Intrahepatic Biliary System — Anatomy and Radiology

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The intrahepatic biliary system can be injured in blunt abdominal trauma, in an inflammatory process, such as biliary sclerosing cholangitis, or can be involved in some benign and malignant neoplasms. The radiographic evaluation of the intrahepatic biliary system mainly consists of computed tomography, ultrasonography, and magnetic resonance cholangiography with hepatobiliary contrast and hepatobiliary scintigraphy. The main goal of each imaging modality in each disease process is different. In this article, we will discuss three main biliary pathologies: traumatic biliary leaks, intrahepatic biliary adenoma, and intrahepatic cholangiocarcinoma.

Anatomy

The biliary tree is made up of channels that collect bile from the hepatic parenchyma and transport it to the duodenum. It is divided into the intrahepatic and extrahepatic ducts.

The clinical organization in most of the population is as follows:

- Bile canaliculi unite to form segmental bile ducts that drain liver segments. These segmental ducts unite as follows:
- Segments VI and VII form the right posterior duct.

- Segments V and VIII form the right anterior duct.
- Segments II, III and IV unite to form the left hepatic duct.
- The right hepatic duct is formed by the joining of the right anterior and posterior ducts.
- The right and left hepatic ducts unite to form the common hepatic duct that joins the cystic duct to form the common bile duct. The common bile duct crosses posterior to the duodenum and pancreas to unite with the main pancreatic duct and form the ampulla of Vater that drains into the duodenum.

Traumatic Biliary Leaks

The biliary tract can be injured in abdominal trauma but this is usually rare. The estimated prevalence of biliary tract injuries in patients who sustain a significant blunt hepatic trauma is around 2.8%.

Biliary tract injuries are usually associated with hepatic, splenic and/or duodenal injuries. The **most commonly injured part of the biliary tract is the gallbladder**. The intrahepatic biliary system is the least common part of the biliary tract to be injured in blunt abdominal trauma.
Patients with intrahepatic biliary system traumatic injuries also have hepatic parenchymal injuries.

The risk of intrahepatic biliary system injury seems to be unrelated to the severity of a hepatic parenchymal injury or the American Association for Surgery of Trauma liver injury grade.

Imaging Studies in Patients with Traumatic Intrahepatic Biliary System Injuries

Computed Tomography Scan

This is the imaging modality of choice in trauma set-ups. A patient with a blunt abdominal trauma usually undergoes a **multidetector computed tomography scan of the abdomen** to look for solid organ injuries and grade such injuries. When there is evidence of hepatic parenchymal injury, the risk of intrahepatic biliary system injury and leak becomes higher. Unfortunately, the **computed tomography findings in patients with biliary injuries are usually non-specific**.

In some patients, the **main imaging finding on computed tomography scans of the liver is intrahepatic contrast accumulation**. These small intrahepatic fluid collections are believed to originate from focal bile leaks which can later develop into a biloma. Patients with intrahepatic fluid collections and extravasation of contrast on delayed imaging usually have a **high-grade liver injury**.

Ultrasonography

Ultrasonography can also be used in the evaluation of the traumatic liver and intrahepatic biliary system. The **main goal of ultrasonography is to evaluate the progress and evolution of a biloma** rather than to exclude or grade hepatic injuries. Ultrasound-guided drainage of the biloma might be performed if the collection is growing.

Hepatobiliary scintigraphy

Hepatobiliary scintigraphy can be also used in patients with suspected intrahepatic or

extrahepatic biliary tract injuries. Contained intrahepatic leaks can be easily identified on hepatobiliary scintigraphy.

Magnetic resonance cholangiopancreatography

The **most sensitive and specific imaging modality** for intrahepatic biliary system traumatic injuries and leaks is magnetic resonance cholangiopancreatography **with a hepatobiliary contrast**. The images produced with this technique can help in evaluating the anatomy of the biliary tract from the intrahepatic part to the gallbladder to the extrahepatic part and intrapancreatic portion.

Magnetic Resonance Cholangiopancreatography

- Heavily T2 weighted sequences performed without contrast
- Very helpful in determining cause and level of obstruction

Intrahepatic Cholangiocarcinoma

Intrahepatic cholangiocarcinoma arises from the intrahepatic portion of the biliary tract and is considered as the **second most common intrahepatic primary tumor**. They arise from the biliary epithelium of mucin-producing cells, known as cylindrical cells, which are found within the segmental bile ducts or from cuboidal cholangiocytes which do not produce mucin.

These tumors are **very invasive and usually have areas of necrosis, fibrosis, and mucin on histopathology**. Intrahepatic cholangiocarcinoma can spread via the biliary system, venous system or lymphatic system.

The clinical presentation of intrahepatic cholangiocarcinoma is **non-specific** and consists of:

- Abdominal pain
- Weight loss
- Jaundice
- Night sweats

Imaging Studies in Intrahepatic Cholangiocarcinoma

The main imaging modalities used in the radiographic evaluation of intrahepatic cholangiocarcinoma are ultrasonography, computed tomography, magnetic resonance imaging, and positron emission tomography. Each imaging modality has its own strong points, weaknesses, and indications.

Ultrasonography in Intrahepatic Cholangiocarcinoma

Ultrasonography is usually the **first imaging modality used in any patient complaining of non-specific abdominal symptoms such as pain and indigestion**.

Intrahepatic cholangiocarcinoma is usually **hyperechoic**. These tumors tend to be **homogenous** and they can **resemble hepatocellular carcinoma**. Contrast-enhanced ultrasound might show washout within intrahepatic cholangiocarcinoma similar to what you would see with hepatocellular carcinoma.

Computed Tomography in Intrahepatic Cholangiocarcinoma

Intrahepatic cholangiocarcinoma can be **infiltrative** and they usually do not have a capsule which can differentiate them from hepatocellular carcinoma. The lesions **appear hypoattenuating on non-enhanced computed tomography**.

When contrast is used, intrahepatic cholangiocarcinoma shows **enhancement only on delayed imaging series,** but not in the arterial or portal venous phase images. When necrosis and mucin are extensive in the center of the tumor, the center of the tumor remains hypodense despite contrast administration. A recent study has found that tumors that show enhancement of more than two-thirds of the tumor's bulk are usually associated with a worse prognosis.

Magnetic Resonance Imaging in Intrahepatic Cholangiocarcinoma

Intrahepatic cholangiocarcinoma is usually **hypointense on T1-weighted images**. On T2-weighted images they can be:

- Hypointense
- Iso-intense
- Hyperintense

Mucin-producing tumors are usually hyperintense on T2-weighted images, whereas tumors with extensive fibrosis are typically hypointense on T2-weighted images.

The administration of intravenous gadolinium typically shows **early peripheral enhancement, followed by delayed progressive central enhancement**. Hepatobiliary specific contrast agents can be used to better understand the extent and margins of the intrahepatic cholangiocarcinoma.

Hepatocytes typically take more contrast compared to the biliary cells; therefore, a tumor that arises from biliary epithelial cells, such as cholangiocarcinoma, is **expected to be hypointense compared to the surrounding hepatic tissue** when a hepatobiliary-specific contrast agent is used.

Positron Emission Tomography

The main purpose of this imaging technique is to **identify occult microscopic metastases**. Tumor cells are expected to be more metabolically active, hence take more glucose; therefore, tumors that arise from the biliary epithelium are expected to appear as hypermetabolic regions. Unfortunately, **benign biliary tumors, such as intrahepatic biliary adenoma, are also metabolically active**.

Klatskin tumor: cholangiocarcinoma located at the confluence of the right and left hepatic ducts.

Intrahepatic Biliary Adenoma

Intrahepatic biliary adenomas are rare benign biliary epithelial tumors that account for about 1% of all primary liver tumors. They are usually an incidental finding and **do not cause any symptoms**.

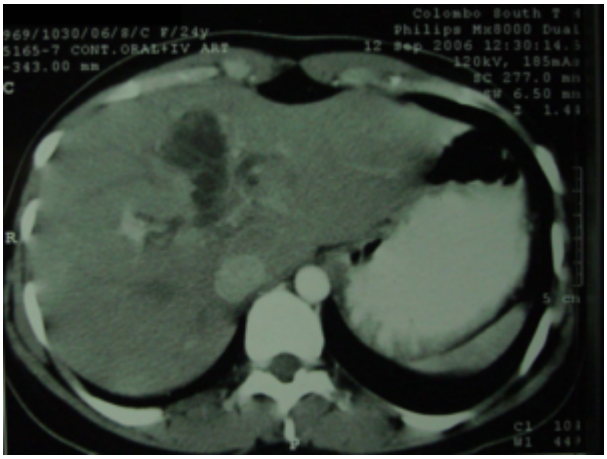

Image: “Septate Intrahepatic Biliary Cystadenoma” by Siriwardana PN, Pathirana A. License: CC BY 3.0

Imaging Studies in Intrahepatic Biliary Adenoma

Ultrasonography

Intrahepatic biliary adenomas are typically **found incidentally** on an ultrasound indicated for another problem. In most cases, you will encounter a patient with an intrahepatic biliary adenoma for further evaluation of a newly identified hepatic mass. The main goal of further imaging is to confirm the benign nature of the lesion.

Computed tomography scans

On computed tomography scans, these lesions are usually **very well-defined and are small in size**. They are typical of low-intensity on unenhanced computed tomography. When contrast is used, these **benign tumors typically show heterogenous enhancement with central cystic changes**.

Because these tumors are very well-defined, they are **unlikely to be malignant** and therefore a **wait-and-see approach** can be followed. A repeat computed tomography scan at two months and six months is recommended to check for any size changes. A benign intrahepatic biliary adenoma is expected to show no growth over this short period or very minimal growth. If the tumor shows slight growth, it is advisable to go for hepatobiliary contrast-enhanced magnetic resonance imaging.

Contrast-enhanced magnetic resonance imaging

Hepatobiliary contrast-enhanced magnetic resonance imaging typically shows a **hypointense lesion on T1 pre-contrast, heterogeneous enhancement and a hypointense lesion** in contrast to the surrounding hepatic tissue after the administration of the contrast agent.

Unfortunately, these **findings are the same one would expect in a cholangiocarcinoma** except for the lack of invasiveness, infiltrative nature, and irregularity which are seen in malignant lesions. Regardless, most patients opt to go for surgical removal of the lesion with a hepatic segmentectomy. **Once the lesion is removed, a biopsy study can then confirm the diagnosis**. If the diagnosis was confirmed to be a benign intrahepatic biliary adenoma, further follow-up and treatment is

usually not needed.

References

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