Extrahepatic Bile Duct Length in the Singapore Population

K B Chuah, C K Yap, H S Ng

ABSTRACT

Background: Although the length of the common bile duct is well documented, the length of extrahepatic biliary tree is less well studied, particularly in among the Asian population. The extrahepatic bile duct (BD) length is defined as the measurement from the hepatic hilum to the papilla.

Objective: This study was performed to assess the normal range of extrahepatic BD length, as defined above, in the Singapore population. This information would be useful in assisting the local endoscopy unit in procuring the different lengths of biliary stents.

Method: Between 1.8.96 to 1.12.97, 486 cholangiograms were obtained post-ERCP, of which only 100 cholangiograms that were representative of a non-distorted BD were used for analysis. The BD length, taken from the mid-point of the confluence of the left and right hepatic ducts at the hilum to the papilla, was measured with a string placed on the cholangiogram. The true length was obtained after correction for radiological magnification.

Results: The range of bile duct lengths followed a normal distribution curve with a mean length of 9.6 cm. The range was from 6.9 cm to 12.6 cm. With respect to the length of stents commonly deployed, the cumulative percentage of BD length less than and equal to 7-, 9-, 10- and 12-cm were 1%, 38%, 57% and 98% respectively.

Conclusion: From a practical point of view, this study suggests that endobiliary stent of 5 cm in length should be readily available for drainage of distal CBD strictures as 1% of our population has BD length less than 7 cm. However, as 2% of the population has BD length greater than 12 cm, 15 cm stents should be available in the endoscopy unit for drainage of hilar obstructions/strictures.

Keywords: ERCP, bile duct length, biliary stenting, cholangiogram, extrahepatic

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INTRODUCTION

Endoscopic stenting of the biliary tree is a standard procedure used in the management of patients with malignant obstructive jaundice. Elderly and high-risk patients with other medical co-morbidity are best managed by endoscopic stenting[1,2]. This modality of treatment may provide symptom relief and enhance the quality of life[3]. An accurate fitting of the stent in the bile duct (BD) is vital in ensuring optimal drainage. If an incorrect length of stent is deployed, patient morbidity may increase either as a result of a repeat procedure or local complications arising from an improperly placed stent e.g. cholangitis due to poor drainage.

Strictures of the extrahepatic biliary tree may arise anywhere from the hepatic hilum to the distal common bile duct (CBD). In endoscopic biliary stenting, the endoscopist must ensure that the stent had adequately traversed the stricture and achieved biliary drainage. Hilar strictures would require longer stents. On the other hand, shorter stent are used in distal CBD strictures. Therefore in endoscopic biliary stenting, the extrahepatic bile duct (BD) length defined as the length of the extrahepatic biliary tree from the hepatic hilum to the papilla is of great clinical relevance. The CBD length is a frequently quoted parameter in the medical textbook. However the CBD length, defined as the bile duct segment from the junction of the common hepatic duct and the cystic duct to the papilla, would grossly underestimate the extrahepatic BD length. The BD extrahepatic length is poorly documented, particularly in the Asian population. This study aims to establish the normal range of extrahepatic BD length in the local Singapore population. It is hoped that the information obtained would provide the basis in recommending the lengths of biliary stents that should be available in the local endoscopic suite involved in the deployment of such stents.

Various techniques had been used to determine the BD length on cholangiogram. During ERCP the anatomic length of the BD had been be estimated by visual assessment of the cholangiogram obtained. This method is unreliable. A second method involved sliding a standard measuring catheter or guidewire through the

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Table I. Clinical indication for the ERCP and cholangiograms used for analysis.

Condition	No. of patients (%)	Cholangiograms used for analysis (%)
Cholangitis	160 (33%)	7 (7%)
Obstructive jaundice	102 (21%)	0 (0%)
Biliary colic	88 (18%)	48 (48%)
Acute pancreatitis	58 (12%)	25 (25%)
Abnormal LFT	45 (9%)	18 (18%)
Chronic pancreatitis	33 (7%)	2 (2%)
Total	486 (100%)	100 (100%)

Table II. Patients' characteristics.

	Male (n=51)	Female (n=49)	Total (n=100)
Race Chinese: Malay: Indian	42:3:6	44:3:2	86:6:8
Age (years) Mean ± SD	57.2 ± 2.4	61.4 ± 1.8	59.3 ± 2.1
Range	32 - 76	45 - 79	32 - 79
Bile duct length (cm) Mean ± SD	9.5 ± 1.3	9.7 ± 1.29	9.6 ± 1.29
Range	7.3 - 12.2	6.9 - 12.6	6.9 - 12.6

catheter channel of the endoscope and then measuring the distance between two markers placed on the wire[4]. A third method devised by Dumonceau et al utilized a measuring mounting-catheter but this device is not readily available[5]. Finally a fourth method described by Guelrud et al measured the BD length on the cholangiogram with correction for the radiological magnification[6]. In this study, we had used the latter method to obtain the range of extrahepatic BD length in the Singapore population for the first time.

PATIENTS AND METHOD

We retrospectively reviewed the Endoscopic Retrograde Cholangiopancreatography (ERCP) performed in Singapore General Hospital between 1 August 1996 to 1 December 1997. The ERCP were performed for suspected pancreaticobiliary disease.

The endoscope used was Olympus TJF 100 which had a uniform external diameter of 1.25 cm. The patients were sedated with midazolam and fentanyl. A cholangiogram was obtained after the introduction of Angiographin (meglumine diatrizoate) into the common bile duct (CBD). With the aid of a string, two measurements were obtained. The first was the bile duct length on the cholangiogram, measured from the midpoint of the confluence of the right and left hepatic duct to the papilla, taken as 'a' cm. The second measurement was the diameter of the duodenoscope at the distal end taken as 'b' cm. The cholangiogram must demonstrate both the distal end of the duodenoscope as well as the entire extrahepatic duct. The actual bile duct length was obtained using direct proportion: 'a'/'b' x 1.25 cm.

Only cholangiograms that satisfied the following criteria were used for analysis:

1) The entire length of the bile duct from the papilla to the confluence of the right and left hepatic ducts was opacified.
2) The confluence of the left and right hepatic ducts present at the hilum.
3) Non-dilated CBD.
4) No strictures seen in the biliary tree that may distort the native bile duct anatomy.
5) No CBD stones seen at the time of the ERCP.
6) No previous ERCP or sphincterotomy.
7) No previous abdominal surgery or cholecystectomy.
8) No radiological evidence either of a primary hepatobiliary malignancy or metastasis to the hilar and peri-hilar lymph nodes.

Quantitative values were presented as mean ± SD. Statistical Analysis was used to compare the male and female bile duct length. Levene's Test for equality of variances was used.

RESULTS

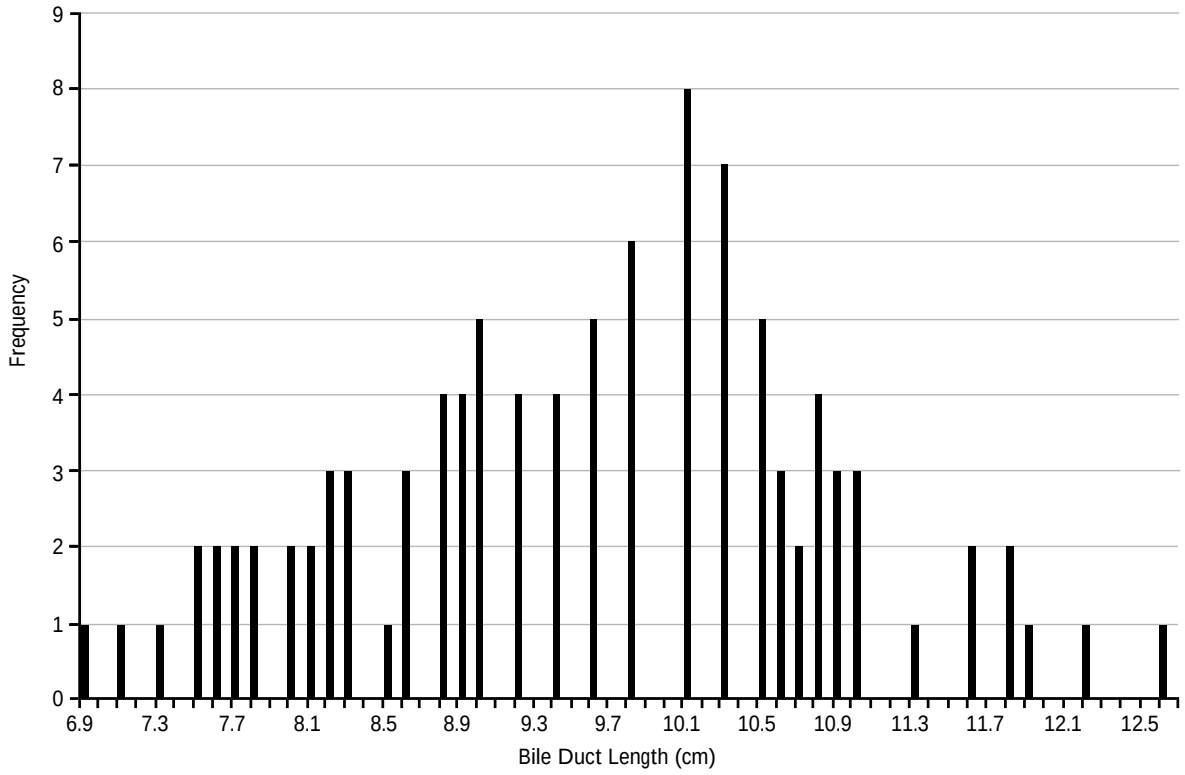
486 ERCP were performed during the study period. The list of indications for the ERCP and the cholangiograms used is reflected in Table I. Of the 486 ERCP that were performed, only 100 (21%) of the cholangiograms qualified for analysis. 48 patients from the biliary colic group were used for analysis and all had transient passage of gallstones. None of the cholangiograms obtained in the evaluation of obstructive jaundice was utilized.

The patient's age distribution and bile duct measurements are shown in Table II. Chinese was the dominant ethnic group in this study. The distribution of the bile duct length followed a near normal distribution curve (Fig. 1). The range was between 6.9 to 12.6 cm with a mean of 9.6 cm. With respect to the commonly used lengths of biliary stents, the calculated cumulative percentages of BD length less than and equal to 7-, 9-, 10- and 12-cm stents were 1%, 38%, 57% and 98% respectively. As for the comparison of the bile duct length between the male and female population, there was no statistical significance with p=0.7.

DISCUSSION

Endoscopic biliary stenting is used rather extensively in the palliation of inoperable malignant obstructive jaundice[1,2], with the success rate of stent placement quoted at around 90%[7] in the hands of experts. Two

Fig. 1 Frequency Histogram of Bile Duct Length.



different types of stents are currently in use, namely the conventional plastic (polyethylene) stent and the self-expanding metal stent. Both stents are manufactured at various lengths to accommodate for the different levels of obstruction/strictures within the biliary tree. The endoscopy unit performing such intervention work must ensure that the lengths of endobiliary stents are appropriate for the local population. Biliary stents of 7, 9 10 and 12cm in length are the most frequently deployed and stored stents in the endoscopy centre. In our study, 1% of the study population had extrahepatic BD length less than 7 cm. Thus, if a 7 cm stent was deployed in this subgroup of patients with a distal CBD stricture, the stent could potentially migrate. Instead, a 5 cm length stent would be more appropriate in the drainage of such CBD strictures. In our analysis, 2% of the population had extrahepatic BD length greater than 12 cm where the maximum BD length was 12.6 cm. In this subgroup, there is a possibility that stents greater than 12 cm may be necessary to traverse a hilar stricture. In hilar obstructions there is usually concomitant distortion of the biliary tree anatomy leading to an increased BD length in a three dimensional fashion. In such patients, 15 cm stents are needed. The findings from this study indicate that stents of 5 cm and 15 cm in length should be readily available in our endoscopy units, as these stents may be necessary for the two extreme subgroup of patient in our population.

A few techniques had been used to measure the bile duct (BD) length. The first is that of visual assessment of the bile duct after a cholangiogram. This method is often flawed. A method devised by Dumonceau et al made use of a measuring mounting catheter with a 1 cm radiopaque band interval located at the distal end of the catheter. The catheter is used for the assessment of the bile duct segment after the CBD had been cannulated[5]. In that study, the endoscopist's visual assessment of the bile duct length and the length as determined by the measuring mounting catheter was grossly different, highlighting the limitation of the human eyes ($p<0.0005$). Although the mounting catheter is extremely accurate but this instrument is not readily available in most worldwide institutions. Another method described by Kendall et al used a guidewire to measure the BD length[4]. The position of the tip of the guidewire was placed at the proximal and distal end of the duct segment to be measured. Tape markers were then placed around the guidewire to indicate the proximal and distal end of the bile duct segment as it exited from the catheter channel of the endoscope. The bile duct length was the distance between the marked proximal and distal end of the guidewire. Finally a method used by Guelrud et al measured the BD length after correction for the radiological magnification[6]. We had modified Guelrud's technique by using a string to measure the extrahepatic BD length in our local population. This

basic parameter had not been documented until this point of time.

In this study, we measured the extrahepatic BD length of cholangiograms that demonstrated the mid-point of the confluence of the hepatic ducts that were located at the hilum, the reason being that the most common anatomical variation in the position where the left and right hepatic ducts joined to form the common hepatic duct is at the hilum[8]. Although other anatomical variants were not considered, they were not encountered during the analysis of all the cholangiograms in our study population.

In most medical textbooks the common bile duct (CBD) is usually quoted as 7.5 cm, although the range may vary from 5 to 15 cm[9,10]. The CBD measurement alone would underestimate the extrahepatic BD length. Although we examined specifically the extrahepatic BD length, it would appear that the range of bile duct length in our population was not as widely distributed as quoted in the surgical and anatomy textbooks. It is possible that the CBD lengths measured in these textbooks were based on a more heterogeneous population. The predominant ethnic race in our study population was the Chinese (>85%). This would contribute to a more homogeneous population base. With this assumption, we postulated that the BD length might be related to the patient's height. A follow-on study of the patient's height in relation to the BD length could be considered in future study.

We had employed multiple exclusion criteria so that the cholangiograms used for analysis were adequately representative of a non-distorted biliary system as the biliary tree may be affected in a three dimensional fashion by some pathological processes. Thus it would be unreasonable to propose using this technique to measure the BD length in a biliary system with cholangiocarcinoma, strictures or pancreatic carcinoma. In such instances, newer imaging modality such as Magnetic Resonance Cholangiopancreatography (MRCP) would be more suitable to assess the BD length. Because the method of measuring the extrahepatic BD length was employed with reference to an undistorted biliary tree, it would be unrealistic to extrapolate the data from this study in order to propose the lengths of stents that should be deployed in the different levels of biliary obstruction. The endoscopist will have to use his or her professional judgement at the time of procedure in deciding the length of stent most suitable for the patient. However the results from this study would provide a guideline as to the different lengths of endobiliary stents that should be available in the local endoscopy unit.

With regards to endobiliary stents, placing the stent above the sphincter of Oddi may prolong the life span of the stent[11]. This "inside-stent" technique was considered after the observation in two animal studies which showed stent that were placed above the intact sphincter improved the duration of stent patency, the rationale being that the intact sphincter of Oddi acts as a bacteriological barrier[12,13]. Liu et al reported that an "inside-stent" approach with a 2 cm clearance between the stricture and the sphincter could be achieved in all hilar strictures and two-third of distal biliary cancers. The authors also estimated that an "inside-stent" could be used in one-third of all patients with malignant obstructive jaundice if a clearance of more than 2 cm between the stricture and sphincter is required. 99 % of our study population had extrahepatic BD length greater than 7 cm. Assuming a 2 cm clearance was needed as above and factoring in an increased BD length in a biliary system with strictures, this innovative technique of stenting could be considered, in particular among patients with hilar strictures. In such an instance, perhaps stents of 5 cm in length may be used.

Our method of measuring the bile duct segment could be used to ascertain the length of the common channel for the common bile duct and the main pancreatic duct. Anomalous pancreaticobiliary union (APBU) or a long common channel is a congenital malformation of the pancreaticobiliary tree in which the confluence of the common bile duct and pancreatic duct is located outside the duodenal wall. APBU can be classified into 3 subtypes: BP, PB and Y[6,14]. Type BP is noted when the CBD joined the main pancreatic duct and type PB is when the pancreatic duct joined a dilated CBD. Type Y describes a long common channel without CBD dilatation. Patients with type BP APBU had a higher incidence of choledochal cyst, choledocholithiasis and biliary stricture[6]. On the other hand, type PB APBU appeared to be directly associated with recurrent pancreatitis[6,15]. Overall, the literature review indicates that patients with APBU had a higher incidence of gallbladder and bile duct carcinoma[6,14,16,17].

In adults, the normal length of the common channel averages 4.5 mm with a range of 1 to 12 mm[14,18]. APBU is considered to be present when the ERCP demonstrates a common channel measures more than 15 mm or the extraduodenal portion of the common channel exceeds 6 mm[14,19]. Using the technique we had described, it is possible to determine the length of the common channel in our population. The rare occurrence of APBU in our population could be due to the difficulty in establishing this diagnosis confidently. A common channel is probably the most frequently encountered form of drainage of the main pancreatic duct and the common bile duct as shown in an autopsy study

conducted on 103 Thai patients where 76.7% of patients displayed a common channel[20]. Our method of measuring the BD segment can be used to determine the length of the common channel. The diagnosis of APBU should be considered in patients with idiopathic recurrent pancreatitis with ERCP remaining the gold standard in the diagnosis of APBU. Although Magnetic Resonance Cholangiopancreatography (MRCP) had been used to study the common channel but the diagnosis of APBU can be missed in 18% of cases as shown by Sugiyama et al[21].

In summary, a normal range of the extrahepatic bile duct length in the local Singapore population has been detailed using a simple and reproducible method of measuring the bile duct segment. This study has two practical clinical applications. Firstly, it provides the basis for the procurement of 5 cm and 15 cm lengths of endobiliary stents in our endoscopy units. Secondly, our method of measuring bile duct segments could be used to measure the common channel in patients suspected of having APBU.

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