Original Article

The diameter of the common bile duct in an asymptomatic Taiwanese population: Measurement by magnetic resonance cholangiopancreatography

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Abstract

Background: Magnetic resonance cholangiopancreatography (MRCP) is a popular modality for evaluation of the biliary tract, yet there is no data on the normal common bile duct (CBD) size of the average Taiwanese adult. This study attempts to establish a reference range for CBD diameter for the Taiwanese population.

Methods: Over a 2-year period, all adults who underwent abdominal magnetic resonance imaging for health screening were recruited into the study. Patients with a prior history of hepatobiliary surgery and other significant morbidity were not included. Patients who were found to have abnormal liver function test results or abnormal imaging findings were also excluded from the study. After the patients fasted for a minimum of 8 hours, MR imaging was performed with a 1.5 T MR imager using a phased-array coil. Breath-hold thick slab single-shot turbo spin echo (ssTSE BH) projections were obtained, and these were used for CBD and portal vein diameter (PVD) measurement by workstation software. Initial recruitment included 265 patients, of which 66 were excluded due to abnormal liver function tests, seven more were excluded due to excess imaging artifacts or incomplete CBD visualization, and five were excluded due to other abnormal blood tests. This yielded a final study group of 187 patients between the ages of 21 and 78 years, which comprised 69 women and 118 men.

Results: The mean CBD diameter is 4.6 mm, with a range from 1.76 to 10.49 mm. CBD diameters are significantly different in patients both younger and older than 65 years of age (p < 0.05), and are not significantly related to gender, serum glucose level, cholesterol level, hepatitis status and PVD.

Conclusion: Our study showed that the average CBD diameter for an asymptomatic Taiwanese adult is 4.6 mm, with an upper limit of 10.49 mm. CBD diameter is only significantly correlated with age. This is a useful reference in today’s clinical setting where MRCP are commonly performed for evaluation of suspected biliary tract disease.

Keywords: adult; biliary tract; common bile duct; MRI; Taiwan

1. Introduction

Over the years, modern medical imaging technology has helped medical practitioners become proficient in the assessment of biliary pathology, thereby better enabling more precise measurement of the biliary tract. Because a dilated common bile duct suggests obstructive causes which may require invasive imaging or remedial procedures, an accurate CBD size reference range should be available. A plethora of published literature exists regarding the normal size of the common bile duct (CBD),1–7 and these range from the cadaveric measurements, operative cholangiograms, and endoscopic retrograde cholangio-pancreatography (ERCP) to sonography, and, more recently, multi-detector-row computed tomography (MDCT).

Since its introduction in 1991, MR imaging of the biliary tract has undergone a progressive evolution.8 Today, magnetic
resonance cholangiopancreatography (MRCP) is one of the diagnostic mainstays for assessment of biliary tract abnormality—especially those involving obstruction. Many consider MR imaging to be the non-invasive “gold standard” imaging for evaluation of biliary pathology, and it is commonly performed first to determine the necessity of subsequent invasive procedures such as ERCP.

Despite the prevalence of MRCP as a first-line modality of biliary pathology, a search of the literature available revealed no formal study that specifically documented normal CBD diameter as measured by MRCP. Consequently, the lack of a reference range may lead to over- or underdiagnosis of biliary dilatation.

The purpose of this study was to evaluate the diameters of CBD in asymptomatic Taiwanese patients using MRCP, and determine the normal size range for this population. In addition, we also attempted to evaluate the relationship between CBD diameter and other variables, in order to see if there is a significant relationship between them.

2. Methods

2.1. Patients

During the period of January 2005 to December 2006, we recruited for our study all asymptomatic individuals who underwent abdominal MRI for health screening and who had not undergone prior hepatobiliary surgery. The institutional review board approved this retrospective study and the informed consent requirement was waived.

We recorded the patients’ age, sex, medical history, list of medications including substances of abuse, fasting blood sugar level, total serum cholesterol, liver function tests, and hepatitis status. Any positive history of myocardial infarction, cerebrovascular accident, biliary disease, pancreatic disease, hepatic disease, or substance abuse precluded the individual from joining the study group. Individuals with abnormal liver function tests (total bilirubin, AST, ALT) or abnormal MRI findings such as biliary stones or chronic cholecystitis were also subsequently excluded from the study, thus preventing any individuals with known potential biliary pathology from joining the study.

The initial recruitment group included 265 participants. Seven were excluded due to excess image artifacts or incomplete CBD visualization, five due to incomplete blood test results, and 66 due to abnormal liver function tests. None were excluded due to actual biliary abnormality found by MRI. The final study population consisted of 187 patients between 21 and 78 years of age (mean age of 51 years) and included 69 (37%) women and 118 (63%) men.

2.2. Imaging

MR imaging was performed on patients after an overnight fast, which translated to at least 8 hours prior to the MR examination. Abdominal MR imaging was performed with 1.5 T MR imagers (GyroScan, Philips Medical Systems, the Netherlands) using phased-array coils. Axial and coronal turbo spin-echo (TSE) T2-weighted images were acquired using the following parameters without and with fat saturation: TR, 2500 ms; TE, 100 ms; TSE factor, 23; matrix, 256 × 256. Dual phase T1-weighted images were obtained within one breath hold using: TR, 210 ms; TE = 2.3 and 4.6 ms; slices thickness, 8 mm; gap, 0.8 mm; flip. Breath-hold thick slab single-shot turbo spin echo (ssTSE BH) projections were also acquired, and these were used for the actual CBD measurement. The parameters of the ssTSE BH sequence were as follows: TR, 8000 ms; effective TE, 850 ms; turbo factor, 128; flip angle, 90°; slice thickness, 30–40 mm; field of view, 250 mm; matrix, 256 × 205; acquisition time, 8 seconds. The entire pancreaticobiliary tree was included in all images. The same pulse sequence was repeated to acquire four to six projections of the pancreaticobiliary system from different angles.

Measurements of the CBD diameters were performed independently by an experienced radiological technologist (with 11 years of experience with MR techniques, A.C.H.) and an experienced radiologist (7 years of experience, T.C.). Coronal ssTSE BH images at 4–6 different angular planes were reviewed, and the one with well-demonstrated CBD and main pancreatic duct with the least superimposed artifacts was used for measurement. A magnification factor of 2.0 was used to ensure precise delineation of the biliary duct margins. The widest diameter of CBD was measured perpendicular to their long axis using the electronic caliper provided by the picture archiving and communications system (Centricity PACS, RA 600 v6.1, GE Medical Systems, Milwaukee, Wisconsin, USA) (Fig. 1). Portions of CBD with superimposed artifacts from the stomach, small intestines, and cystic ducts were avoided. The anteroposterior diameters of portal vein anterior to inferior vena cava were measured using the same method with PACS electronic caliper, in T2-weighted images.

2.3. Statistical analysis

Statistical analysis was performed using SPSS (SPSS for Windows, version 15.0, SPSS Inc, Chicago, IL, USA). The
recorded maximal CBD diameters were then analyzed against age, gender, blood sugar, and cholesterol using Student t-test. The CBD diameters were also analyzed against the presence of hepatitis B and C antigens using ANOVA. CBD diameters were analyzed against portal vein diameters using the Pearson correlation.

Interobserver agreement was assessed with Pearson’s correlation coefficient and paired t-test. Multiple linear regressions were used to confirm the relationships between CBD diameters and these variables. A $p$ value $< 0.05$ was considered statistically significant.

### 3. Results

The mean CBD diameter of 187 patients obtained by Reader 1 was $4.6 \text{ mm} \pm 1.8 \text{ mm}$, with a range of $1.76$–$10.49 \text{ mm}$. The mean CBD diameter observed by Reader 2 is $5.0 \text{ mm} \pm 1.7 \text{ mm}$, with a range of $2.42$–$11.65 \text{ mm}$. The mean portal vein diameters obtained by Reader 1 and 2 are $8.13 \text{ mm} \pm 1.8 \text{ mm}$ and $8.14 \text{ mm} \pm 1.8 \text{ mm}$, respectively (Table 1). There was excellent interobserver agreement between Reader 1 and Reader 2’s measurements of CBD and portal vein diameter (Pearson correlation coefficients $= 0.89$ and $0.90$, $p < 0.0001$).

The mean CBD diameter for females was slightly larger than that of males ($4.8 \pm 1.7 \text{ mm} \text{ vs. } 4.5 \pm 1.8 \text{ mm}$), although this lacks statistical significance ($p < 0.05$). CBD diameter is directly proportion to age ($p < 0.05$), when patients are divided into two groups using 65 years as the cut-off age. When patient age is subdivided into decades, further analysis reveals that there is a somewhat linear relationship between CBD size and age in decades ($R^2 = 0.62$, Fig. 2). However other variables such as fasting blood sugar levels, serum cholesterol, presence of hepatitis B or C, and portal vein diameters show no statistically significant effect on the CBD diameter. The results are summarized in Table 1.

### 4. Discussion

Most recently, MRCP is the principle diagnostic modality that determines if ERCP is needed—especially when ultrasound findings are equivocal. The decision to perform ERCP depends on whether an organic abnormality or an abnormal dilation could be demonstrated. To prove the presence of abnormal dilatation there needs to be a reference range, with diameters exceeding its upper limit deemed abnormal.

Our results show that the average CBD diameter as measured by MRCP is $4.6 \text{ mm} \pm 1.8 \text{ mm}$, with a range of $1.97$–$10.49 \text{ mm}$. Compared to the results of available research papers using other imaging modalities, it is well within the reported range. Jonson et al. showed that the average diameter in patients with normal cholangiography was $5.9 \text{ mm}$. By using ultrasound measurement, Kaim et al. found that

### Table 1

CBD diameters and its relations with different parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reader 1</th>
<th>Reader 2</th>
<th>Gender</th>
<th>Number</th>
<th>Mean (mm)</th>
<th>Standard deviation</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient CBD diameter</td>
<td>Reader 1</td>
<td>187</td>
<td>Female</td>
<td>69</td>
<td>4.6</td>
<td>±1.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reader 2</td>
<td>118</td>
<td>Male</td>
<td>118</td>
<td>4.5</td>
<td>±1.8</td>
<td>0.226</td>
</tr>
<tr>
<td>Age* (y)</td>
<td>&lt;65</td>
<td>176</td>
<td></td>
<td>11</td>
<td>4.4</td>
<td>±1.7</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>≥65</td>
<td>11</td>
<td></td>
<td></td>
<td>6.0</td>
<td>±2.6</td>
<td></td>
</tr>
<tr>
<td>Serum glucose* (mg/dL)</td>
<td>≤110</td>
<td>167</td>
<td></td>
<td>4.6</td>
<td>±1.8</td>
<td>0.855</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;110</td>
<td>20</td>
<td></td>
<td>4.5</td>
<td>±1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol* (mg/dL)</td>
<td>≤200</td>
<td>100</td>
<td></td>
<td>4.5</td>
<td>±1.6</td>
<td>0.512</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;200</td>
<td>87</td>
<td></td>
<td>4.7</td>
<td>±2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatitis status**</td>
<td>Negative</td>
<td>157</td>
<td></td>
<td>4.5</td>
<td>±1.8</td>
<td>0.909</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HBV+</td>
<td>25</td>
<td></td>
<td>4.5</td>
<td>±2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HCV+</td>
<td>5</td>
<td></td>
<td>4.8</td>
<td>±1.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portal vein diameter***</td>
<td>Continuous variable</td>
<td>187</td>
<td></td>
<td>8.13</td>
<td>±1.8</td>
<td>0.785</td>
<td></td>
</tr>
</tbody>
</table>

*Student t-test.
**ANOVA.
***Pearson Correlation Coefficient.

CBD = common bile duct.
asymptomatic patients without prior biliary surgery had a mean CBD diameter of 6.2 mm. Horro et al.13 also analyzed 258 asymptomatic patients’ routine ultrasounds, and found mean CBD diameters are 3.9 mm. The sonographic analysis of the Iranian population presented by Adibi et al.14 revealed an average CBD diameter of 3.72 mm. Park et al.15 measured 398 Koreans’ CBD diameter using multi-detector row CT, and found the average diameter to be 6.7 mm. Our finding that the average Taiwanese patients’ CBD of 4.6 mm as measured by MRI is well within the range of currently reported range-values of normal CBD diameter, and appears to be unrelated to the race of the patients. It is also unique in that this is the only study that used MRCP to measure the CBD range of healthy individuals.

The reason that average CBD diameter reported in available medical literature varies is complex, and, most likely, multi-factorial. One possible source of this discrepancy is the intentional omission of drugs of abuse such as heroin. While this screening questionnaires did specifically ask for list of medications from the study participants, including substances of abuse such as alcohol and other drugs, patients may have intentionally omitted drugs of abuse such as heroin. While this study cohort does contain a wide range of patient age, there is an insufficient number of patients at either end of the spectrum, which may lead to some statistical bias.

In conclusion, our study shows that the average CBD diameter of the Taiwanese population measured by MRCP is 4.6 mm, with an upper limit of 10.5 mm. CBD diameter is significantly larger in patients older than 65 years of age, and increases proportionally by age for each subsequent decade of life. Otherwise no significant association was found with gender, blood sugar level, cholesterol level, viral hepatitis, and portal vein diameter. This can serve as a useful reference tool when medical professionals are faced with clinical decisions involving biliary obstruction and the need for further investigation or intervention.

References


and C are also endemic in Taiwan with a high prevalence rate. However, our results suggest that none of these are significantly related to CBD diameter (p = 0.86, 0.51 and 0.91, respectively). Adibi et al.14 assert that there is a statistically significant relationship between portal vein and CBD diameter, although our results suggest the opposite. This could either be due to the intrinsic differences between MR and sonography measurements or variances in the study populations.

There are some limitations to this retrospective study. First, medications such as morphine, calcium antagonists, and nitroglycerine can cause CBD dilatation.24 Although our screening questionnaires did specifically ask for list of medications from the study participants, including substances of abuse such as alcohol and other drugs, patients may have intentionally omitted drugs of abuse such as heroin. While this study cohort does contain a wide range of patient age, there is an insufficient number of patients at either end of the spectrum, which may lead to some statistical bias.

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