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Original Article

Age-Related Variations in Common Bile Duct Diameter: Implications for Diagnostic Accuracy

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Abstract

Background: Dilation of the common bile duct (CBD) is a frequently observed phenomenon, particularly in the aging population. Several clinical conditions, including choledocholithiasis, strictures, tumors, previous surgeries, and periampullary diverticula, may contribute to CBD enlargement. However, age-related physiological changes may also cause gradual dilation, potentially confounding diagnostic interpretations.

Objective: This study aims to assess the variation in CBD diameter among different age groups, in order to establish age-specific reference values and avoid misdiagnosis.

Methodology: A descriptive cross-sectional study was conducted at the Department of Diagnostic Radiology, Saidu Group of Teaching Hospital, Swat. Data collection spanned from March 22, 2022, to June 30, 2022. All patients undergoing ultrasonography who met the inclusion criteria were enrolled. Written informed consent was obtained from each participant. CBD diameter was measured using high-resolution ultrasonography.

Results: The mean CBD diameter across all patients was 5.3 ± 1.4 mm. Age-stratified analysis revealed progressive enlargement with age: 4.5 mm in patients <30 years, 4.8 mm in those aged 31–40 years, 5.2 mm in the 41–50 years group, 5.4 mm in the 51–60 years group, and 6.6 mm in patients aged ≥61 years. The differences in mean CBD diameter across age groups were statistically significant (p-value = 0.001).

Conclusion: The study found a significant age-related increase in CBD diameter. Recognizing this physiological expansion is essential to avoid over-diagnosis of pathological conditions. Age-specific normal ranges for CBD diameter should be considered in clinical practice to improve diagnostic accuracy, especially in elderly patients.

Keywords: Aging, CBD Diameter, Common Bile Duct, Dilation, Diagnostic Accuracy, Ultrasonography.

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Introduction

The biliary system comprises the liver, which produces bile, and a complex network of intrahepatic and extrahepatic ducts. Among these, the extrahepatic ducts include the right and left hepatic ducts that merge to form the common hepatic duct, which further joins with the cystic duct to form the common bile duct (CBD) [1]. The CBD descends posterior to the first part of the duodenum and the pancreas, joining the pancreatic duct at the ampulla of Vater, which opens into the second portion of the duodenum [2].

Measurement of CBD diameter is a critical component of biliary system evaluation. Ultrasonography remains the most widely used non-invasive diagnostic modality for visualizing abdominal organs, including the biliary tree. It plays a central role in identifying biliary dilatation, which can help distinguish between obstructive and non-obstructive causes of jaundice [3]. Generally, the normal internal diameter of the CBD on ultrasonography is approximately 6 mm, though this may vary depending on age, prior surgeries, and clinical conditions [4].

Numerous studies have identified that dilation of the CBD becomes more prevalent with advancing age [5]. In fact, aging is recognized as one of several factors associated with increased CBD diameter, alongside common bile duct stones, strictures, malignancies (gallbladder or pancreatic), postoperative anatomical changes, and periampullary diverticulum [6-9].

While existing literature has explored associations between various pathological conditions and CBD size, there remains a noticeable gap regarding its variation with age in otherwise healthy individuals [10]. Most prior studies have treated CBD diameter as a static parameter, without considering the influence of age-related physiological changes [11]. Failure to recognize these changes may result in overestimation of pathology, potentially leading to unnecessary investigations or delayed treatment.

The lack of consensus or clear guidelines regarding age-adjusted normal ranges for CBD diameter presents a diagnostic challenge. Clinicians often rely on fixed thresholds, which may not account for physiological dilation associated with aging. This discrepancy underscores the need for studies that specifically evaluate the relationship between age and CBD diameter.

Therefore, this study aims to assess variations in CBD diameter among patients across different age groups. Establishing age-specific reference ranges can help clinicians accurately differentiate between pathological and physiological dilatation, improving diagnostic accuracy and optimizing patient management.

Methodology

Study Design

This was a descriptive cross-sectional study conducted to evaluate the anatomical characteristics and dimensions of the common bile duct (CBD) using ultrasonography.

Ethics

The study protocol was reviewed and approved by the Hospital Ethics Committee and the Advanced Studies Research Board (EBR No: 17-EBR/2022), dated March 22, 2022. Prior to enrollment, written informed consent was obtained from all patients after explaining the purpose and procedures of the study. Confidentiality and anonymity of participant data were ensured throughout the research process.

Setting

The study was conducted at the Department of Diagnostic Radiology, Saidu Group of Teaching Hospital, Swat. Data collection was carried out over a period of three months, from March 22, 2022, to June 30, 2022.

Participants

All male and female patients referred for abdominal ultrasonography due to various abdominal complaints, including jaundice and hepatic issues, were screened for inclusion. Patients who met the inclusion criteria and provided written

informed consent were enrolled in the study. Exclusion criteria included patients with pre-diagnosed liver diseases such as hepatitis B, hepatitis C, and liver cirrhosis, as well as those who refused to provide informed consent. Strict adherence to inclusion and exclusion criteria was maintained to minimize confounding.

Variables

The primary variables included demographic characteristics (age and sex), clinical presentation, duration of illness, and any relevant treatment history. The main outcome variable was the size of the common bile duct (CBD), which was measured in millimeters.

Data Sources/Measurement

A structured questionnaire was used to gather demographic and clinical data after taking a brief history from each participant. Ultrasonographic examination was conducted by the principal investigator using a Toshiba Grand Prime color Doppler ultrasound machine. The common bile duct was operationally defined as a tube-like, anechoic structure visualized on ultrasonography extending from the liver and gallbladder to the duodenum. Measurements were taken at the widest visible portion of the CBD in the longitudinal plane. All scans and measurements were performed by the researcher to ensure consistency and control of measurement bias.

Bias

To control for observer bias and inter-rater variability, all ultrasound scans and measurements were performed by the same trained radiologist (the principal investigator). Strict exclusion criteria were applied to avoid confounding due to pre-existing liver conditions.

Study Size

The study used a non-probability consecutive sampling technique. All eligible and consenting patients who presented during the data collection period were included in the study.

Quantitative Variables

Quantitative variables included age and CBD size. These were recorded in continuous form and later categorized for stratified analysis.

Statistical Methods

Data were entered and analyzed using SPSS version 22. Categorical variables, such as gender, were expressed as frequencies and percentages. Continuous variables like age and CBD size were reported as means ± standard deviations. Inferential statistics included Student's t-test and Analysis of Variance (ANOVA) to compare CBD size across different age groups and between genders. A p-value of <0.05 was considered statistically significant.

Results

Participants

This study was conducted at two clinical sites: the Department of Radiology at Saidu Group of Teaching Hospital and the City Medical Complex, both located in Swat. A total of 80 patients who underwent abdominal ultrasonography during the study period were included based on eligibility criteria. The participants represented a diverse age range, with a mean age of 47.1 ± 14.1 years. (Table 1)

Descriptive Data

Participants were stratified into five age categories to analyze the distribution of common bile duct (CBD) diameter across different age groups. Of the total participants, 13 (13.2%) were under 30 years of age, 16 (20.0%) were between 31 and 40 years, 22 (27.5%) were between 41 and 50 years, 14 (17.5%) were in the 51 to 60 age group, and 15 (18.8%) were aged 61 years or above. The majority of participants (27.5%) belonged to the 41 to 50 years' group.

Outcome Data

The primary outcome measured was the diameter of the common bile duct as visualized on ultrasonography. The overall mean CBD diameter across all patients was 5.3 ± 1.4 mm. A progressive increase in mean CBD diameter was observed with advancing age.

Main Results

When analyzed by age group, the mean CBD diameter was found to be 4.5 ± 2.1 mm in participants under 30 years, 4.8 ± 1.1 mm in the 31–40 years group, 5.2 ± 0.9 mm in the 41–50 years group, 5.4 ± 0.9 mm in the 51–60 years group, and 6.6 ± 1.1 mm in participants aged 61 years or older. These findings suggest a clear trend of increasing CBD diameter with age. The difference in mean CBD diameters across the five age groups was statistically significant, as determined by one-way Analysis of Variance (ANOVA), with a p-value of 0.001 (Table 2). This significant age-related variation in CBD size underscores the importance of age-specific reference ranges for accurate sonographic assessment of biliary structures.

Table 1: Age Distribution of patients (n-80)

Age (years)	No of cases	%age
< 30	13	13.2%
31 to 40	16	20.0%
41 to 50	22	27.5%
51 to 60	14	17.5%
61 or above	15	18.8%
Mean ± SD	47.1 ± 14.1	

Table 2: Mean Common bile duct diameter according to patient age (n-80)

Age (years)	Mean ± SD	p-value (ANOVA)
< 30	4.5 mm ± 2.1	0.001
31 to 40	4.8 mm ± 1.1	
41 to 50	5.2 mm ± 0.9	
51 to 60	5.4 mm ± 0.9	
61 or above	6.6 mm ± 1.1	
Overall	5.3 mm ± 1.4	

Discussion

The present study found that the average common bile duct (CBD) diameter among participants was 5.3 ± 1.4 mm, which is relatively higher when compared to various regional and international data sets. Several previous studies conducted in similar contexts have reported comparable findings. For instance, Parulekar et al. observed a mean CBD diameter of 5.0 ± 1.9 mm [13], while Landry D et al. in a Canadian cohort reported an even larger average CBD diameter of 7.9 mm [14]. In contrast, Lal N and colleagues reported a slightly lower average diameter of 4.1 ± 1.01 mm [3]. Similarly, Park et al. documented a mean CBD diameter of 6.7 mm [15], reflecting regional differences. On the lower end, studies conducted in the United Kingdom and Israel reported smaller CBD sizes, with average diameters of 3.2 mm and 3.39 mm respectively [16]. These differences in CBD diameter measurements could be attributed to various factors, including population-specific anatomical variations, nutritional status, and even the respiratory phase during ultrasonographic imaging [17].

An important finding in our study was the significant positive correlation between age and CBD diameter. This trend is consistent with the results of prior investigations. For example, Benjamino G et al. demonstrated a linear increase in CBD size with advancing age in their study cohort [18]. Similarly, Bruno M and colleagues also

established a statistically significant positive correlation between age and CBD diameter [19]. Another study noted a progressive increase in CBD diameter from 2.8 mm in individuals aged 20 years or younger to 4.1 mm in those aged 71 years or older, reinforcing the relationship between age and ductal diameter [20, 21].

Our study confirmed this association by stratifying patients into five age groups and comparing the mean CBD diameter using Analysis of Variance (ANOVA). The observed p-value of 0.001 signifies a statistically significant difference among groups, suggesting that the variation in CBD diameter by age is not due to random chance. The trend of continuous increase in the CBD diameter with aging observed in our results aligns well with existing literature, supporting the hypothesis that age is an independent factor influencing CBD size.

Despite its strengths, including well-defined inclusion/exclusion criteria and consistency in ultrasonographic measurements, this study has certain limitations. The cross-sectional design restricts our ability to establish causal relationships. Moreover, the sample size, although adequate for preliminary analysis, may not capture the full spectrum of variability present in the general population. Other potentially confounding factors such as dietary habits, concurrent medications, or metabolic conditions were not investigated in depth.

Future Recommendations

For future research, a longitudinal study design involving larger and more diverse populations is recommended. Incorporating additional variables such as diet, comorbidities, and lifestyle factors would enhance understanding of CBD dynamics over time. These improvements would help in establishing normative data for various subgroups and further clarify the physiological versus pathological changes in bile duct morphology with age.

Conclusion

This study demonstrates that the diameter of the common bile duct increases with age. This age-associated change should be taken into account during radiological evaluations to ensure accurate interpretation of imaging findings and to avoid unnecessary investigations for presumed biliary pathology in elderly individuals. Understanding normal anatomical variations, particularly those linked with aging, is crucial for distinguishing benign physiological changes from true pathological conditions.

Authors' Contributions

All authors meet the ICMJE criteria for authorship. They have reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Author 1: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 2: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 3: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 4: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.
Author 5: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 6: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.

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