRCP and two different observers to measure the median CBD diameter of 187 patients. The first observer found that the median was 4.6 mm (+ 1.8 mm) with a range of 1.76-10.49 mm, and the second observer found that the median was 5.0 mm (+ 1.7 mm) with a range of 2.42-11.65 mm. (2) These measures are similar to those found in our population. Another study with a much larger population has been conducted in Southern California. In 4,119 tests which were classified as normal, the mean diameter of the CBD was 3.8 mm (+ 1.6 mm). (29) Again, this similar to what was found in our population. More recently, 200 adult patients were studied in India. The diameter of CBD was measured at 3 different sites and the mean was found to be 4.1 mm (1.01 mm standard deviation). (1) Again, the average found in our population is in agreement with those found in other latitudes in different populations.

Most likely, multiple factors explain the complexity of finding the average diameter of the CBD. One possible source of discrepancies is the fact that the CBD cross-section is oval when it is distended. This may affect measurement when different diagnostic methods are used. Other variations relate to the time at which measurements are made. These include inspiration versus expiration, weight, fasting, consumption of some medications and dysfunctions of the sphincter of Oddi. (17-19). None of the four studies cited above correlate to the significant variability according to gender that we found in our study. (1, 2, 17, 29)

Similarly, we did not find increasing CBD diameter according to patients' ages as has been identified by some other studies such as the 1983 study of Niederau et al. (5) They documented that the diameter of CBD was significantly correlated with age (r = 0.16). Other studies have also reported a correlation of duct diameter with age. (1, 18, 22, 45).

Other studies such as those performed by Hollow et al. have not observed any increase in CBD size with age. (12) Kaude et al. reported that mean CBD size was 2.8-4.1 mm in patients aged 20 to 71 years. (6) More recently Matcuk et al. found that age has a small impact on increases in CBD diameter of approximately 0.2 mm per decade. (29) This enlargement of the CBD diameter in relation to age can be explained by the fragmentation of myocyte bands of the longitudinal smooth muscle and loss of the network of reticular elastic fibers of the connective tissue dues to aging. This leads to reduction of contractility and hypotonia of the CBD. Another factor that may be associated is consumption of medications such as calcium channel blockers, nitroglycerin, morphine, and phosphodiesterase type 5 inhibitors (PDE-5) which may influence the contractility and tone of the duct. (46) In our population there was no statistically significant variation in CBD size related to age. This could be because there was an insufficient number of patients at each end of the age spectrum. This could guide future study based on comparing among age groups in a larger population.

No relation was found in this study between increased CBD diameters and histories of cholecystectomy. This is similar to what has been found in other populations. One study of 234 patients monitored by TU before and after cholecystectomy found that the mean diameter of CBDs prior to cholecystectomy was 5.9 mm and that following cholecystectomies it was 6.1 mm. Despite this difference, the authors concluded that most patients did not experience significant CBD dilatation post cholecystectomy. (4) Subsequently, a 1999 study monitored 59 patients with TU before the procedure and at three months, six months, one

year and five years after open cholecystectomy. That study found that the mean diameter before surgery was 3.43 mm and at that the mean diameter at the five year follow-up was 3.96 mm (1 mm margin of error in the measurement), but this difference is not statistically significant. (47-49)

Despite what has been said so far, there are some limitations in this study. First, it was conducted in only one medical center. Second, we did not investigate the consumption of drugs such as opioids, calcium antagonists, nitroglycerin, and PDE-5 inhibitors although they can cause dilatation of CBD. Finally, especially given the wide range of ages in the population that we study, there was an insufficient number of patients at each end of the age spectrum that may have caused some statistical bias.

CONCLUSION

The CBD diameter of the Colombian population is 4.89 mm with an upper limit of 7 mm as measured by EUS. There were no statistically significant associations with gender, age or histories of cholecystectomies. This may be useful as a reference tool for making clinical decisions regarding biliary obstruction and for defining whether further study of a patient or intervention is required.

REFERENCES

1. Lal N, Mehra S, Lal V. Ultrasonographic measurement of normal common bile duct diameter and its correlation with age, sex and anthropometry. J Clin Diagn Res. 2014;8(12):AC01-4. Doi: https://doi.org/10.7860/jcdr/2014/8738.5232
2. Chen T, Hung CR, Huang AC, et al. The diameter of the common bile duct in an asymptomatic taiwanese population: measurement by magnetic resonance cholangiopancreatography. J Chin Med Assoc. 2012;75(8):384-8. Doi: https://doi.org/10.1016/j.jcma.2012.06.002
3. Mahour GH, Wakim KG, Ferris DO. The common bile duct in man: its diameter and circumference. Ann Surg. 1967;165(3):415-9.
4. Parulekar SG. Ultrasound evaluation of common bile duct size. Radiology. 1979;133(3 Pt 1):703-7. Doi: https://doi.org/10.1148/133.3.703
5. Niederau C, Muller J, Sonnenberg A, et al. Extrahepatic bile ducts in healthy subjects, in patients with cholelithiasis, and in postcholecystectomy patients: a prospective ultrasonic study. J Clin Ultrasound. 1983;11(1):23-7. Doi: https://doi.org/10.1002/jcu.1870110106
6. Kaude JV. The width of the common bile duct in relation to age and stone disease: an ultrasonographic study. Eur J Radiol. 1983;3(2):115-117.
7. Wu CC, Ho YH, Chen CY. Effect of aging on common bile duct diameter: a real-time ultrasonographic study. J Clin Ultrasound. 1984;12(8):473-8. Doi: https://doi.org/10.1002/jcu.1870120804
8. Co CS, Shea Jr WJ, Goldberg HI. Evaluation of common bile duct diameter using high resolution computed tomography. J Comput Assist Tomog.1986;10(3):424-7.
9. Burrell MI, Zeman RK, Simeone JF, et al. The biliary tract: imaging for the 1990s. AJR Am J Roentgenol 1991;157(2):223-33. Doi: https://doi.org/10.2214/ajr.157.2.1853798
10. Wachsberg RH, Kim KH, Sundaram K. Sonographic versus endoscopic retrograde cholangiographic measurements of the bile duct revisited: importance of the transverse diameter. AJR Am J Roentgenol. 1998;170(3):669-74. Doi: https://doi.org/10.2214/ajr.170.3.9490950
11. Perret RS, Sloop GD, Borne JA. Common bile duct measurements in an elderly population. J Ultrasound Med. 2000;19(11):727-30. Doi: https://doi.org/10.7863/jum.2000.19.11.727
12. Horrow MM, Horrow JC, Niakosari A, et al. Is age associated with size of adult extrahepatic bile duct: sonographic study. Radiology. 2001; 221(2):411-4. Doi: https://doi.org/10.1148/radiol.2212001700
13. Bachar GN, Choen M, Belenky A, et al. Effect of aging on the adult extrahepatic bile duct. A sonographic study. J Ultrasound Med. 2003;22(9):879-82. Doi: https://doi.org/10.7863/jum.2003.22.9.879
14. Shanmugam V, Beattie GC, Yule SR, et al. Is magnetic resonance cholangiopancreatography the new gold standard in biliary imaging? Br J Radiol. 2005;78(934):888-93. Doi. https://doi.org/10.1259/bjr/51075444
15. Sodickson A, Mortele KJ, Barish MA, et al. Three-dimensional fast-recovery fast spin-echo MRCP: comparison with two-dimensional single-shot fast spin-echo techniques. Radiology. 2006;238(2):549-59. Doi: https://doi.org/10.1148/radiol.2382032065
16. Karvonen J, Kairisto V, Gronroos JM. The diameter of common bile duct does not predict the cause of extrahepatic cholestasis. Surg Laparosc. Endosc Percutan Tech. 2009;19(1):25-8. Doi: https://doi.org/10.1097/SLE.0b013e31818a6685
17. Bowie JD. What is the upper limit of normal for the common bile duct on ultrasound: how much do you want it to be? Am J Gastroenterol. 2000;95(4):897-900. Doi: https://doi.org/10.1111/j.1572-0241.2000.01925.x
18. Holm AN, Gerke H. What should be done with a dilated bileduct? Curr Gastroenterol Rep. 2010;12(2):150-6. Doi: https://doi.org/10.1007/s11894-010-0094-3
19. Adibi A, Givechian B. Diameter of common bile duct: what are the predicting factors? JRMS. 2007;12(3):121-4.
20. Eloubeidi MA, Varadarajulu S, Desai S, et al. A prospective evaluation of an algorithm incorporating routine preoperative endoscopic ultrasound guided fine needle aspiration in suspected pancreatic cancer. J Gastrointest Surg. 2007;11(7):813-9. Doi: https://doi.org/10.1007/s11605-007-0151-x
21. Soriano A, Castells A, Ayuso C, et al. Preoperative staging and tumor resectability assessment of pancreatic cancer: prospective study comparing endoscopic ultrasonography, helical computed tomography, magnetic resonance imaging,

and angiography. Am J Gastroenterol. 2004;99(3):492-501. Doi: https://doi.org/10.1111/j.1572-0241.2004.04087.x
22. Fusaroli P, Saftoiu A, Mancino MG, et al. Techniques of image enhancement in USE (with videos). Gastrointest Endosc. 2011;74(3):645-55. Doi: https://doi.org/10.1016/j.gie.2011.03.1246
23. Tse F, Liu L, Barkun AN, et al. USE: a meta-analysis of test performance in suspected choledocholithiasis. Gastrointest Endosc. 2008;67(2):235-44. Doi: https://doi.org/10.1016/j.gie.2007.09.047
24. Garrow D, Miller S, Sinha D, et al. Endoscopic ultrasound: a meta-analysis of test performance in suspected biliary obstruction. Clin Gastroenterol Hepatol. 2007;5(5):616-23. Doi: https://doi.org/10.1016/j.cgh.2007.02.027
25. Palazzo L, O'toole D. USE in common bile duct stones. Gastrointest Endosc. 2002;56(4 Suppl):S49-57. Doi. https://doi.org/10.1016/S0016-5107(02)70086-2
26. Wani S, Wallace MB, Cohen J, et al. Quality indicators for USE. Am J Gastroenterol. 2015;110(1):102-13. Doi: https://doi.org/10.1038/ajg.2014.387
27. Becker BA, Chin E, Mervis E, et al. Emergency biliary sonography: utility of common bile duct measurement in the diagnosis of cholecystitis and choledocholithiasis. J Emerg Med. 2014;46(1):54-60. Doi: https://doi.org/10.1016/j.jemermed.2013.03.024
28. Gandolfi L, Torresan F, Solmi L, et al. The role of ultrasound in biliary and pancreatic diseases. Eur J Ultrasound. 2003;16(3):141-59. Doi: https://doi.org/10.1016/S0929-8266(02)00068-X
29. Matcuk GR Jr, Grant EG, Ralls PW. Ultrasound measurements of the bile ducts and gallbladder: normal ranges and effects of age, sex, cholecystectomy, and pathologic states. Ultrasound Q. 2014;30(1):41-8. Doi: https://doi.org/10.1097/RUQ.0b013e3182a80c98
30. Pedersen OM, Nordgard K, Kvinnsland S. Value of sonography in obstructive jaundice. Limitations of bile duct caliber as an indext of obstruction. Scand J Gastroenterol. 1987;22(8):975–81. Doi: https://doi.org/10.3109/00365528708991945
31. Hou LA, Van Dam J. Pre-ERCP imaging of the bile duct and gallbladder. Gastrointest Endosc Clin N Am. 2013;23(2):185-97. Doi: https://doi.org/10.1016/j.giec.2012.12.011
32. Andriulli A, Loperfido S, Napolitano G, et al. Incidence rates of post-ERCP complications: a systematic survey of prospective studies. Am J Gastroenterol. 2007;102(8):1781-8. Doi: https://doi.org/10.1111/j.1572-0241.2007.01279.x
33. Coelho-Prabhu N1, Shah ND, Van Houten H, et al. Endoscopic retrograde cholangiopancreatography: utilisation and outcomes in a 10-year population-based cohort. BMJ Open. 2013 31;3(5).
34. Craanen ME, van Waesberghe JH, van der Peet DL, et al. Endoscopic ultrasound in patients with obstructive jaundice and inconclusive ultrasound and computer tomography. Eur J Gastroenterol 2006;18(12):1289-92. Doi: https://doi.org/10.1097/01.meg.0000243875.71702.68
35. ASGE Standards of Practice Committee, Maple JT, Ben-Menachem T, et al. The role of endoscopy in the evaluation of suspected choledocholithiasis. Gastrointest Endosc. 2010;71(1):1-9. Doi: https://doi.org/10.1016/j.gie.2009.09.041
36. Buscarini E, Tansini P, Vallisa D, et al. EUS for suspected choledocholithiasis: do benefits outweigh costs? A prospective, controlled study. Gastrointest Endosc. 2003;57(4):510-8. Doi: https://doi.org/10.1067/mge.2003.149
37. Karakan T, Cindoruk M, Alagozlu H, et al. EUS versus endoscopic retrograde cholangiography for patients with intermediate probability of bile duct stones: a prospective randomized trial. Gastrointest Endosc. 2009;69(2):244-52. Doi: https://doi.org/10.1016/j.gie.2008.05.023
38. Romagnuolo J, Currie G, Calgary Advanced Therapeutic Endoscopy Center Study Group. Noninvastive vs. selective invasive biliary imaging for acute biliary pancreatitis: an economic evaluation by using decision tree analysis. Gastrointest Endosc. 2005;61(1):86–97. Doi: https://doi.org/10.1016/S0016-5107(04)02472-1
39. Chen CH, Yang CC, Yeh YH, et al. Endosonography for suspected obstructive jaundice with no definite pathology on ultrasonography. J Formos Med Assoc. 2015;114(9):820-8. Doi: https://doi.org/10.1016/j.jfma.2013.09.005
40. Rana SS, Bhasin DK, Sharma V, et al. Role of endoscopic ultrasound in evaluation of unexplained common bile duct dilatation on magnetic resonance cholangiopancreatography. Ann Gastroenterol. 2013;26(1):66-70.
41. Benjaminov F, Leichtman G, Naftali T, et al. Effects of age and cholecystectomy on common bile duct diameter as measured by endoscopic ultrasonography. Surg Endosc. 2013;27(1):303-7. Doi: https://doi.org/10.1007/s00464-012-2445-7
42. Strazzabosco M1, Fabris L. Functional anatomy of normal bile ducts. Anat Rec (Hoboken). 2008;291(6):653-60. Doi: https://doi.org/10.1002/ar.20664
43. Blidaru D1, Blidaru M, Pop C, et al. The common bile duct: size, course, relations. Rom J Morphol Embryol. 2010;51(1):141-4.
44. Joshi BR. Sonographic variations in common bile duct dimensions. J of Inst of Medicine. 2009; 31(3):27-9.
45. Park JS, Lee DH, Jeong S, et al. Determination of diameter and angulation of the normal common bile duct using multidetector computed tomography. Gut Liver. 2009;3(4):306-10. Doi: https://doi.org/10.5009/gnl.2009.3.4.306
46. Admassie D. Ultrasound assessment of common bile duct diameter in Tikur Anbessa Hospital, Addis Ababa, Ethiopia. Ethiop Med J. 2008;46(4):391-5.
47. Feng B, Song Q. Does the common bile duct dilate after cholecystectomy? Sonographic evaluation in 234 patients. AJR Am J Roentgenol. 1995;165(4):859-61. Doi: https://doi.org/10.2214/ajr.165.4.7676981
48. Majeed AW, Johnson AG. The preoperatively normal bile duct does not dilate after cholecystectomy: results of a five year study. Gut. 1999;45(5):741-3. Doi: https://doi.org/10.1136/gut.45.5.741
49. Horrow MM. Ultrasound of the extrahepatic bile duct: issues of size. Ultrasound Q. 2010;26(2):67-74. Doi: https://doi.org/10.1097/RUQ.0b013e3181e17516