Anatomy and Embryology of the Biliary Tract

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KEYWORDS

• Gallbladder • Biliary tree • Portal triad • Anatomy • Embryology

KEY POINTS

- Variation in the anatomy of the extrahepatic biliary tree and its associated vasculature should be anticipated. When aberrant anatomy is encountered, other aberrancies should be expected.
- The embryologic development of the extrahepatic biliary tract is complex and incompletely understood; however, several important factors in cell signaling have been defined in recent years.
- Biliary atresia is an uncommon but serious cause of perinatal jaundice and requires operative intervention, usually a Kasai portoenterostomy. Liver transplant is often ultimately required.
- The symptoms of choledochal cysts may be nonspecific, but diagnosis is important in the face of increased risk of cholangiocarcinoma inherent to these patients.
- The replaced right hepatic artery is a common aberrancy of the hepatic vasculature and is found posterolateral in the portal triad. The replaced left hepatic artery can be found in the gastrohepatic ligament.
- Ducts of Luschka, perhaps better termed *subvesical ducts*, are an important cause of postcholecystectomy bile leak, a complication that may be avoided by cautious, shallow dissection of the gallbladder from the fossa.

INTRODUCTION

Working knowledge of extrahepatic biliary anatomy is of paramount importance to the general surgeon. The laparoscopic cholecystectomy is one of the most common surgical procedures in the United States. In surgical training, it is the procedure whereby learners often cut their teeth in the laparoscopic arena, first with the privilege of peeling the gallbladder from its fossa and later by dissecting out the cystic structures. The variation of the anatomy can be staggering. Depending on the disease process, the

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setting of inflammation can significantly impair visualization and distort the usual locations of the regional structures. Congenital malformations are also a source of anatomic variation and can confuse or surprise the surgeon at the time of surgical exploration. Misunderstanding and underestimation of the anatomy can result in misdiagnosis and serious injury to the biliary tree in the operative setting. Although biliary injury is uncommon, its potential complications carry a high morbidity. In this article, the authors review the embryologic development of the extrahepatic biliary tract and gallbladder as well as its variable anatomy.

EMBRYOLOGY

General Biliary Embryology

Understanding of the biliary tract begins with the appreciation of its embryologic development. Beginning in the fourth week of gestation, the liver bud arises from the distal extent of the foregut. As the liver parenchyma develops, the cells between it and the foregut proliferate, forming the precursor to the bile duct.[1] Between the fourth and fifth weeks of gestation, the gallbladder primordium buds off the caudal extent of the bile duct giving rise to the gallbladder and cystic duct. This bud lies in close proximity to the ventral pancreatic bud. The shared stalk rotates posteriorly and medially to join the dorsal pancreatic bud (**Fig. 1**). The ventral pancreatic bud gives rise to the uncinate process; its duct, the duct of Wirsung, typically joins with the common bile duct (CBD). This confluence occurs at the ampulla of Vater, and they drain into the duodenum via the major papilla. Usually, the duct draining the dorsal pancreatic bud will fuse with the duct draining the ventral pancreatic bud. This duct, the duct of Santorini, may fail to fuse (known as *pancreas divisum*) and/or drain directly into the duodenum at the minor papilla.

The extrahepatic biliary tree develops in close concert with the hepatic artery. Further details of the development of the extrahepatic biliary tract remain nebulous. It was initially thought that the biliary tract lumen passed through a phase in which the lumen was obliterated by proliferating endothelial cells, and failure to recanalize resulted in biliary atresia in neonates, similar to the pathogenesis of duodenal atresia. This belief has been refuted by studies in human embryos showing that the lumen never obliterates during maturation.[2] The process of how the intrahepatic and extrahepatic biliary networks anastomose is not well understood, but they seem to be in continuity throughout development.

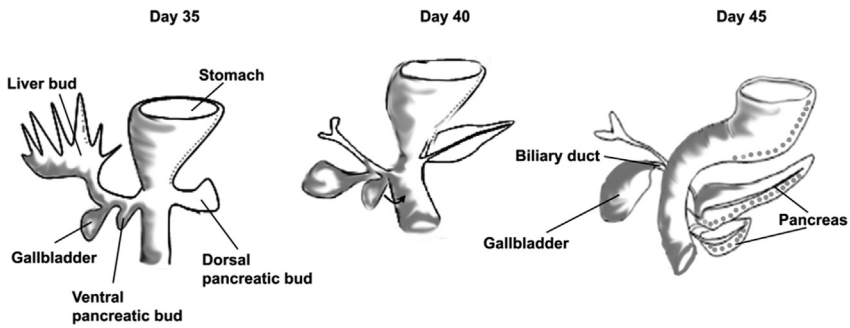

Fig. 1. Embryologic development of the biliary tree and pancreas. (*From* Sahu S, Joglekar MV, Yang SNY, et al. Cell sources for treating diabetes. In: Gholamrezanezhad A, editor. Stem Cells in Clinic and Research, 2011. InTech, http://dx.doi.org/10.5772/24174. Available at: http://www.intechopen.com/books/stem-cells-in-clinic-and-research/cell-sources-for-treating-diabetes.)