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Morphometric Analysis of Common Bile Duct: A Cadaveric Study

Sanjay Kumar Sah[1]*, Himal Panth[2] and Ying Xiong Wang[3]

[1]Department of Basic Medicine, Joint International Research Laboratory of Reproduction & Development, Chongqing Medical University, Chongqing, People's Republic of China
[2]Department of Basic Medicine, Universal College of Medical Sciences, Bhairahawa, Nepal
[3]Joint International Research Laboratory of Reproduction & Development, Chongqing Medical University, Chongqing, People's Republic of China

ABSTRACT

Introduction: Though human beings look similar in their general anatomical appearances but during the investigation of a particular structure in detail, it is surprising how frequently we meet one sort or another type of variation. Literature reports that accurate dimensions of CBD are debatable. Therefore, determination of a spontaneous abnormality or atypical variation is important and reference range plays a significant role to classify the normal or abnormal duct.

Materials and Methods: A total of thirty (30) cadavers were dissected at MGM Medical College Mumbai, India from Jan 2012 to March 2013 for anatomical features of the common bile duct-like their size, variations in the course and termination.

Results: The length of the common bile duct varies 35.19 mm to 62.43 mm with Mean ± SD 46.92 ± 7.91 mm and diameter varied between 3.65 mm to 10.31 mm with mean value 6.50 ± 1.77. The correlation between length and diameter of common bile duct is statistically insignificant (p = 0.243)

Conclusion: We established a reference range for the CBD length and diameter. Thus, the exact knowledge of the anatomy of the common bile duct is significant for successful hepato-biliary surgery and biliary pathology.

INTRODUCTION

The Common Bile Duct (CBD) is formed near the porta hepatis, by the union of cystic duct & common hepatic duct and responsible for the transportation of bile from liver & gall bladder to the duodenum. Normally, 6 to 8 cm in length, and its diameter tends to increase somewhat with the age but usually around 6 mm in adults [1].

The common bile duct descends within the lesser omentum immediately to the right of the hepatic artery proper and portal vein. Upon leaving the lesser omentum, passes behind the 1st part of the duodenum and the head of the pancreas before traversing the posteromedial wall of the 2nd part of duodenum along with the main pancreatic duct. The two ducts unite to form a dilated saccule called the hepatopancreatic ampulla (Ampulla of Vater), which opens into the lumen of the duodenum at the summit of the major duodenal papilla [2].

BACKGROUND

The human body is thought to be singularly alike in their general anatomical construction but the anatomy of the biliary tree presents lots of variations. Dissection or radiological investigations reported anatomical variations of either the intra-hepatic or extra-hepatic bile ducts, which are found in approximately 50% of the general population. Understanding of the common patterns and normal

***Corresponding author**

Sanjay Kumar Sah, Department of Basic Medicine, Joint International Research Laboratory of Reproduction & Development, Chongqing Medical University, Chongqing, People's Republic of China

Tel: +861-534-041-4211
E-mail: ssah608@gmail.com

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measurements and their variations are important to the surgeons as it is essential for the reduction of morbidity and mortality rates during hepatobiliary surgery [3-5].

An abnormally dilated common bile duct has been considered as a clinical indication for choledochostomy [6]. Therefore, studies to determine the range of normality for the common bile duct length and breadth are essential as they would help in defining the patients suffering from obstructive jaundice [7]. However, studies done in the cadaver where the size of the Common Bile Duct (CBD) is measured are scarce. In the clinical setting, measurements of CBD are performed using either Sonography, magnetic resonance cholangiopancreatography, or computerized tomography scans [8] but in cadaver, the measurements are done by directly exposing the organ using a Vernier caliper. This study aimed at obtaining data by measuring the length and diameter of the CBD from cadavers to determine the normal reference range and find out the relationship between them.

MATERIALS AND METHODS

The institutional ethical approval was obtained from the ethical committee of the Mahatma Gandhi Mission Institute of Health Sciences, Navi Mumbai, India. A total of 30 male and female embalmed adult human cadavers without a history of hepatobiliary diseases were dissected for the measurement of length from origin to termination and diameter of the common bile duct from Jan 2012 to March 2013.

DISSECTION

Dissection was performed according to the dissection manual detailed in [9]. Briefly, an incision was taken for reflecting the skin of the anterior abdominal wall. All the layers of the anterior wall were reflected and removed. The ribs and diaphragm were cut to allow the liver to be retracted superiorly, exposing the lesser omentum. The visceral surface of the liver was in contact with the gallbladder and the peritoneum covering the stomach, duodenum, and colon. The right kidney, and right suprarenal gland were identified.

The three large structures that are contained within the hepatoduodenal ligament; bile duct, hepatic artery, and portal vein were identified. The bile duct was lateral to the three structures followed by the common hepatic duct superiorly and portal vein medially. A probe was used to trace the bile duct superiorly and thus the cystic duct and common hepatic duct were identified. Now the bile duct was traced inferiorly by identifying its opening into the duodenum and carefully measured the length (Figure 1) and diameter (Figure 2) with the help of Vernier caliper.

STATISTICAL ANALYSIS

Data were entered and analyzed in SPSS Vs 20. All quantitative data are expressed as mean ± standard deviation. Correlation and Regression were used to find the relationship between dependent and independent variables. A P-Value of less than 0.05 was considered as statistically significant.

Figure 1 Measurement of the length of the Common Bile Duct (CBD) using Vernier caliper. The image represents the longest CBD identified in the study.

Figure 2 Measurement of the diameter of the common bile duct using Vernier caliper. The image represents the widest CBD identified in the study.

RESULTS

Dimensions of the CBD

Length: A total of 30 cadavers were involved in the measurement of CBD length. The longest CBD had 62.43mm and the shortest had 35.19 mm. The mean length was 46.91 mm ± 7.90 mm (Table 1).

Diameter: The highest CBD diameter (n = 30) was recorded at 10.31mm and the lowest was 3.65 mm. The mean diameter was 6.50 mm ± 1.77 mm (Table 1).

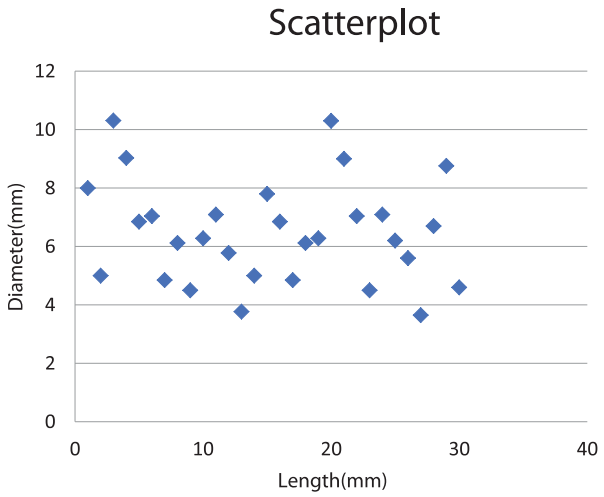
Relationship between length and breadth: The average length of CBD is 46.92 ± 7.91 whereas its diameter is 6.50 ± 1.77. The Correlation results show a statistically insignificant low degree of negative correlation between the length and diameter of the common bile duct (p = 0.243). (Tables 2-4). This result indicates that per unit increase in length of common bile duct will be associated with a decrease of 0.49 units of its diameter.

Table 1: Summary of the dimensions of the common bile duct measured from 30 embalmed adult human cadavers.

Parameter (mm)	Sample size	Minimum	Maximum	Mean ± SD
Length	30	35.19	62.43	46.92 ± 7.91
Diameter	30	3.65	10.31	6.50 ± 1.77

Table 2: Correlation Table, shows the correlation between length and diameter of the common bile duct.

		Length	Diameter
Length	Pearson Correlation	1	-.220
	p-value		.243
	N	30	30



Regression table

Table 3: ANOVA Table. This table shows the output of the ANOVA analysis and whether there is a statistically non-significant difference between length and diameter of common bile duct. We can see that the significance value is 0.243 (i.e., $p = 0.243$), which is above 0.05. and, therefore, there is statistically non-significant.

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.400	1	4.400	1.420	0.243
Residual	86.753	28	3.098		
Total	91.153	29			

Table 4: Coefficient table provides us with the necessary information to predict length from breadth, as well as determine whether length contributes statistically significantly to the model (by looking at the "Sig." column). Furthermore, we can use the values in the "B" column under the "Unstandardized Coefficients" column, as shown below:

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	8.810	1.966		4.481	< 0.001
Length	-.049	.041	-.220	-1.192	.243

Dependent Variable: Breadth of bile duct
Independent Variable: Diameter of bile duct
Regression Equation: Y = 8.810-0.49 X_1
Diameter of bile Duct = 8.810-0.49 x length of bile duct.

DISCUSSION

This study was conducted among 30 cadavers belonging to the Mumbai city, India. The present study state the length of the common bile duct varied between 35.19 to 62.43 mm with a mean average length of 46.91 mm ± 7.90 mm and the diameter of the common bile duct varied between 3.65 mm to 10.31 mm with a mean average breadth of 6.50 mm ± 1.77 mm. According to Dana Blidaru, et al. [10] length of common bile was reported as 72.02mm ± 11.56 mm and breadth was 5.25 ± 1.28mm. Nidhi LAL et al reported the lower and upper limits of normal common bile duct diameter were found to be 2.0 mm and 7.9 mm respectively [7]. The diameter of CBD showed a considerable increase with age, where the largest diameter of the CBD was up to 6 mm in most of the patients up to the age of 50 yrs. and an upper limit of 8 mm appears reasonable after the age of 50 by Senturk, et al. [8].

According to previously published data in the literature regarding the dimensions of the common bile duct (length/diameter) are: Rouvière H [11], 50 mm/5 mm, Testut L and Latarjet A [12], 60-80 mm/4-5 mm, Couinaud C [13], 80–100 mm/5–6 mm, Mahour GH, et al. [6], found diameters between 6.21 and 8.39 mm (a mean of 7.39 mm), and in the meantime, he observed an abatement of the diameter in older people, Leslie D, et al. [14], 5-17 mm (a mean of 12 mm) on normal ducts and 9–58 mm on pathological ducts, Hollinshead HW [15], 50-150 mm/6-8 mm, Anson BJ, et al. [16], 90 mm in length, Papilian V [17], 30-35 mm/ 5 mm, Bannister LH [18], 75 mm/6 mm. Among these results, the lowest length of CBD is 9 mm and the highest is 150 mm wherein the lowest diameter is 4 mm and the highest is 8.39 however the present study reported the length of lowest 35.19 mm & highest 62.43 mm while the diameter of lowest 3.65 mm and highest 10.31 are noted (Table 5).

The lower and upper limits of normal common bile duct diameter were found to be 3.77 mm to 10.31 mm respectively in our study. However, the majority of the study subjects (95%) had a common bile duct diameter of < 6 mm wherein 8 mm was recommended as the upper limit for common bile duct diameter reported by Behan, et al. [19] studies conducted by Testula & Latarjet Areported the lowest upper limit 5 mm. A study in Korea, Park, et al. [20] reported the average diameter of the common bile duct was 6.7 mm which is almost similar to our study. The lower limit of the breadth of the common bile duct is 3.65 mm in our study which is similar to that reported by Kaude JV, et al. [21].

A study conducted in Jordan, Daradkeh S, et al. [22], demonstrated a significant correlation with Body Mass Index (BMI). However, our study is limited where correlation with body mass index is excluded because of a cadaveric study. Mahour GH, et al. [6] found that the outer diameters of the duct varied in all subjects and the values ranged from 4 to 12 mm with an average of 7.39 mm whereas the presented study reported the average diameter of the bile duct is 6.50 mm.

Rodríguez-Luna MR, et al. [23] conducted a radiological study named transcystic intraoperative cholangiogram showed common bile duct duplication without signs of the biliary obstruction. Also, a case of double CBD was reported by Imamura H.et al and discussed the novel anatomical findings of the accessory CBD from the viewpoint of embryology [24]. However, the present study has not come across the duplication of the common bile duct. Aristotle S. et al reported an absence of common bile duct in one case out of 25 subjects where bile was drained by long cystic duct directly to the second part of duodenum whereas the present study has not found its absence [25].

A Study by Gwal K, et al. [26] provides normative measurements for the common bile duct for children up to age 10 years and the values range 1.1-4.0 mm and also suggested that the upper limits of the duct increase with the age. However, the present study has not included the children as a subject. The Correlation results of the present study show a statistically insignificant low degree of negative correlation between Length and Diameter of the bile duct ($p = 0.243$).

A study by Lal. N. reported that the correlation of common bile duct between diameter and various age groups is statistically and a linear trend was also observed with age. Besides, they did not find any statistically significant correlation of common bile duct diameter with sex [7]. Niederau, et al. [27] reported no correlation with height and body surface area; although the common bile duct showed correlation with weight and Jordan, Daradkeh, et al. [22] demonstrated a significant correlation with Body Mass Index (BMI). However the present study is limiting the correlation measurements between the length and diameter of the common bile duct.

CONCLUSION

The common bile duct has an average length of 46.92 ± 7.91 mm and an average diameter of 6.50 ± 1.77 mm. This study established the reference range of length and diameter of the common bile duct of human beings by a

Table 5: Length and breadth of common bile duct reported by various authors.

S. N.	Researcher Name	Year	Length (mm)	Diameter (mm)
1	Rouviere H	1924	50.00	5.00
2	Testula & Latarjet A	1931	60-80	4.00- 5.00
3	Couinand C	1963	80.00-100.00	5.00-6.00
4	Mahour GH et al	1967	-	6.21-8.39
5	Leslie D et al	1968	9-58	5-17
6	Holinshead HW	1971	90	-
7	Anson BJ et al	1971	50-150	6.00-8.00
8	Papilian V	1979	30-35	5.00
9	Banister LH	1995	75	6.00
10	Present study	2013	35.19-62.43	3.65-10.31

study performed in cadavers. Also, it found that there is a statistically insignificant correlation between length and diameter (p = 0.243).

Besides the variable range of dimensions, we have not found other anomalies like absence or duplication of CBD which has been reported in the pieces of literature. Knowledge of the variable range of dimensions of the common bile duct occupies an important place in the field of medicine and also significant for the surgeon to avoid iatrogenic ductal injuries and inadvertent complications during gallbladder, pancreas, and duodenum.

RECOMMENDATIONS

Common bile duct length was not observed to have a statistically significant correlation with diameter. It maybe due to sampling size was less so this study recommends that similar types of studies can be conducted with a large sample size.

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