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Original Article

Anatomy Section

Ultrasonographic Measurement of Normal Common Bile Duct Diameter and its Correlation with Age, Sex and Anthropometry

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ABSTRACT

Background: Ultrasonography is the diagnostic method of choice for visualization and rational work-up of abdominal organs. The dilatation of the common bile duct helps distinguish obstructive from non-obstructive causes of jaundice. Availability of normal measurements of the common bile duct is therefore important. There exists significant variations in the anthropometric features of various populations, regions and races.

Aim: Study was conducted to obtain data on sonographically measured diameters of common bile duct in a series of normal Rajasthani population and to measure its correlation with age, sex and anthropometry.

Setting and Design: Cross-sectional hospital-based study conducted at Mahatma Gandhi Medical College and Hospital, Jaipur, India.

Materials and Methods: Study included 200 participants with equal proportion belonging to either sex. Common bile duct was measured at three locations- at the porta hepatis, in the most distal aspect of head of pancreas and mid-way between these points. Anthropometric measurements including height, weight, chest circumference, circumference at transpyloric plane, circumference at umbilicus and circumference at hip were obtained using standard procedures.

Statistical Analysis: Univariable analysis with measures of frequency and standard deviation and bivariable analysis using correlation.

Results: Mean age of study subjects was 34.5 years (Range 18-85 years). Mean diameters of the common bile duct in the three locations were: proximal, 4.0 mm (SD 1.02 mm); middle, 4.1 mm (SD 1.01 mm); and distal, 4.2 mm (SD 1.01 mm) and overall mean for all measures 4.1 mm (SD 1.01 mm). Average diameter ranged from 2.0 mm to 7.9 mm, with 95 percent of the subjects having a diameter of less than 6 mm. We observed a statistically significant relation of common bile duct with age, along with a linear trend. There was no statistically significant difference in common bile duct diameter between male and female subjects. The diameter did not show any statistically significant correlation with any of the anthropometric measurements.

Conclusion: Our study reported the upper limit of normality as 7.9 mm. The diameter increased progressively from 3.9 mm among those aged 18-25 years to 4.7 mm among those in the age group more than 55 years. This was found to be statistically significant. Ductal diameters beyond these limits should prompt the need for further investigations.

Keywords: Anthropometry, Common bile duct, Ultrasonography

INTRODUCTION

The size of the common bile duct is a predictor of biliary obstruction and it's measurement is therefore an important component in the evaluation of the biliary system. Availability of normal measurements of the common bile duct would help to distinguish obstructive from non-obstructive causes of jaundice.

Ultrasonography is an accurate, safe, non-invasive and inexpensive imaging modality, which is highly sensitive and specific for the detection of many biliary tree diseases [1]. Ultrasonography is comparable in accuracy to oral cholecystography, radionuclide studies, computed tomography and magnetic resonance imaging, and more cost-effective [2].

With the development of high resolution scanners, the luminal diameters of the common bile duct can be assessed accurately. The normal internal diameter of the common bile duct on ultrasonography is 6 mm [3]. Different opinions regarding the size of the common bile duct have been revealed in literature.

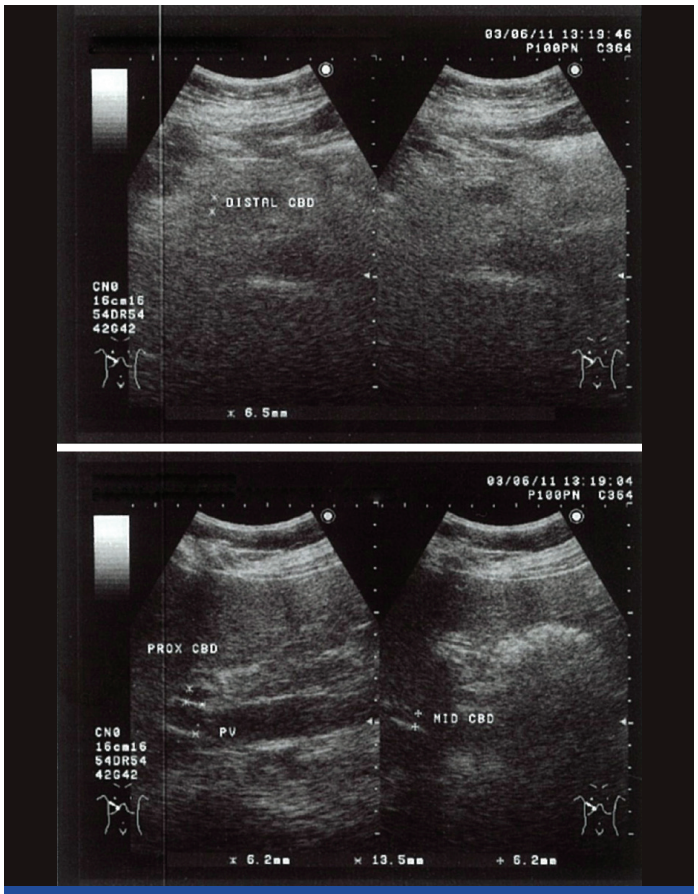
It is an established fact that variations exist in the anthropometric features of various populations, races and regions [4]. Studies have suggested correlation between different kinds of body builds and diseases. However, despite technological advancements, the association of anthropometric measurements with the diameters of common bile duct has remained controversial.

We conducted this study to obtain data on sonographically measured diameters of common bile duct among Rajasthani population in order to determine the range of normal diameters for common bile duct among this population and to determine its association with age, sex, physical measurements like height, weight, chest circumference, circumference at the transpyloric plane, circumference at the umbilicus and circumference at the hip.

MATERIALS AND METHODS

We conducted a cross-sectional hospital-based study at Mahatma Gandhi Medical College and Hospital, Jaipur. A total of 200 subjects, comprising an equal proportion of males and females were included in the study. The study included normal healthy adult male and non-pregnant female subjects visiting hospital OPD for regular check-up without any history of or known hepatobiliary disease, cardiac disorders, splenomegaly and portal hypertension. An informed consent was obtained from all the subjects prior to enrolment in the study.

Socio-demographic details related to age, sex and place of residence were recorded for each subject. The ultrasonographic findings with regard to common bile duct diameter were obtained. In order to reduce observer bias, the same expert radiologist was involved in conducting ultrasonography for all subjects. A 3.5 megahertz (MHz)



[Table/Fig-1]: Ultrasonographic measurement of CBD at three locations

Age Group (in completed years)	Number of Participants	Mean (mm)	Standard Deviation (mm)
18-25	70	3.9	0.86
26-35	50	4.0	0.91
36-45	46	4.1	1.17
46-55	23	4.4	1.23
>55	11	4.7	0.81
Total	200	4.1	1.01

[Table/Fig-2]: Mean and standard deviation of common bile duct diameter by age group

Anthropometric Measurement	Male		Female	
	Correlation Coefficient	Sig. (p-value)	Correlation Coefficient	Sig. (p-value)
Weight	- 0.01	0.851	0.13	0.177
Height	- 0.02	0.782	0.01	0.863
Chest circumference	0.03	0.712	0.09	0.328
Circumference at transpyloric plane	0.04	0.684	0.18	0.071
Circumference at umbilicus	0.08	0.421	0.09	0.340
Circumference at hip	- 0.03	0.771	0.07	0.432

[Table/Fig-3]: Summary of correlation between common bile duct diameter and anthropometric measurements by sex

transducer was used. 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. With the indicator directed toward the patient's right, the right ear is the common bile duct and the left ear, the hepatic artery.

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 porta hepatis, in the most distal aspect of head of pancreas and mid-way between these points [Table/Fig-1].

All the physical measurements were conducted in a separate area, screened off to provide privacy. The following procedures were adopted for conducting anthropometric measurements [5]: Subjects were asked to stand with their feet together with weight evenly distributed over both feet and with their arms relaxed at the sides during the measurements.

Height was measured using a stadiometer with a sensitivity of 0.1 centimeter. The weighing scale with a sensitivity of 0.1 kg was used to measure weight. 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 point 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 (at the upper border of manubrium between the sternal heads of sternomastoid muscles) and the symphysis pubis (at the lower end of median line). Circumference at the umbilicus was obtained by measuring the abdominal circumference using measuring tape at the level of the umbilicus. Circumference at the hip was measured with the measuring tape positioned around the maximum circumference of the buttocks.

RESULTS

We studied a total of 200 subjects; wherein an equal proportion belonged to either sex. The study subjects belonged to the age group 18-85 years of age; the mean age was 34.5 years (SD 13.24 years). A majority of the participants belonged to the age group 18-25 years. The mean age for males was 35.8 years while that for females was 33.1 years. This difference in ages was not statistically significant.

The mean weight and height of the participants was 51.4 kg (SD 12.25 kg) and 163.4 cm (SD 9.98 cm) respectively. The mean circumference measured at levels of chest, transpyloric plane, umbilicus and hip were 83.5 cm (SD 9.04 cm), 75.2 cm (SD 9.94 cm), 78.1 cm (SD 12.02 cm) and 87.2 cm (SD 10.0 cm) respectively.

The mean diameters of the common bile duct in the three locations were: proximal, 4.0 mm (SD 1.02 mm); middle, 4.1 mm (SD 1.01 mm); and distal, 4.2 mm (SD 1.01 mm). The overall mean for all measures was 4.1 mm, with a standard deviation of 1.01 mm. All the three diameters were highly correlated and statistically significant (p-value<0.001). While the lower limit of common bile duct diameter among the normal subjects was 2.0 mm, the upper limit was found to be 7.9 mm. However, 95% of the study participants showed a common bile duct diameter of < 6 mm.

[Table/Fig-2] shows the distribution of common bile duct diameter by age group. The diameter was found to increase progressively from 3.9 mm among those aged 18-25 years of age to 4.7 mm among those in the age group more than 55 years of age.

In order to compare the diameter across the five age groups, and test the null hypothesis that the groups have the same common bile duct diameters, we applied the Analysis of Variance (ANOVA). The difference was found to be statistically significant (p = 0.05).

Further, we applied a test for linear trend on the age-wise distribution of common bile duct diameter. This was found to be statistically significant (p = 0.003), with an F-statistic of 8.78.

The mean diameter of common bile duct was observed to be 4.1 mm (SD 0.95 mm) for males and 4.0 mm (SD 1.07 mm) for females. This difference was tested by applying independent samples t

-test. The t value was 0.86, which was not found to be statistically significant (p = 0.38).

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 not observed to have statistically significant correlation with any of the anthropometric measurements. The diameter was not observed to have statistically significant correlation with any of the anthropometric measurements among either sex [Table/Fig-3].

DISCUSSION

This study was conducted among 200 normal subjects belonging to the state of Rajasthan. An equal number of males and females in the age group 18-85 years of age were included in the study. The subjects underwent ultrasonographic measurements of common bile duct diameters by experienced radiologist at the Mahatma Gandhi Medical College and Hospital at Jaipur, India. In addition, anthropometric data on weight, height, chest circumference, circumference at transpyloric plane, circumference at umbilicus and circumference at hip were obtained for each of the study subjects.

The mean diameter observed in our study was 4.1 mm with a standard deviation of 1.01 mm. This was similar to that reported by Parulekar [6] in his study on 200 normal subjects. Mesenas et al., [7], reported a higher mean diameter of 5 mm (SD 1.9 mm). In a study in Korea, Park et al., [8] reported the average diameter of the common bile duct was 6.7 mm. Other studies have reported lower mean diameters at less than 4 mm [9-11].

The lower and upper limits of normal common bile duct diameter were found to be 2.0 mm and 7.9 mm respectively in our study. However, majority of the study subjects (95%) had a common bile duct diameter of < 6 mm. The upper limit was similar to that reported in a study by Behan et al., [12], wherein 8 mm was recommended as the upper limit for common bile duct diameter. However, the upper limits of normality for common bile duct diameter have been reported variably by several studies. A much lower upper limit at 5 mm has been reported by some studies [13-15]. In a study by Dewbury [16] the range of measurements in all patients was from 2 mm to 5 mm. He therefore recommended the upper limit to be 6 mm. Among 750 adult subjects, Bruneton et al., [17] found only 5.9% of to have a bile duct with a diameter greater than or equal to 5 mm. However, a high 10 mm as the normal upper limit for common bile duct diameter was reported by Wu CC et al., [18].

The mean common bile duct diameters of proximal and distal parts were 4.0 mm (SD 1.02 mm) and 4.2 mm (SD 1.01 mm), respectively. A strong correlation was found between proximal and distal part of CBD due to constant diameter. Similar correlation has been reported by Adibi and Givechian [19] and Niederau et al., [9].

We found a statistically significant difference between common bile duct diameters across age groups. In addition, a linear trend was also observed with age. Several studies have reported a statistically significant correlation of common bile duct diameter with age. Niederau et al., [9] found the diameter to be significantly correlated with age (r = 0.16). In a study by Kaude [10] the mean width of the common bile duct increased from 2.8 mm in the age group 20 years or younger to 4.1 mm in patients 71 years of age or older. Several other studies have also reported a correlation of common bile duct diameter with age [18-22].

However, some authors like Reinus et al., [15] have reported no relation of common bile duct diameter with age.

We did not find any statistically significant correlation of common bile duct diameter with sex. This finding was similar to other studies by Niederau et al., [9], Admassie [11], Reinus et al., [15], Adibi and Givechian [19], Brogna et al., [20] and El Sharkawy E et al., [23].

In our study, the common bile duct did not have any significant correlation with the anthropometric measurements. Niederau et al., [9] reported no correlation with height and body surface area; although the common bile duct showed correlation with weight, albeit a poor one (r = 0.11). Admassie [11] found positive correlation of common bile duct diameter with weight, however no such relation was found with height. However, Reinus et al., [15] in his study observed no such correlation with weight.

In a study conducted in Jordan, Daradkeh et al., [22] demonstrated a significant correlation with body mass index (BMI). A correlation of common bile duct diameter with BMI was also reported by Adibi and Givechian [19]. However, no such correlation was reported in a study by Brogna et al., [20].

Studies to determine the range of normality for the common bile duct diameter would help in defining the upper limit in assessment of patients suffering from obstructive jaundice. Ductal diameters beyond these limits should prompt the need for further investigations. It is important to know clinically if a jaundiced patient has obstruction of the bile duct as opposed to a hepatocellular or biliary ductular disease. Causes of biliary obstruction may include benign (choledocholithiasis, infectious cholangitis or congenital disease) or neoplastic (cholangiocarcinoma, gall bladder carcinoma) [24]. Biliary stenting is widely used to palliate malignant obstruction or to treat benign biliary disease. The diameter of the stents varies from 5F to 12F. Ensuring patency duration and reducing recurrent obstruction are often dependent on the diameter of these stents [25].

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