

Clinically relevant biliary tree variants

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Learning Objectives



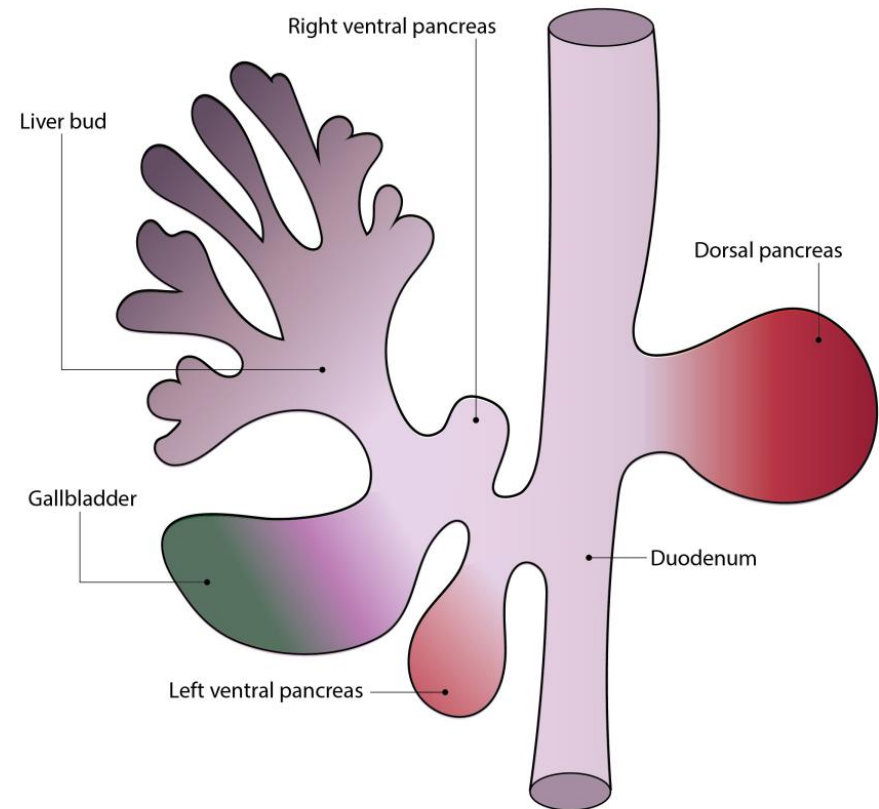
- Review the embryology and normal anatomy of the biliary tree
- Identify common biliary tree anatomical variants and understand the potentially clinically significant variants the HPB surgeon should be alerted to.

Background

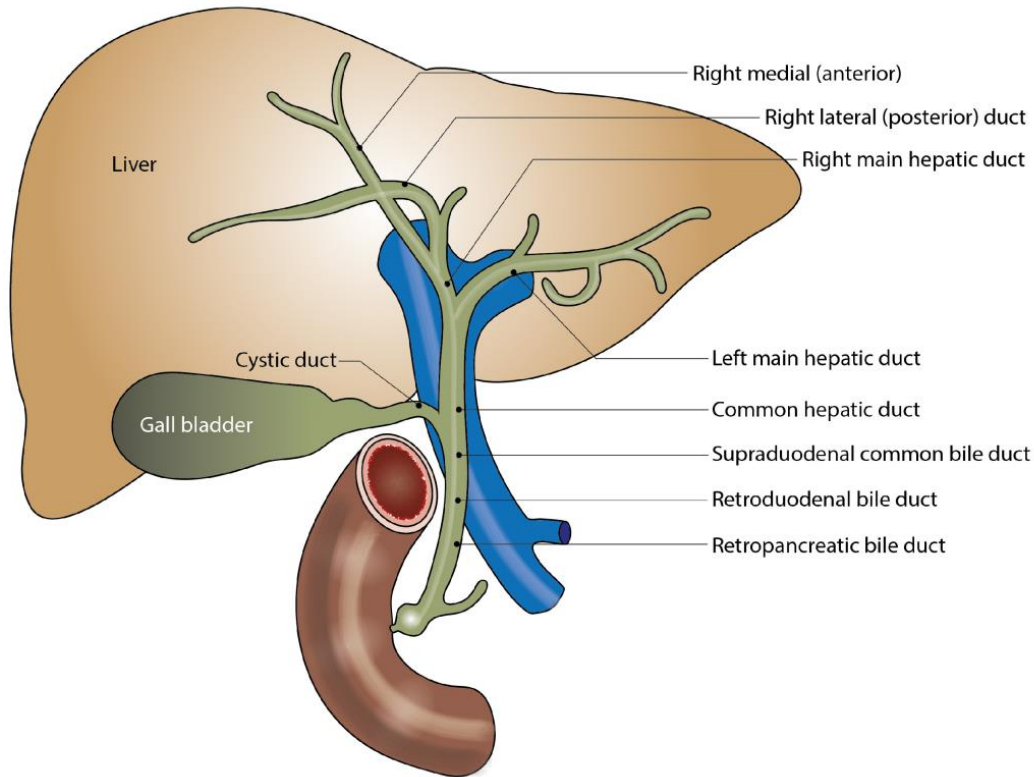
- Imaging of the biliary tree is one of the most common examinations that both the specialist Gastrointestinal and General Radiologist report daily. In patients with ultrasound detected or clinically suspected cholelithiasis and choledocholithiasis, cross-sectional imaging prior to surgery is becoming commonplace in most radiology departments.
- Whilst cholecystectomy is a relatively straightforward procedure it is not without its complications. Bile duct injury, bile leak, or segmental biliary obstruction, are associated with significant morbidity. Through pre-surgical Magnetic resonance cholangiopancreatography (MRCP) the radiologist can alert the surgeon to clinically significant duct variants that could lead to iatrogenic injury.

Embryology of the biliary tree

The hepatic diverticulum arises from the primitive foregut at around the 4th gestational week and gives rise to the gallbladder and liver buds by the 5th week. The ventral pancreatic bud/process rotates 180° by the 6th week. From the 8th to 12th weeks the biliary tree develops¹.



Conventional biliary tree anatomy



We are all very familiar with textbook appearance of the biliary tree, however, it is suggested this is only present in about 58% of patients².

The remaining 42% demonstrate some form of normal variant. Some of these variants can have implications for the HPB surgeon.

Conventional biliary tree anatomy



- Most radiologists use Couinauds classification of functional liver segments³.
- Centrally each segment has its own portal vein, hepatic artery and bile duct, while peripherally each segment drains via a hepatic vein.
- Four main structures divide the liver into segments: portal vein, right and middle hepatic veins, and the falciform ligament.

Common biliary tree variants



Multiple normal variants of the biliary tree have been described in the literature ^{2,4-6}.

The common variants can be divided into those of the cystic duct and its insertion or around the confluence of the intrahepatic biliary ducts.

GI radiologists at our institution always comment on these variants identified on MRCP and if thought to present a significant intraoperative risk a note of caution is advised.

Next, we will demonstrate some of these common variants we have seen at our institution.



Imaging findings

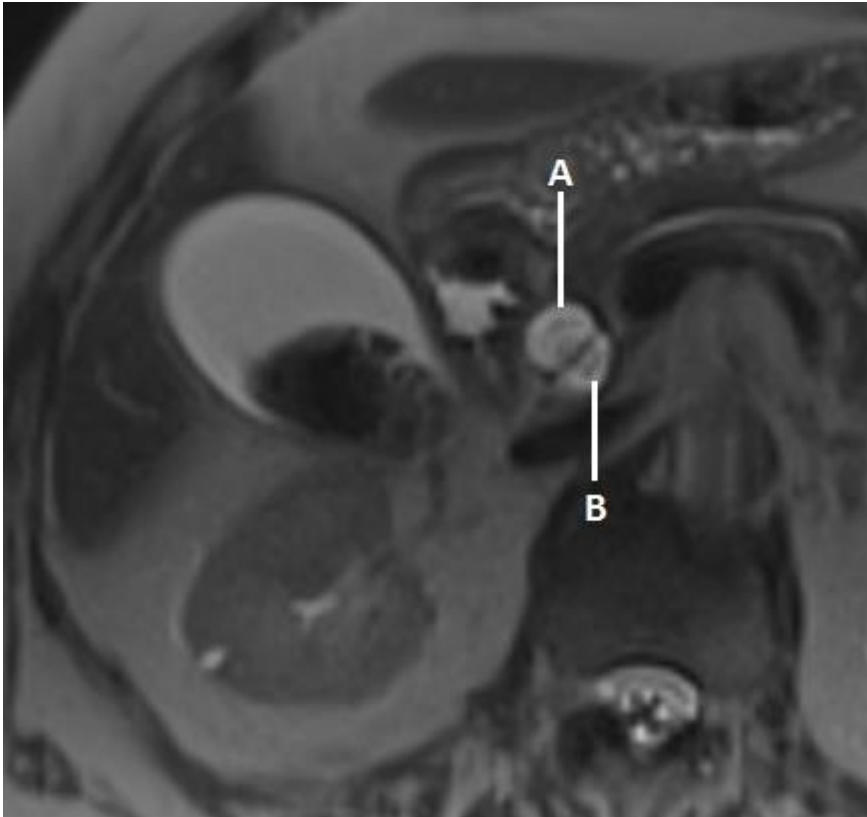


Figure 1. Axial T2 MRCP.

The structure labelled A is the common bile duct, while the structure labelled B is the cystic duct.

Here the cystic duct has a long course and inserts posteromedially in the distal CBD.

Imaging findings

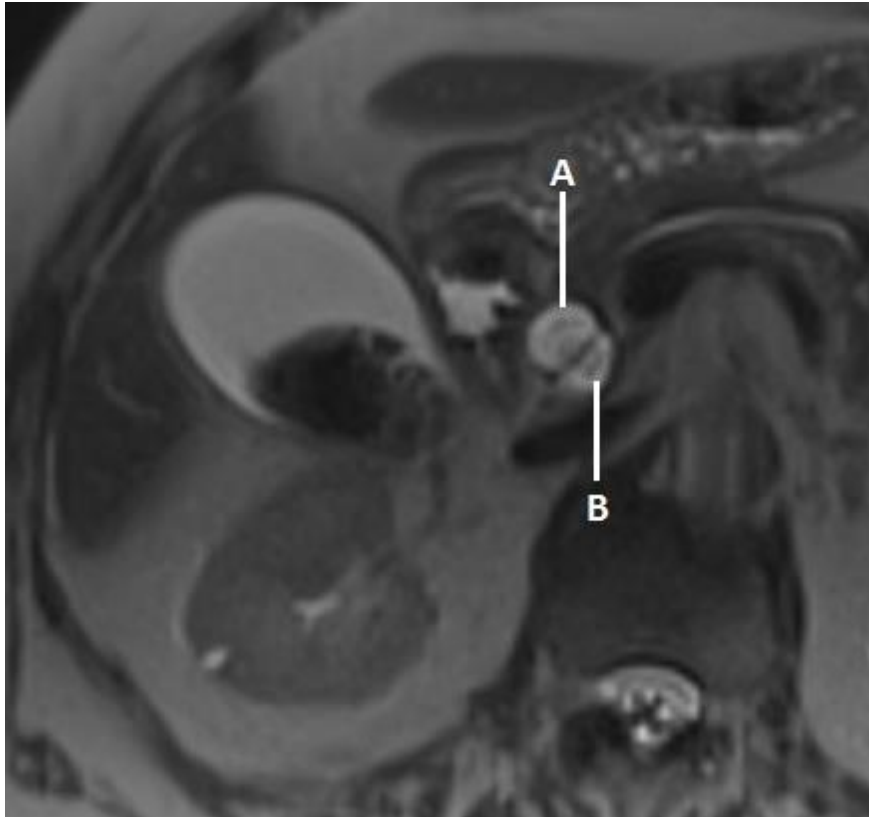


Figure 1. Axial T2 MRCP.

Low cystic duct insertion is seen in approximately 5% of cases⁵. Within this group the most common low insertions are posteriorly (20%) and a spiral course with medial insertion (16%)⁴.

Knowing there is a low cyst duct insertion and its position relative to the CBD (i.e. medial, lateral, posterior, or anterior) allows for accurate identification of the CBD during surgery and therefore reduce the possibility of CBD transection⁴.

Imaging findings

Figure 2. Thick-slab coronal MRCP

This image demonstrates the right posterior sectoral duct (A) inserting into the common hepatic duct close to the insertion of the cystic duct (D). B and C are the right and left hepatic ducts, respectively. F is the normal appearing pancreatic duct. This variant occurs in approximately 5% of cases⁵.

In this case the right posterior sectoral duct inserted close to or with the cystic duct significantly increasing the risk of bile duct injury during surgery.

Additionally, mistaking an aberrant sectoral bile duct for the cystic duct could lead to segmental biliary obstruction if ligated in error.



Imaging findings

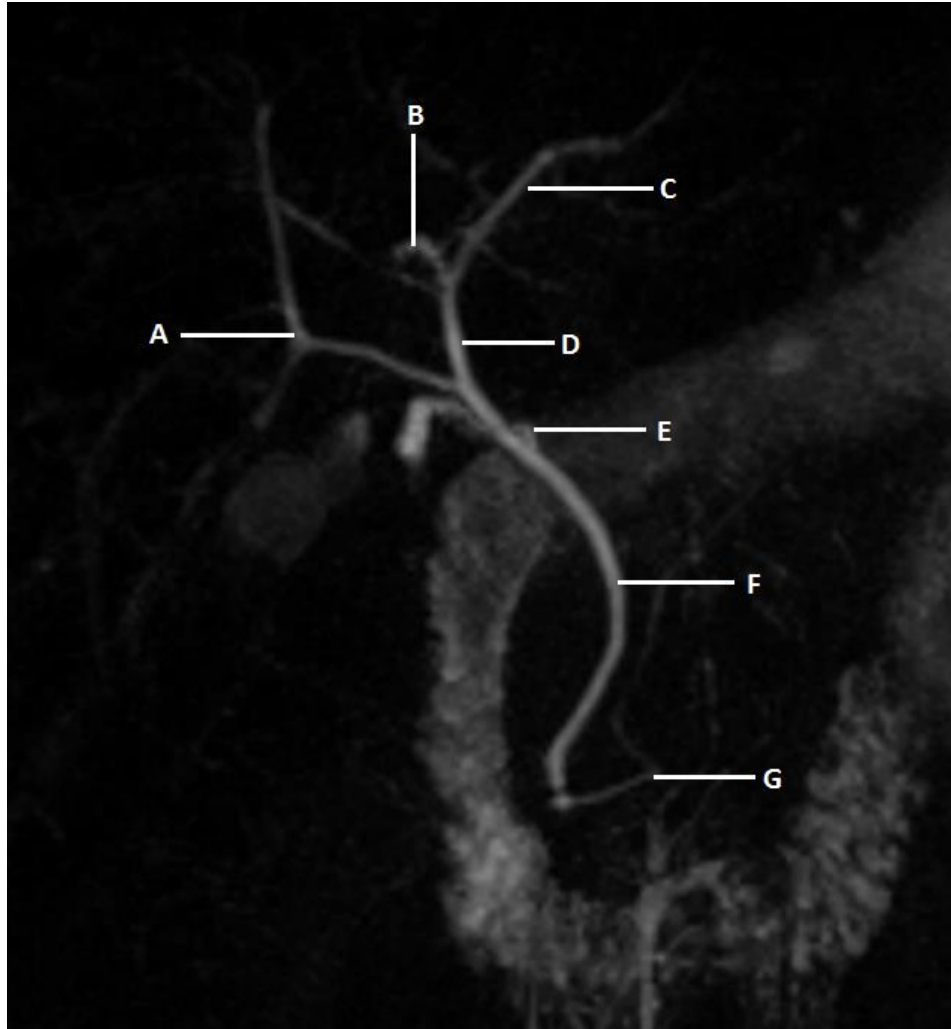


Figure 3. Thick-slab coronal MRCP

This case again demonstrates an aberrant right posterior sectoral duct (A) inserting into the common hepatic duct (D). Conventional right and left hepatic ducts are noted, B and C.

However, this patient also demonstrates a medially inserting cystic duct (E).

Otherwise normal calibre CBD and pancreatic ducts are demonstrated, F and G respectively.

Imaging findings

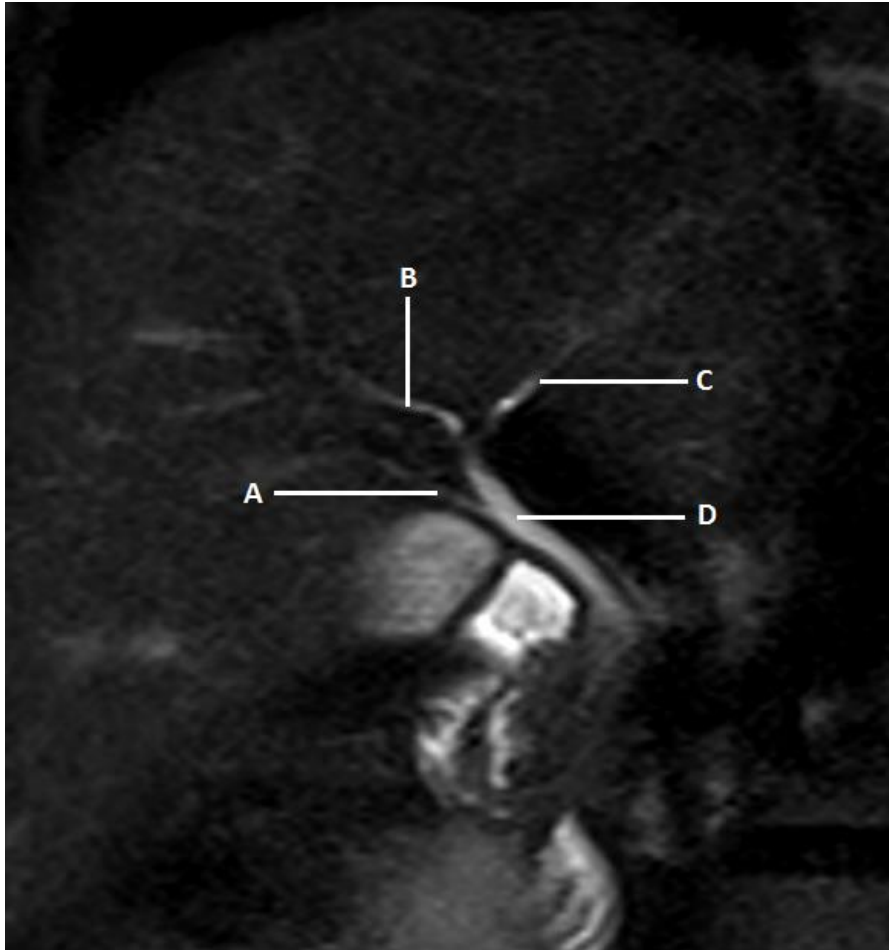


Figure 4. Thick-slab coronal MRCP

Another example of aberrant right posterior sectoral duct (A) inserting into the normal calibre common hepatic duct (D). Conventional right and left hepatic ducts are noted, B and C.

These common but significant variants may change the surgeons approach to cholecystectomy.

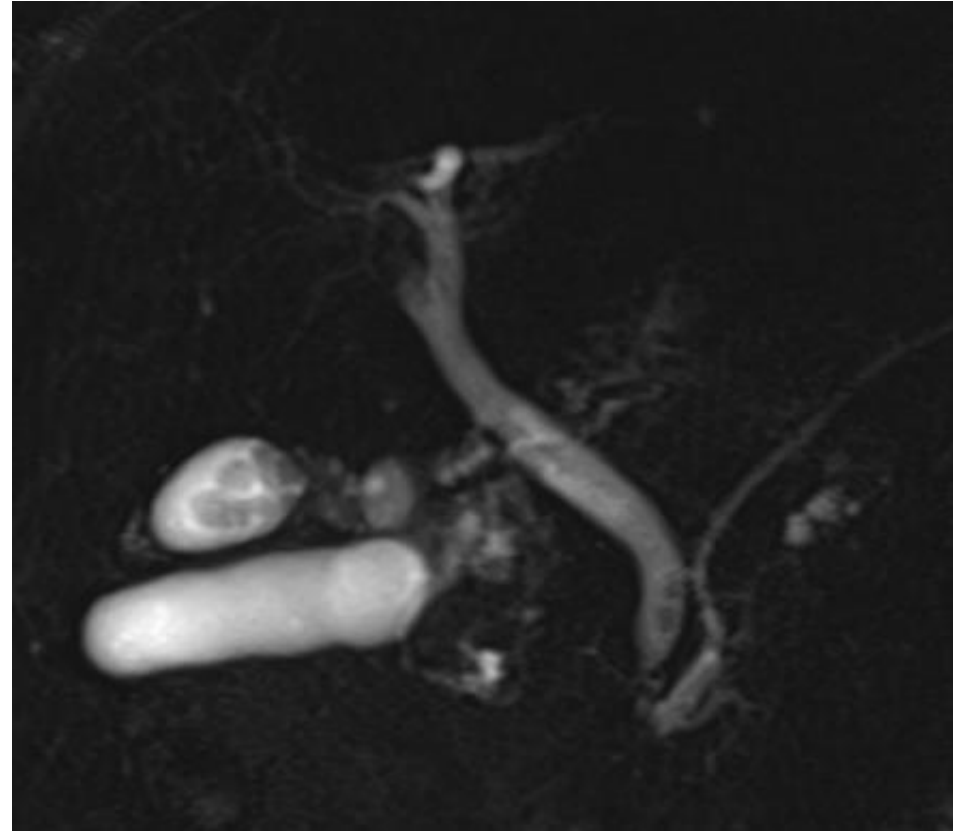
Imaging findings

Figure 5. Thick-slab coronal MRCP

The incidence of gallbladder duplication is quoted in the literature as about 1:3800-5000 births⁷. Here both gallbladders share a cystic duct.

Embryologically this occurs due to bifurcation of the gallbladder bud and happens between the 5th and 6th gestational weeks.

In this case the more superiorly positioned gallbladder contained stones and demonstrated cholecystitis while the other was completely normal.



Imaging findings



Figure 6. Thick-slab coronal MRCP

Although common, and not a significant surgical risk, pancreas divisum, if present, should always be reported.

Other pancreatic variants if present should be reported also.

These include and are not limited to:

- Persistent duct of Santorini

- Ansa pancreatica

- Anomalous union with the CBD

- Looped pancreatic duct

- Annular pancreas

Imaging findings



Figure 7. Thick-slab coronal MRCP

Another example of pancreas divisum.

Otherwise unremarkable appearance of the biliary tree.

Imaging findings

- Other biliary tree variants include:
 - Right posterior duct insertion into the left hepatic duct prior to the confluence of the anterior sectoral duct, 19%
 - Triple confluence of the intrahepatic bile ducts, 11%
 - Accessory hepatic ducts, 2%⁵
- Even rarer variants:
 - Cystic duct draining via the right or left hepatic ducts
 - Ducts of Luschka (subvesical bile ducts)

Conclusion



Radiologists are well placed to warn our surgical colleagues about normal biliary variants which could lead to iatrogenic bile duct injury leading to significant patient harm.

This can only be achieved by the radiologist having a detailed knowledge of normal and variant biliary anatomy and their clinical significance within surgical procedures.

Through this educational ePoster we have reviewed embryology and normal anatomy but also highlighted some common clinically significant biliary variants.

References

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Thank you for reading

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