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Sonographic measurement of common bile duct diameter in apparently healthy adults in Abakaliki metropolis

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Abstract

Common bile duct ectasia is a sonographic evidence of obstruction to normal flow. Availability of a reference range is therefore clinically warranted. This Study is aimed at establishing a reference range of the Common Bile Duct diameter in apparently healthy adults and its relationship with age, gender and anthropometry.

This is a prospective cross sectional survey involving 424 participants aged 18 to 90 years. The luminal ductal diameter was measured at: the proximal, middle and the distal aspects. Anthropometric measurements were obtained using standard techniques.

The mean ductal diameters from proximal to distal were: 3.57±1.25 mm; 3.57±1.30 mm and 3.70±1.41 mm. overall mean for all measures was 3.61±1.22 mm. There was statistically significant positive correlation of common bile duct diameter with age in both male and female ($r = 0.804$ and 0.706 respectively; $p = 0.001$). There was no statistically significant difference in mean CBD diameter between male and female within the same age group ($p > 0.05$). However, there was statistically significant difference in the overall mean diameter between gender ($p = 0.001$). A moderate positive correlation was noted with the weight, BMI, circumferences at the transpyloric plane and the umbilical regions for both gender ($0.226 < r < 0.411$, $p < 0.001$).

Ductal diameters beyond this range should prompt the need for further evaluation and anthropometry put to bear in predictions.

Keywords: Common bile duct

Introduction

The size of the common bile duct is a predictor of biliary obstruction and its measurement is therefore an important component in the evaluation of the biliary system. Availability of a reference range would help to distinguish between medical and surgical jaundice.

The mean diameter of a normal common duct is 4.1 mm[1]. A common duct greater than 7 mm in diameter is possible in non-jaundiced patients with cholelithiasis, pancreatitis or jaundiced patients with common duct obstruction by stone or tumour. A common duct greater than 11 mm in diameter is strongly suggestive of

obstruction[1]. An upper limit of 8 mm appears reasonable after the age of 50; and an upper limit of 10 mm seems appropriate for cholescystectomized individuals[2]. In many patients, biliary ectasia does indicate obstruction. However, such an assessment is dependent on knowledge of the normal duct size.

A variety of factors, such as age, prior surgery congenital abnormalities, anatomical variations, body mass index (BMI), portal vein diameter, cholelithiasis and medications or opium addiction affect the size of the common bile duct[3,4,5,6] Ultrasonography is an accurate, safe, non-invasive, readily available and inexpensive imaging modality, which is highly sensitive and specific for the detection of many biliary diseases[7]. Ultrasonography is comparable in accuracy to oral cholecystography, radionuclide studies, computed tomography and magnetic resonance imaging, and more cost-effective[8]. Evaluation of the biliary tree continues to be one of the most preeminent uses of ultr asound imaging, even in the current era of en dospic retrograde cholangiopancreatography (ERCP), magnetic resonance cholangiopancr eatograph(MRCP), and endoscopic ultrasoun d[3]. Though Interpretations from CT, MRCP a nd ERCP usully are more descriptive, ultraso nography is cheap, non-invasive, readily available and the diagnostic method of choice for visualization and rational work-up of abdominal structures[3]. It is a pivotal study for evaluation of the hepatobiliary system. Although the establishment of a normal duct diameter via ultrasound is very important, but clinical symptoms and abnormal laboratory values should prompt need for further evaluation despite a normal appearance of the ducts; whereas pursuit of an isolated finding of an enlarged duct without supporting clinical data may be unwarranted[3].

A growing body of literature exists that has examined the correlation of CBD diameter with age, gender and anthropometry; however many of these studies have a limited sample size; with variations in the reported duct diameter and to the best of the researcher's knowledge no such work has been done within this locality; bearing in mind that there exist significant variations in CBD diameter with anthropometric features of various populations, regions and races[8]. However, despite technological advancements, the association of anthropometric measurements with the diameters of common bile duct has remained controversial. Sonographic CBD diameter assessment may be used in every situation where its diameter affects further treatment and prognosis; hence a need to establish CBD reference values for our population using ultrasonography which is a useful non-invasive, readily available and cheap procedure for accurate hepatobiliary and pancreatic assessment.

We conducted this study to obtain data on sonographically measured diameters of common bile duct among south-eastern Nigerian population in order to determine the range of normal diameters for this population and its association with age, gender, and some anthropometric measurements.

Materials and Method

We conducted a prospective cross-sectional non experimental study at the Department of Human Anatomy, Ebonyi state university, Presco Campus, Abakaliki, south-eastern Nigeria. A total of 424 apparently healthy adult easterners consisting of 216 males and 208 females with essentially normal scan result,no hepatobiliary or pancreatic patholog y[4], adequate visualisation of the pancreas and entire extra hepatic duct, no subjective complain of abdominal pain[9],nil physical evidence of jaundice[10], no history of renal, respiratory and cardiac disease[10] no noticeable pregnancy [10], nil splenomegaly and portal hypertension[10], nil cholecystectomy, congenital abnormalities, anatomical variations, and medications[3]

In line with Helsinki Declaration, approval for this study was obtained from the Human Research and Ethics Committee of the Federal Teaching Hospital, Abakaliki, Ebonyi State. The procedures were explained to the subjects and written informed consent was obtained from each subject before enrolling into the study.

Sonoline Prima 3.5 MHz curvilinear transducer (Siemens medical system, Germany, 1996) was used to measure the common bile duct diameter. Other materials used were non-extensible flexible measuring tape (TR-13-60" Tailor's Tape [60 in. / 1.5 m]), for circumference acquisition, balanced beam scale with an incorporated height adjustable rule (seca Germany) for weight and height measurements, aqueous gel to dispel air at probe-skin interface and a chart prepared in advance for recording of observations.

The subjects had an overnight fast as necessary for gastro-intestinal imaging to help reduce bowel gas[11]. A total of 424 subjects were studied with Socio-demographic details related to age and gender recorded for each subject. All the physical measurements were conducted in a separate area, screened off to provide privacy. Anthropometric measurements were made based on the recommendations of Centre for Disease Control and Prevention (2008)[12]: Subjects were asked to stand with their feet together with weight evenly distributed over both feet and the arms relaxed by the sides during the measurements. To measure the weight, the volunteer was made to empty the pockets of mobile phones, bunches of keys, wallets and other objects that could add a gram or more to the weight. The weight was taken bare-foot, the volunteer stood erect on the beam balance without resting hands or body on the table or wall. The weight, in kg was read to nearest 0.5kg. while still standing erect and as motionless as reasonably practicable, with heels, gluteal muscles and occiput touching the upright bar of the height scale, the short, horizontal bar of the scale was adjusted to make firm contact with the vertex of the head, the height was then read off the nearest centimetre. The BMI was calculated as weight (kg) over height^2 (meter^2)[13].

As part of assessment to determine if CBD diameters vary with body build, Chest circumference was measured using a measuring tape over light clothing and while breathing normally. In the males, the measurement was made at the widest diameter of the chest; in the females, the measurement was made at the level of the nipples with the measuring tape held horizontally. The circumference at the transpyloric plane was measured at a level midway between the suprasternal notch and the symphysis pubis; 5 cm above the lower coastal margin. Circumference at the umbilicus was obtained by measuring the abdominal circumference using measuring tape at the level of the umbilicus.

The common bile duct diameters were obtained using a 3.5 MHZ curvilinear transducer. With the patient supine or in a left lateral oblique position, whichever provides more optimal images[5]. The common bile duct was identified through its association with the portal vein in the long axis of the gallbladder. At this location the common bile duct and hepatic artery appear as two smaller circles anterior to the portal vein, giving an appearance of a face with two ears – also called a 'Mickey Mouse' sign[10]. A single measurement of the bile duct can be misleading as the duct may be normal at this point, yet be distended lower down in early obstructive jaundice. Thus, the common bile duct was measured at three locations: at the portahepatis just after where the left and right extrahepatic ducts join (proximal), in the most distal aspect of head of pancreas and mid-way between these points, just before the duct enters the pancreas (middle)[10]. For each location, antero-posterior (AP) measurements were obtained from the

longitudinal images. Measurements were made from inner to inner walls of the ducts by using electronic callipers[9] and overall mean for all measurements obtained[10]. All sonographic measurements were taken on quiet respiration. To reduce intra observer variability, two measurements were taken and the average calculated[14,15].

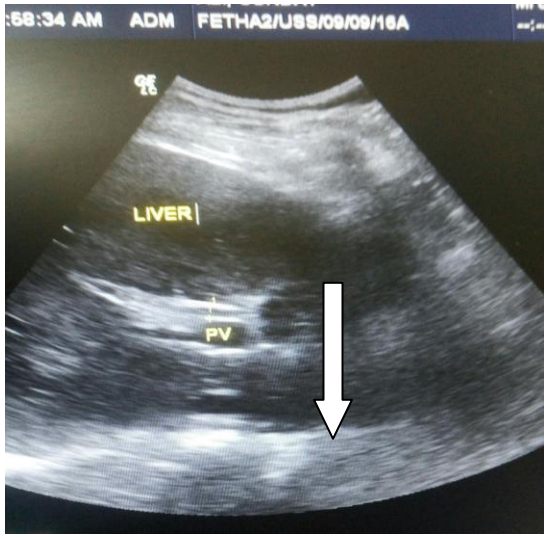

Figure 1: Sonogram showing the CBD at the portahepatis . Arrow: common bile duct
Key: PV: portal vein.

Results

A total of 424 subjects were studied consisting of 216 males (50.9%) and 208 females (49.1). The study subjects belonged to the age group 18-90 years of age; the mean age was 34.03±16.16 years. A majority of the participants belonged to the age group 18-25 years. The mean age for males was 37±18.3 years while that for females was 30.9±13 years. This difference in ages was statistically significant (p = 0.000).

The mean weight, height, BMI and BSA of t he participants was 65.3±9.61 kg, 166±7.45 cm, and 23.7±3.53 kg/m^2 and 1.5±0.25 m^2 respectively.

The mean circumference measured at levels of chest, transpyloric plane, and umbilicus were 89.2±10.20 cm, 78.58±8.77 cm, 80.2±10.77 cm respectively.

The mean diameters of the common bile duct at the proximal, middle and distal segments were: 3.57±1.25, 3.57±1.29 and 3.70 mm respectively. The overall mean for all measures was 3.61±1.22 mm. The lower limit of common bile duct diameter among the normal subjects was 2.0 mm, the upper limit was found to be 8.0 mm. Nevertheless a greater percentage of the study participants showed a common bile duct diameter of < 6 mm.

Table 1 shows the distribution of mean CBD diameter according to age group. The mean diameter was found to increase progressively from 2.79 mm among those aged 18-25 years of age to 5.44 mm among those in the age group more than 55 years of age. The difference in mean CBD diameter across the five age groups was compared using analysis of variance. This was found to be statistically significant (p = 0.000). However, the post hoc test revealed that the mean CBD for subjects aged 18-25, 26-35 and 36-45 years showed statistically significant difference in comparison to the diameters of the different age groups (p < 0.001); while the mean diameters in the age group 46-55 and >55 years was not statistically significant (p > 0.05).

All the three diameters were highly correlated and statistically significant (p-value < 0.001). The overall mean common bile duct diameters for males and females were:

3.81±1.36 mm and 3.41±1.03 mm respectivel y. This difference was tested by applying independent samples t-test and was found to be statistically significant (p = 0.001). Similar observation was also made for the middle and distal portions (p = 0.000). However, no statistically significant difference was noted within each age group (p > 0.05).

In order to assess the association between common bile duct diameter and

anthropometric measurements, both of which were continuous variables, correlation was used. Common bile duct diameter was strongly and positively correlated with age in males and females (r = 0.804 and 706 respectively. p = 0.000). Similarly, there is a positive correlation of common bile duct diameter with weight, body mass index, circumference at the transpyloric and umbilical regions for both genders; albeit a moderate one ($0.226 \leq r \leq 0.411$, $p \leq 0.001$). The diameter did not show any statistically significant correlation with height and chest circumferences.

Table 1: Descriptive statistics of mean CBD diameters according to age group.

Age group (years)	n	Mean±SD	F-value	p-value
18-25yrs	188	2.79±0.64		
26-35yrs	92	3.38±0.73		
36-45yrs	59	4.02±0.54	196.27	0.000
46-55yrs	40	5.36±0.55		
>55yrs	45	5.44±1.23		
Total	424	3.61±1.22		

Table 2: Pearson correlation of CBD Diameter with the demographic data according to gender.

Parameter	Male		Female	
	r	p-value	r	p-value
Age (years)	0.804	0.000	0.706	0.000
Weight (kg)	0.226	0.001	0.300	0.000
Height (cm)	-0.181	0.008	-0.076	0.276
BMI (kg/m^2)	0.340	0.000	0.116	0.096
BSA (m^2)	0.148	0.029	0.212	0.002
Chest circumference	0.109	0.111	0.122	0.079
Transpyloric Circumference (cm)	0.247	0.000	0.371	0.000
Umbilical Circumference (cm)	0.374	0.000	0.411	0.000

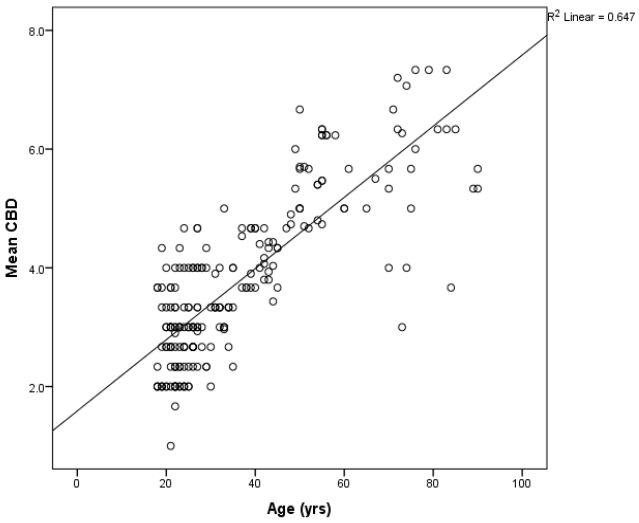

Figure 2: Scatter plot and trend line for the mean common bile duct diameter and age for males. Predictive equation: Y = 1.590 + 0.06X. r = 0.804 R^2= 0.647 p-value = 0.000.

Discussion

Ultrasonography is a cheap, non-invasive and relatively easily available means of evaluating the hepatobiliary system. In many parts of Nigeria and other resource limited countries, ultrasonography may be the only method available[11]. Very limited data is available in our environment on quantification of the common bile duct diameter. It is expected that in the use of these values as nomograms, the false positive rate (type 1 error) might be lower in symptomatic patients. This is because healthy subjects have a low pretest probability of having a disease, while patients clinically referred for abdominal sonography have a pretest likelihood of disease. These patients have undergone extensive work-up prior to referral to exclude other diseases[16]. The Bayes theorem indicates that in healthy subjects who have a low pretest probability of disease, a positive test result is likely to be false positive, that is, the positive predictive value is low. The result can be validated on account of the normal distribution pattern of the sample population as proved by Lyapunov central limit theorem[17].

The results of this study have shown a normal common bile duct diameter (mean ± 2SD) of 3.61±1.23 mm, range (2.79-5.44 mm) and median value of 4.02 mm. These findings are in agreement with Atoosa & Behrooz[5], Horrow[18], Kaude[19] and Mindy[3]. There is a disagreement by Kaim *et al.*[20] and Parulekar[1] where mean common bile duct diameter was reported as 4.1 mm and 6.5 mm respectively. The sample size and the population studied were strongly suspected to be the cause of this variation. For instance, Kaim *et al.*[20] studied 92 subjects over 75 years while Parulekar[1] studied 73 subjects aged 20-65 years.

The lower and upper limits of normal common bile duct diameter were found to be 2.0 mm and 8.0 mm respectively in this study. However, majority of the study subjects had a common bile duct diameter of < 6 mm. These findings are in agreement with Behan & Kazam[21] , Nidhi *et al.*[10]. There is a disagreement by Mohammad *et al*[22] and Wu *et al.*[23] who reported the upper limit of normal common bile duct diameter as 10 mm. This may be due to the inclusion of paediatric population in their studies. Including a paediatric population will clearly accentuate age differences in duct measurements[18].

There was no statistically significant difference in mean common bile duct diameter between male and female within the same age group ($p > 0.05$); but there is statistically significant difference in the overall mean common bile duct diameter between male and female ($p = 0.001$) wherein, males showed larger CBD compared to females. These findings are in agreement with some studies[5,10,24]. There is a disagreement by Mohammad *et al.*[22] who reported that in general, the females had slightly larger CBDs compared to the males. This controversy is strongly suspected to be due to the non-uniform distribution of their

sample by gender. Out of 196 subjects studied, 135 were females and 61 males.

There is a strong positive correlation of common bile duct diameter with age in both males and females ($r = 0.804$, $p = 0.000$ and $r = 0.706$, $p = 0.000$ respectively); with a statistically significant age dependence ($p = 0.000$). The mean diameter of the common bile duct increased from 2.8 mm in the age group 18-25 years to 5.4 mm in subjects above 55 years of age. These findings are in agreement with some studies[4,5,10,19,23]. There is a disagreement by Kaim *et al*.[20]. This may be due to age, race or sample size; for instance, they studied 92 subjects over 75 years. The inclusion of paediatric population forces the regression to show an age effect[18].

The mean common bile duct diameter showed moderate positive correlation with the weight, BMI, circumferences at the transpyloric plane and umbilical regions. These findings are in agreement with some works[4,5,24].

The overall mean common bile duct diameter was 3.61±1.23 mm. This reference value of the range of normality for the common bile duct and pancreatic duct diameters would help in defining the upper limit in assessment of patients with related pathologies. Ductal diameters beyond these limits should prompt the need for further investigations[10]. The common bile duct diameters at the various segments and the composite mean showed a strong positive correlation with age and moderate positive correlation with weight, BMI and trunk circumferences at the transpyloric and umbilical regions. This proves the reliability of ultrasound in common bile duct assessment amongst Easterners in Abakaliki metropolis. With the predictive equation of regression derived, it is possible to predict common bile duct diameter using age.

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