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The Significance of Biliary Anatomical Variation as a Key Indicator in Laparoscopic Bile Duct Injuries

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ABSTRACT

Introduction: The science of Gastrointestinal (GI) endoscopy is the science and art of millimeters that has marvelously evolved over the past 30 years. Cholecystectomy, most of which is done laparoscopically, is one of the most common procedures performed today (approximately 750,000 cases are performed annually in the USA) and is considered relatively safe. However, laparoscopic cholecystectomy is associated with bile duct injuries. Several studies examining bile duct injuries have found significant rates of complication (0.39%---1.5%, that comes roughly to over 3,000 patient per year). Therefore, bile duct injuries are commonly encountered, and a clear understanding of the extensive variation in biliary anatomy is imperative to appropriately and successfully manage this common clinical problem to ultimately provide the highest level of patient care.

Aim: To educate gastroenterologists, general surgeons, and Hepato-Pancreato-Biliary (HPB) surgeons regarding the definition of anatomical variation and its various anatomical markers.

Materials and Methods: A Survey research about our GI department in addition to an online research of published literature was made on PubMed, Ovid Medline, Science Direct, and Springer.

Results: This paper presents the various anatomical variations of the biliary tree which is critical in defining bile duct injuries during surgical hepato-pancreato-biliary (HPB) procedures.

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Introduction

Cholecystectomy is one of the most common procedures in the United States with more than 1.2 million cholecystectomies performed annually and even more globally [1]. Cholecystectomy is considered a relatively safe procedure and today, 92% of cholecystectomies are done laparoscopically [2]. However, laparoscopic cholecystectomy is associated with a higher incidence of bile duct injuries (BDI).1 BDIs have an overall estimated incidence of 0.39–1.5% [3]. Several studies examining bile duct injuries and laparoscopic cholecystectomy have found major significant BDI rates of 0.1-0.4% and an overall biliary complication rate of up to 0.8% if bile leaks are included [3-11]. Therefore, BDIs are commonly encountered and detailed knowledge of the biliary anatomy is required to appropriately and successfully manage this common clinical problem.

Survey research was conducted, so during a recent educational meeting with the University of Mississippi Division of Digestive Diseases, the Division Director, Faisal A. Bukeirat, MD, requested the ten (10) gastroenterology physicians (including faculty and fellows) in attendance draw their understanding of the biliary anatomy as seen on a high-quality magnetic resonance cholangiopancreatography (MRCP) and endoscopic retrograde cholangiopancreatography (ERCP). Figure 1 consisted of a large majority (90%) of
Responses.

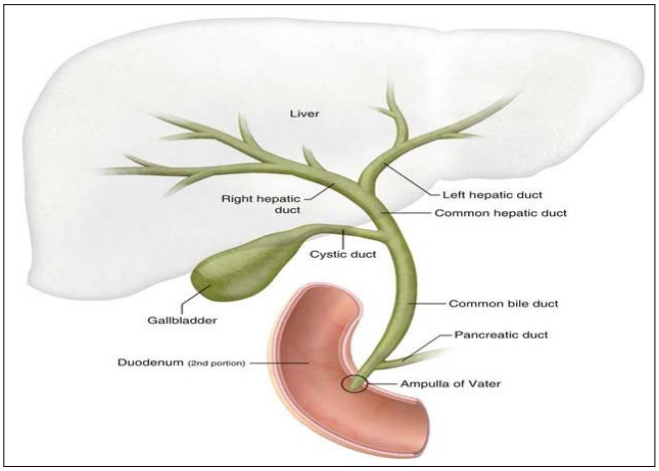

Figure 1: Normal Biliary Anatomy.Figure adapted from Radiology Key [12].

Although this anatomy in Figure 1 is the most commonly described, it only accounts for 48-58% of the general population, leaving the remaining staggering 42-52% with considerable biliary anatomical variation [13-16]. A clear understanding of the extensive variation in anatomy is imperative to safely perform advanced laparoscopic and robotic surgical procedures

such as laparoscopic cholecystectomy. Most importantly, is the understanding of the anatomical relationship of the bile ducts to the portal system.

Discussion

Biliary anatomical variation classification has become increasingly complicated in congruence with the advancement of imaging techniques. Several characteristics are considered when organizing variations. These characteristics include the location of common bile duct implantation, the shape of pancreatic duct implantation, common bile duct aspect, and cystic duct branching [17]. Specific characteristics include the classification of the right and left hepatic ducts, variations of cystic duct insertion into the common bile duct18, and variations of the pancreatic duct [14, 18]. The classic anatomical position and course of the cystic duct along with the classic anatomic relation with neighboring structures is seen only in 33% of patients. The two most crucial anatomical points of the cystic duct are, (i) the angle formed between the cystic duct and the common bile duct. (ii) the point at which the cystic duct drains into the common hepatic duct. There is significant variation in the length of the cystic duct. Toouli et al reported that 20% of ducts are shorter than 2 cm, whereas the majority are between 2 cm to 4 cm [19]. Classification of the right and left hepatic duct as described by Huang et al, is seen in Figure 2 and Figure 3 [17].

Aljiffry et al demonstrated both the variation of cystic duct insertion into the common bile duct is seen in Figure 4, as well as variations of the pancreatic duct as seen in Figure 5 [20].

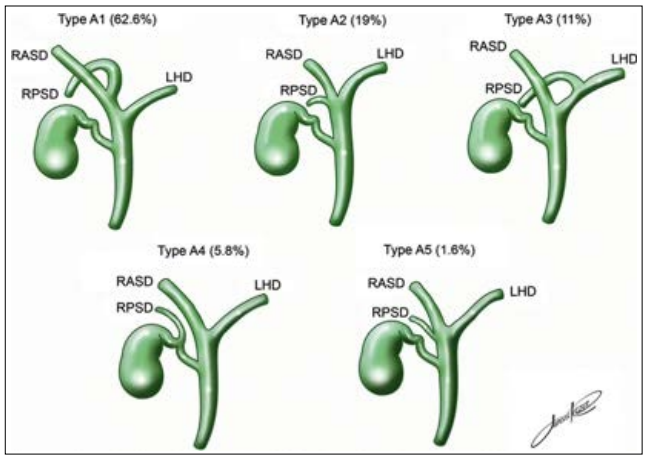

Figure 2: Huang et al [14]. classification of the right hepatic duct. Figure adapted from Aljiffry et al [19].

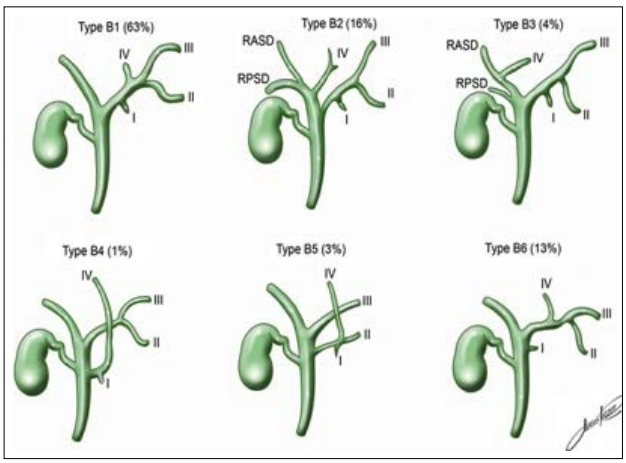

Figure 3: Huang et al classification 14 of the left hepatic duct. Figure adapted from Aljiffry et al [19].

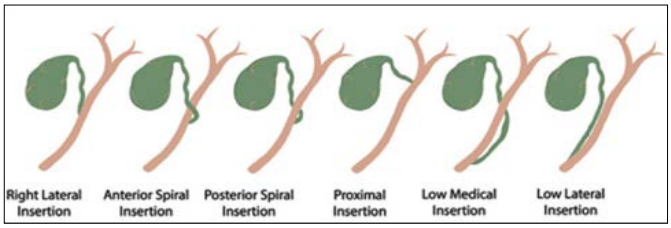

Figure 4: Variations of Cystic Duct Insertion into the Common Bile Duct as Illustrated by Aliffry et al [19].

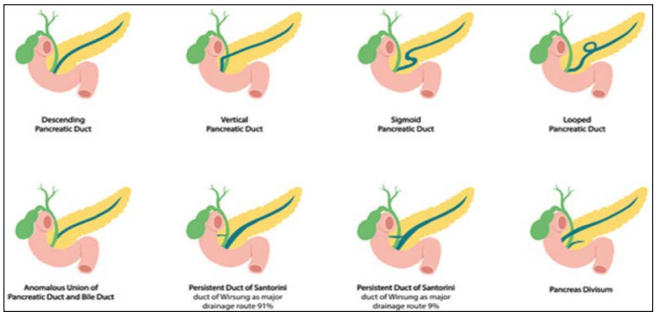

Figure 5: Variations of the Pancreatic Duct as Illustrated by Aliffry et al [19].

Among the most common complications associated with HPB surgery, particularly laparoscopic cholecystectomy, are injuries to the right main hepatic duct and its branches that happen during attempts to ligate the cystic artery [21].

Conclusion

Given the rising frequency of bile duct injuries (BDI), the timely recognition of anatomical variation with "altered" anatomy that is basically normal and not a congenital anomaly during laparoscopic cholecystectomy has never been more critical. Advanced techniques, specifically Robotic and laparoscopic minimally invasive surgical procedures have emerged as safe and cost-effective alternatives to open surgical interventions. However, the specter of complications, notably leaks, ligations, transection, and perforations, looms as a formidable concern. An in-depth comprehension of biliary anatomy and the precise location of the gall bladder, cystic duct and cystic artery holds substantial relevance in guiding intra-procedural decision-making and conferring valuable prognostic insights should a surgical injury occur. Leveraging EUS endoscopic ultrasound and MRCP/ERCP for the determination of the exact anatomy in case there is trouble during the laparoscopic or robotic surgical procedure is a useful strategy, particularly in the context of aborted surgery.

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