Anatomy of Hepatopancreatobiliary System
A RO’s Perspective

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Hepatopancreatobiliary System
Liver

• Liver: second largest organ
  • Weighs around 1.5kg

• 25% of CO is supplied to liver

• Located just below diaphragm
  • extends from the right 5th intercostal space superiorly to the edge of the costal margin inferiorly

• Covered by Glisson’s capsule
# Ligaments of liver

<table>
<thead>
<tr>
<th>Ligament</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary ligament</td>
<td>Coronal ligament. Attaches the liver to the diaphragm, and the right kidney and adrenal gland.</td>
</tr>
<tr>
<td>Triangular ligament</td>
<td>Asymmetrical. Right and left components. Covers left lobe of the liver.</td>
</tr>
<tr>
<td>Falciform ligament</td>
<td>Sickle-shaped. Anchors the liver the anterior abdominal wall and the diaphragm.</td>
</tr>
<tr>
<td>Ligamentum teres (hepatis)</td>
<td>Round ligament of the liver. A remnant of the left umbilical vein.</td>
</tr>
<tr>
<td>Ligamentum venosum</td>
<td>A remnant of the ductus venosum. Occupies the fissure of the ligamentum venosum.</td>
</tr>
<tr>
<td>Lesser omentum</td>
<td>L-shaped. Two parts: hepatogastric ligament, hepatoduodenal ligament.</td>
</tr>
</tbody>
</table>
Segments of liver

• Evolved over time
  • Various classifications used
  • Hjortsjö, Healey and Schroy, Couinaud, Goldsmith and Woodburne, and H. Bismuth
  • Couinaud eight segment classification in 1954 favoured
    • Eight independent segments
    • Spatially divided by Cantlie’s line, which runs from the fundus of the gallbladder to the suprahepatic inferior vena cava (IVC). Within the substance of the liver, the middle hepatic vein courses along this same path and is the true division of the right and left hemilivers
    • Own function, biliary drainage and vascular outflow and inflow (separate portal, hepatic artery and biliary flow, but venous drainage is shared with adjacent segments)
The Brisbane 2000 Terminology of liver anatomy and resections

• Uses four planes to separate the segments:
  • Three longitudinal planes joining the inferior vena cava to respectively the right hepatic vein, the median hepatic vein, and the umbilical portion of the left hepatic vein.
  • One imaginary transverse plane passing by the portal vein bifurcation is also used.
  • Three segments to the left liver (segments II, III, and IV) fed by the left portal vein and four segments to the right liver fed by the right portal vein (segments V, VI, VII, and VIII).
  • Segment I is located posteriorly between the portal vein and the inferior vena cava and is fed by multiple branches coming from both the left and right portal veins and does not belong either to the right or left liver.
• First order division
  • Left and right hemiliver (falciform ligament)
  • Left hepatectomy or left hemihepatectomy (segments 2 to 4)
  • Right hepatectomy or right hemihepatectomy (segments 5-8).
• Second order division
  • Right anterior section (segment 5&8), the right posterior section (segments 6&7),
  • the left medial section (segment 4) and the left lateral section (segment 2&3).
  • The resection of these sections is termed as the corresponding sectionectomy.
<table>
<thead>
<tr>
<th>Anatomical term</th>
<th>Couinaud segments referred to</th>
<th>Term for surgical resection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right anterior section</td>
<td>Sg5,8</td>
<td>Add ‘-ectomy’ to any of the anatomical terms as in Right anterior sectionectomy</td>
</tr>
<tr>
<td>Right posterior section</td>
<td>Sg6,7</td>
<td>Right posterior sectionectomy</td>
</tr>
<tr>
<td>Left medial section</td>
<td>Sg4</td>
<td>Left medial sectionectomy OR Resection segment 4 (also see under third order) OR Segmentectomy 4 (also see under third order)</td>
</tr>
<tr>
<td>Left lateral section</td>
<td>Sg2.3</td>
<td>Left lateral sectionectomy OR Bisectionectomy 2,3 (also see under third order)</td>
</tr>
<tr>
<td>Right hemiliver plus left medial section</td>
<td>Sg4-8 (± Sg1)</td>
<td>Right trisectionectomy or Extended right hemihepatectomy or Extended right hemihepatectomy</td>
</tr>
<tr>
<td>Left hemiliver plus right anterior section</td>
<td>Sg2.2–5,5,8 (± Sg1)</td>
<td>Left trisectionectomy or Extended left hepatectomy or Extended left hemihepatectomy</td>
</tr>
</tbody>
</table>

Borders or watersheds:
An additional alternative second-order division based on *portal vein* recommended in this terminology which used the term *sector* instead of section and the resection of these sectors is known as *sectorectomy*.
• Third-order division,
• these sections are divided into segments and the resection of these segments is termed as *segmentectomy*.
Porta Hepatis

• Short but deep fissure 5cm long extending transversely beneath the left portion of the right lobe of the liver, nearer its posterior surface than its anterior border.
• Separates the quadrate lobe in front from the caudate lobe and process behind.
• It transmits
  • Hepatic duct(ant)
  • Hepatic artery
  • Hepatic portal vein(post)
  • Nerves and lymphatics
• Lies in transduodenal ligament
CT Anatomy
CT Anatomy
Blood Supply

• Hepatic artery arises from celiac artery at T12 level  
  • 20-30% % of hepatic blood flow
• Left gastric and Left hepatic artery (LHA)
• Portal trunk separates in liver hilum into left and right  
  • 70-80% of blood flow
• Left vein supplies seg II, III and IV
• Right portal vein branch divides further into two branches: the right anterior portal vein supplying segments V and VIII and the right posterior vein supplying segments VI and VII.
Lymphatic Drainage of Liver
Applied Anatomy

• For SBRT for liver lesions, approximity to porta hepatis has to be assessed
  • MECC defines varying doses accordingly
    • <2cm from porta hepatis: 10Gy*5#
    • >2cm from porta hepatis: 20Gy*3#

• Minimum 5mm distance between liver lesion and any hollow GI organ

• RFA vs SBRT for liver lesions
  • Heat sink effect with RFA if lesion in close proximity to GB or portal vein
Gall Bladder (biliary vesicle)

- Small organ where bile is stored
- Hollow organ, sits just beneath right lobe of liver
- Extends from end of porta hepatis to inf border of liver
- 7-10cm long, 3cm wide, 30 ml capacity
Biliary Tree

Intrahepatic bile ducts

Bile canaliculi

Segmental bile ducts (individual liver segment)

Sectional bile ducts

RPD  RAD  LHD

RHD
Biliary Tree

• Bile ducts from segment I drain into the merging point of the RHD and LHD.
• Extra-hepatic bile ducts include the CHD and the cystic duct which combine to form the common bile duct.
• The neck of the gallbladder is attached to the CHD by the cystic duct, draining bile from the biliary tree
Blood Supply and Venous Drainage of GB

- Cystic artery
  - GB
  - Hepatic ducts
  - Cystic duct, upper part of bile duct
- Post sup pancreaticoduodenal a.
  - Lower part of bile duct
- Right hepatic artery
  - Minor part of middle bile duct
- Hepatic vein
  - Sup part of GB
  - Right br of Portal vein
  - Rest of GB drained by cystic veins
- Lower part of bile duct drains into portal vein
Lymphatic Drainage of GB

- Lymphatic metastasis is initially to cystic and pericholedochal nodes and then to the pancreaticoduodenal system, with later potential spread to the rest of the celiac axis or the superior mesenteric or aortic nodes.
Cholangiocarcinoma

- Intrahepatic (10%)
- Extrahepatic
  - Perihilar (70%): between secondary biliary radicles and proximal to cystic duct insertion
  - Klatskin tumour: confluence of RHD and LHD
  - Distal (20%): distal to cystic duct insertion
    - Ampulla of Vater
Bismuth Corlette Classification (Perihilar)

• Type I
• Type IIa
• Type IIIa
• Type IIIb
• Type IV
• Type V
Pancreas

• Retroperitoneal organ at L1-L2 level.
• Accessory organ, exocrine and endocrine gland
• 5 parts: head (including the part called uncinate process), neck, body, and tail
• Intimate contact with surrounding organs, including stomach, duodenum, jejunum, kidneys, and spleen as well as major vessels, which can be involved by direct tumor extension.
• Tumors in the head of the pancreas often invade or compress the common bile duct, causing jaundice and dilatation of the bile ducts and gallbladder.
Blood Supply
Lymphatic Drainage
### NCCN Resectability Criteria

<table>
<thead>
<tr>
<th>Resectable</th>
<th>Borderline</th>
<th>Irresectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial:</td>
<td>Head/uncinate process:</td>
<td>H/U process:</td>
</tr>
<tr>
<td>No contact</td>
<td>- Solid tumor contact with CHA without extension to CA or hepatic artery bifurcation or abutment and no extension to the SMA or variant artery*</td>
<td>&gt; 180° SMA or CA</td>
</tr>
<tr>
<td>Body/tail:</td>
<td>Body/tail:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Abutment (≤180° ) to the celiac axis or encasement of the celiac axis without involvement of the aorta or gastroduodenal a.</td>
<td>&gt; 180° SMA or CA or ≤180° CA and aortic involvement</td>
</tr>
<tr>
<td>Venous:</td>
<td>&gt; 180° or with contour irregularity / thrombosis</td>
<td>&gt; 180° or with contour irregularity or thrombosis</td>
</tr>
<tr>
<td>≤ 180°</td>
<td>resection &amp; reconstruction possible</td>
<td>r &amp; r not possible</td>
</tr>
<tr>
<td>without contour irregularity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Applied Anatomy

• For adjuvant RT in ca pancreas, high risk of recurrence around CA and SMA,
  • CTV should include these regions along with preop tumour volume
• For tumour involving tail of pancreas, splenic nodes should be included in the CTV.
To summarise....

• Liver, GB, biliary tree and pancreas.. closely associated organs
  • Complimentary physiological association

• Good anatomical understanding helps in appropriate management of malignancies

• Blood supply and lymphatic drainage are important considerations while considering radiotherapy planning
Thank you!