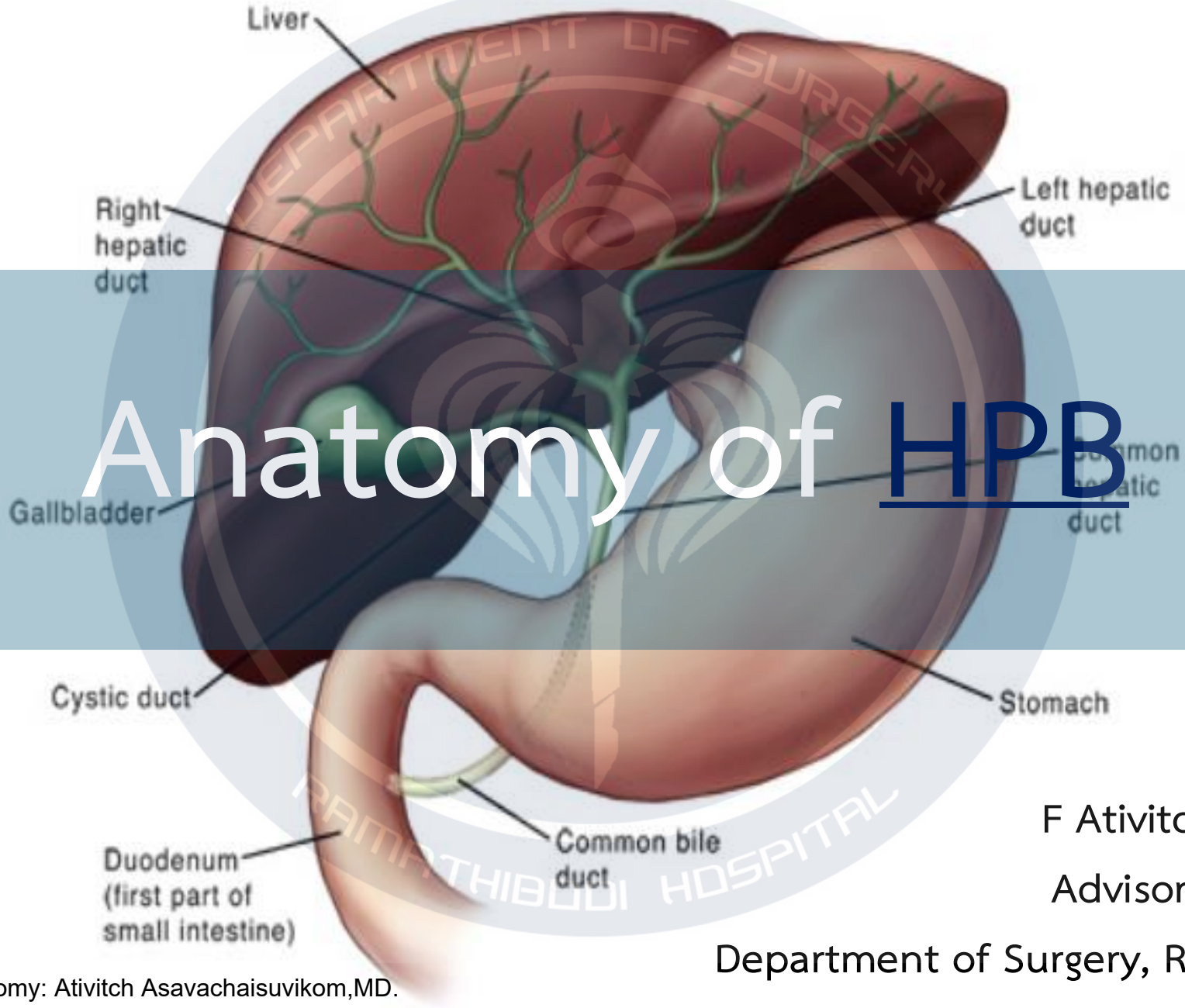



# Anatomy of HPB

F Ativitch Asavachaisuvikom

Advisor : Dr. Wikarn Suragul

Department of Surgery, Ramathibodi Hospital

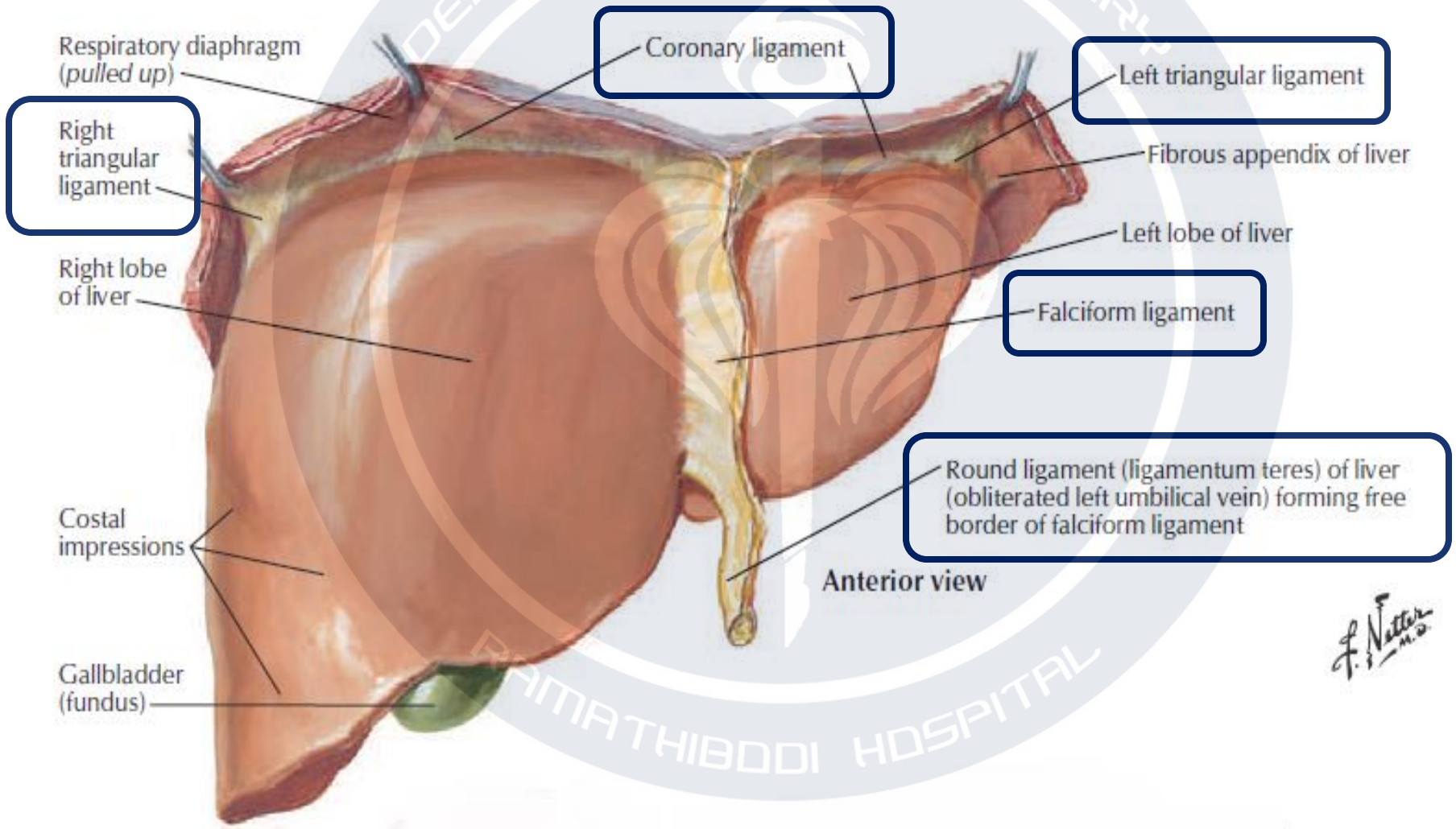
# OUTLINE

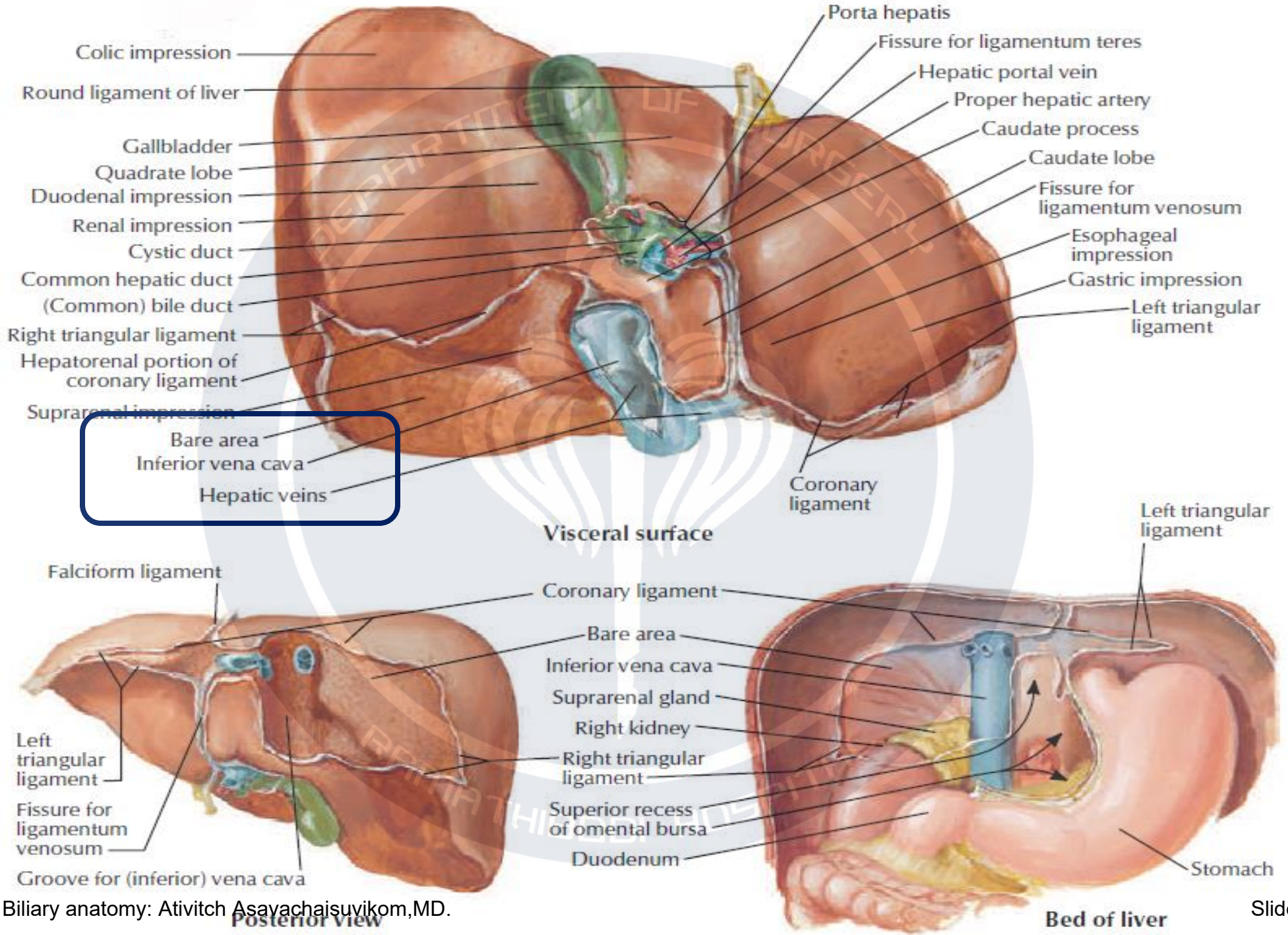
- Hepatic
- Biliary tract
- Pancrease

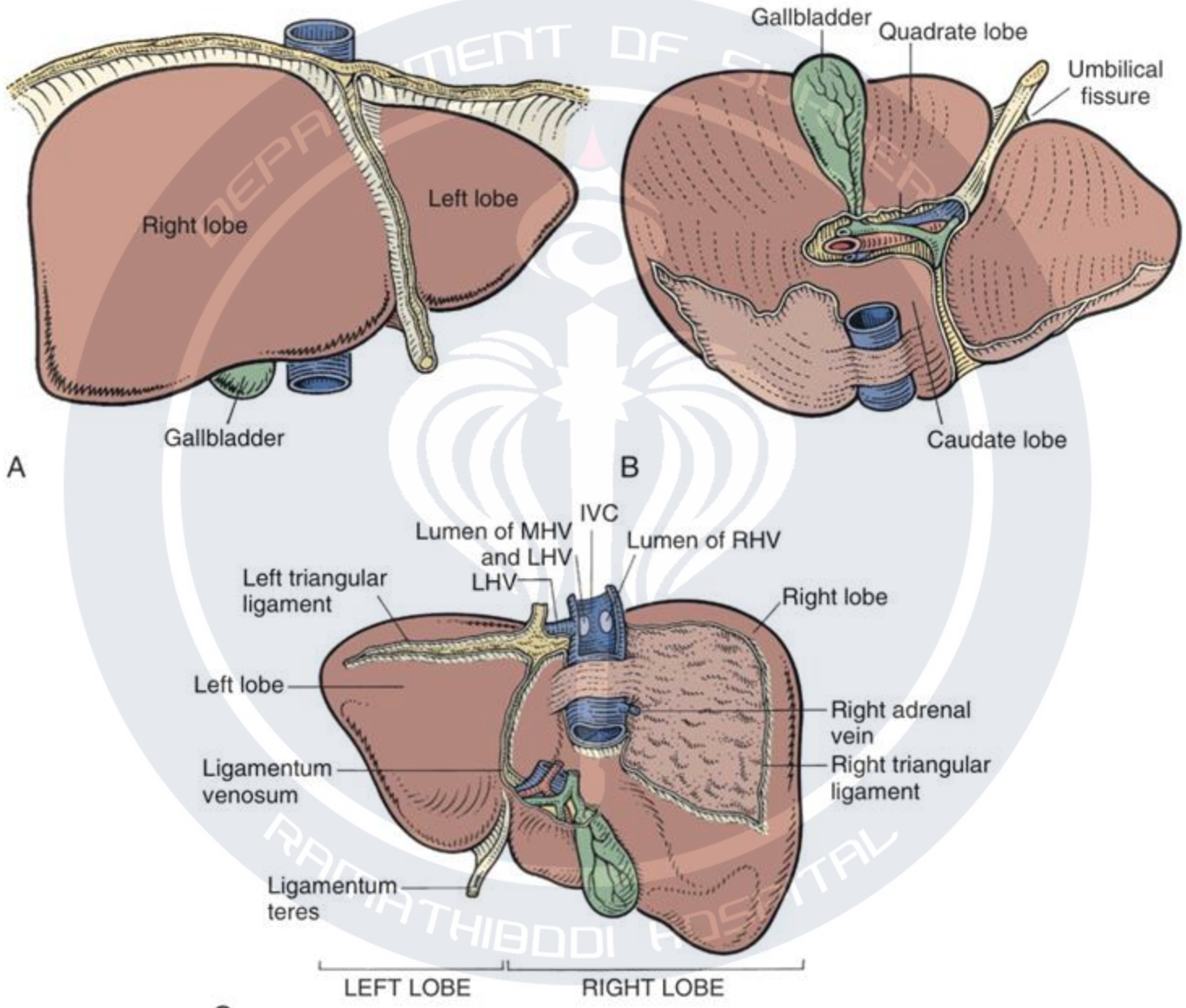
# LIVER

- Greek word for the liver, hepar, which means “mend” or “repair.”
- Largest solid organ in the body
- Weighting approximately 1500 g.
- Located beneath the right dome of diaphragm , within costal margin
- Reddish brown, Surrounded by fibrous sheath “Glisson’s capsule”

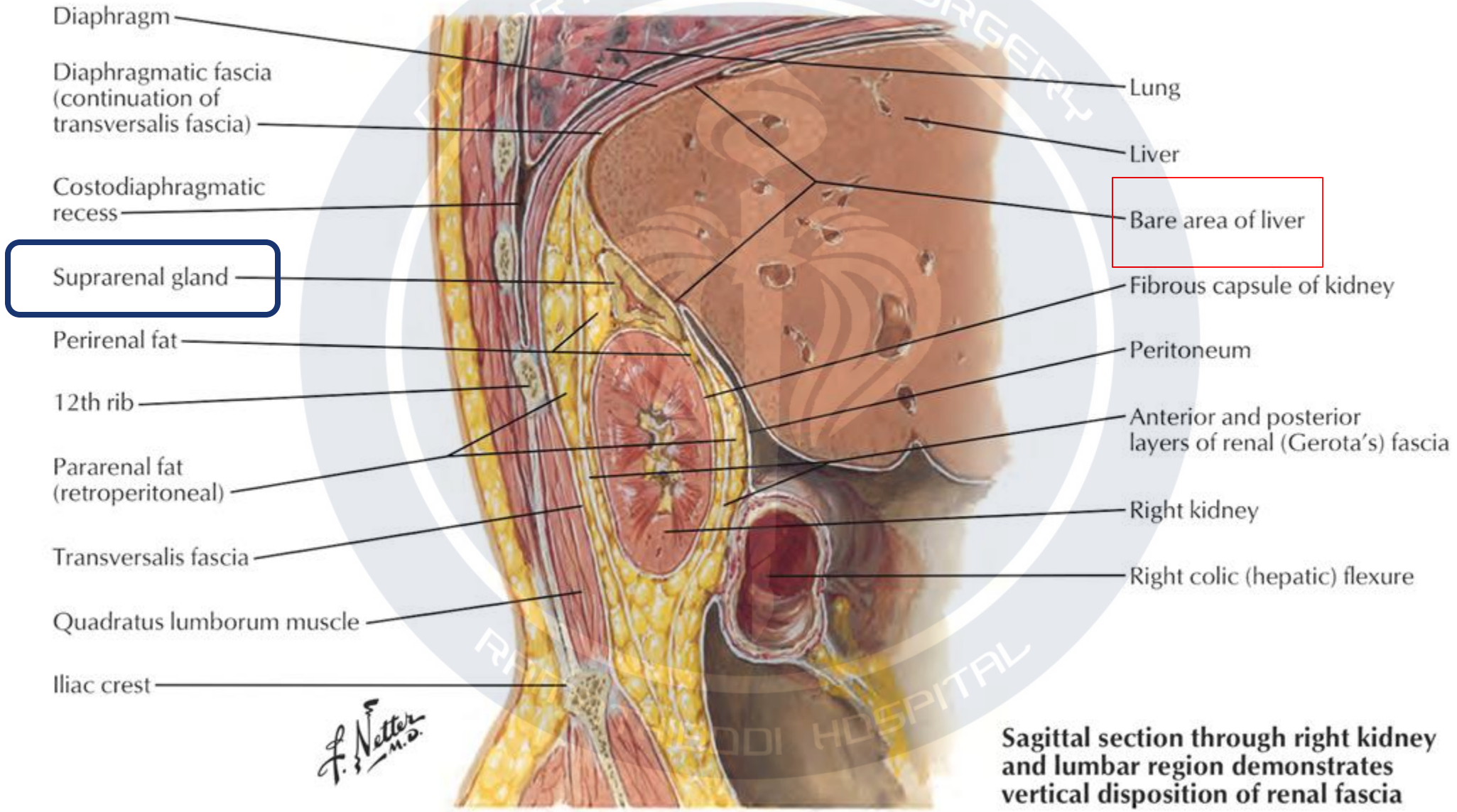
# SURFACE ANATOMY




Porta hepatis
Fissure for ligamentum teres
Hepatic portal vein
Proper hepatic artery
Caudate process
Caudate lobe
Fissure for ligamentum venosum
Esophageal impression
Gastric impression
Left triangular ligament
Colic impression
Round ligament of liver
Gallbladder
Quadrate lobe
Duodenal impression
Renal impression
Cystic duct
Common hepatic duct
(Common) bile duct
Right triangular ligament
Hepatorenal portion of coronary ligament
Suprarenal impression
Bare area
Inferior vena cava
Hepatic veins
Coronary ligament
Visceral surface
Falciform ligament
Left triangular ligament
Fissure for ligamentum venosum
Groove for (inferior) vena cava
Posterior view
Coronary ligament
Bare area
Inferior vena cava
Suprarenal gland
Right kidney
Right triangular ligament
Superior recess of omental bursa
Duodenum
Left triangular ligament
Stomach
Bed of liver


Right lobe
Left lobe
Gallbladder
A
Gallbladder
Quadrate lobe
Umbilical fissure
Caudate lobe
B
IVC
Lumen of MHV and LHV
LHV
Lumen of RHV
Left triangular ligament
Right lobe
Left lobe
Right adrenal vein
Ligamentum venosum
Right triangular ligament
Ligamentum teres
LEFT LOBE
RIGHT LOBE
C

**Transverse section through 2nd lumbar vertebra demonstrates horizontal disposition of renal fascia**




**Sagittal section through right kidney and lumbar region demonstrates vertical disposition of renal fascia**

# Functional anatomy

- Rex, 1888 and Cantlie, 1898
  - Rex-Cantlie line
- Healey and Schroy, 1993
  - Left lateral, Left medial, Anterior and Posterior
- Couinaud, 1954
  - Couinaud's segment
- Takasaki, 1986
  - Takasaki's concept : 3 segments and caudate area
- Brisbane, 2000
  - Brisbane terminology of liver anatomy

Sakamoto, Yoshihiro & Kokudo, Norihiro & Kawaguchi, Yoshikuni & Akita, Keiichi. (2016). Clinical Anatomy of the Liver: Review of the 19th Meeting of the Japanese Research Society of Clinical Anatomy. Liver Cancer. 6. 146-160. 10.1159/000449490.

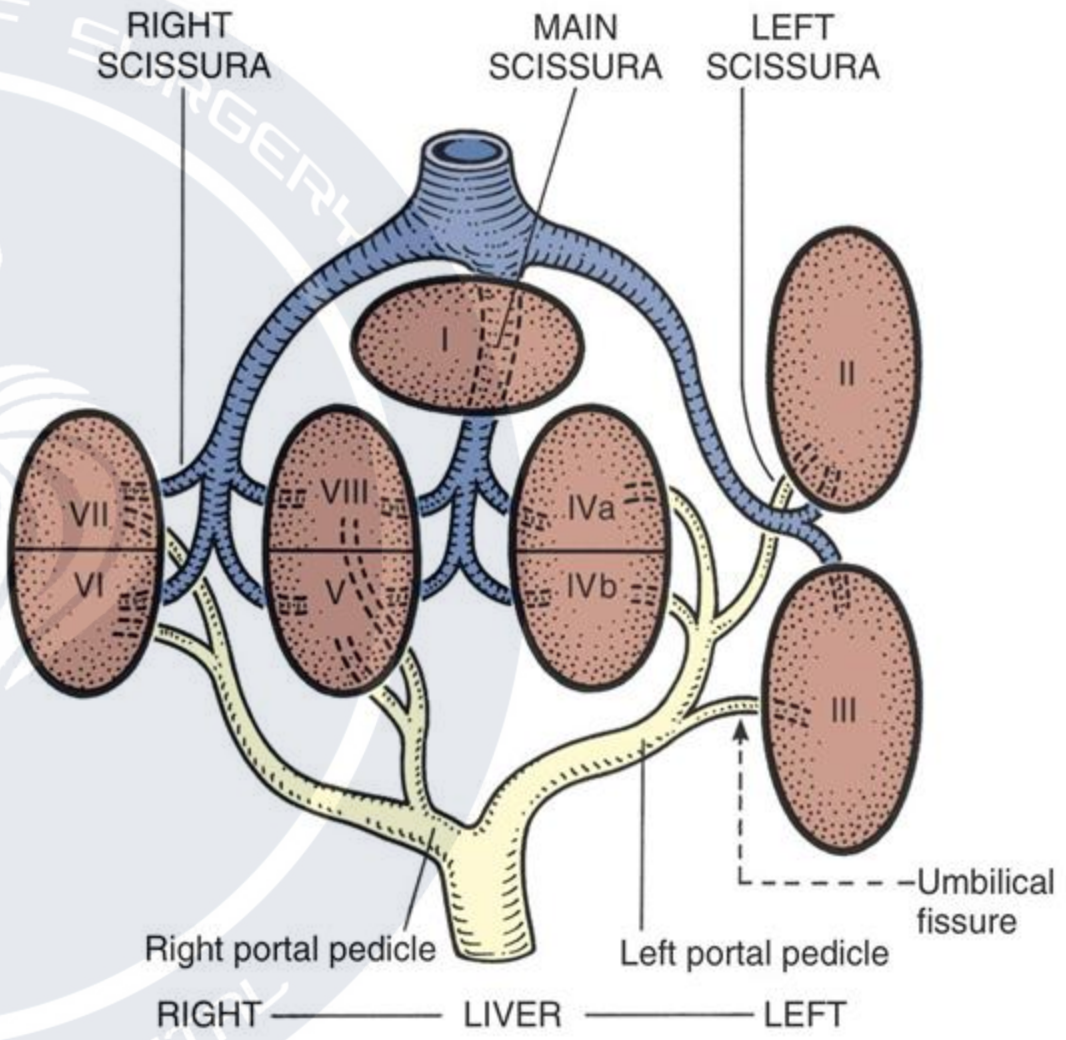
## Hemilivers : Cantlie's line

- Direction from the gallbladder fossa to the left side of the vena cava.

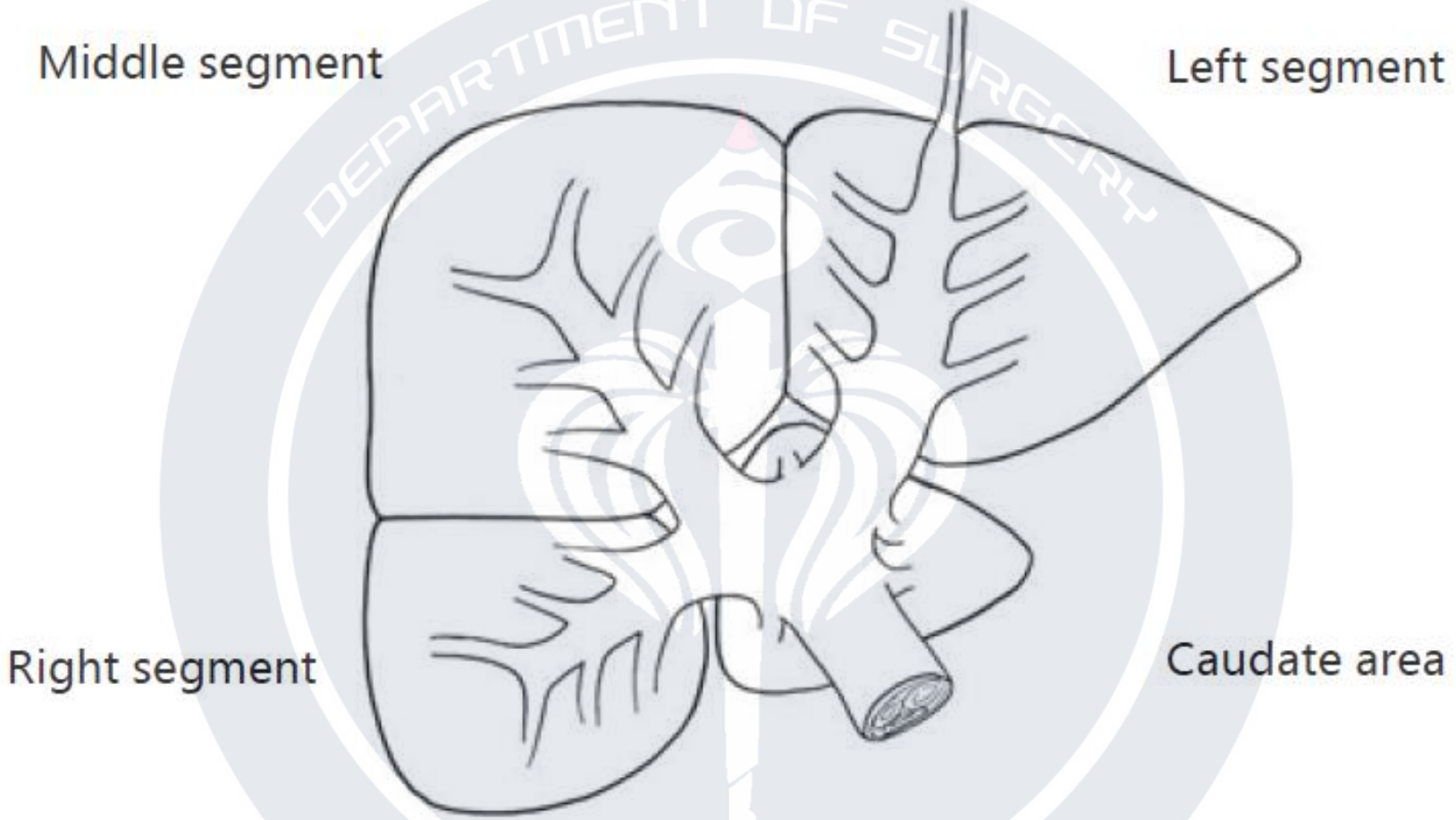
## 4 sectors : three main hepatic vein

- **Right scissura : Rt anterior(V,VIII) , Rt posterior(VI,VII)**
- **Left scissura : Lt medial(IV),Lt lateral(II,III)**

## 8 segments (Couinaud's segment): Base on portal pedicle

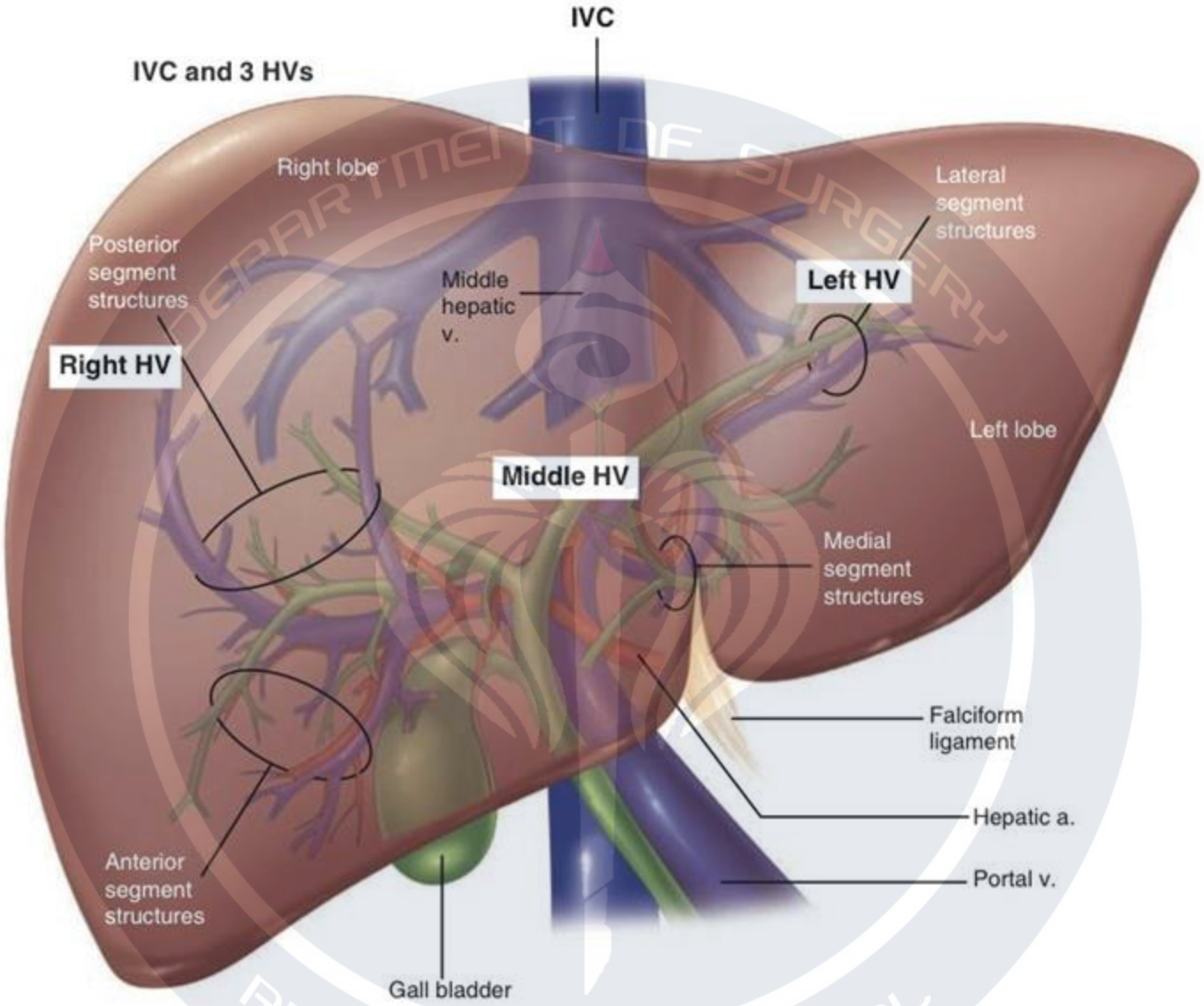



Sakamoto, Yoshihiro & Kokudo, Norihiro & Kawaguchi, Yoshikuni & Akita, Keiichi. (2016). Clinical Anatomy of the Liver: Review of the 19th Meeting of the Japanese Research Society of Clinical Anatomy. Liver Cancer. 6. 146-160. 10.1159/000449490.




# Takasaki's concept

Sakamoto, Yoshihiro & Kokudo, Norihiro & Kawaguchi, Yoshikuni & Akita, Keiichi. (2016). Clinical Anatomy of the Liver: Review of the 19th Meeting of the Japanese Research Society of Clinical Anatomy. Liver Cancer. 6. 146-160. 10.1159/000449490.



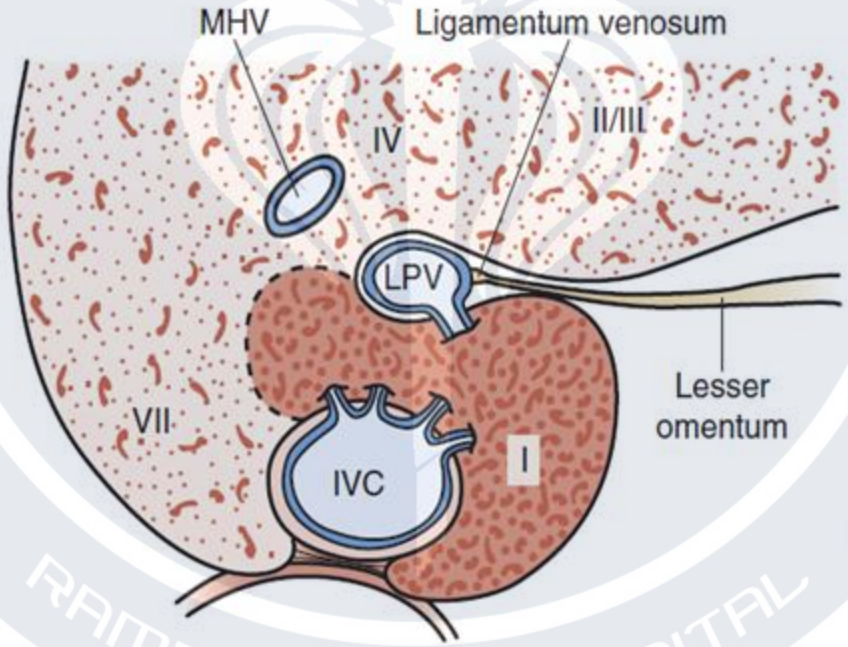

**Each segment (I to VIII) is supplied by a portal triad composed of a branch of the portal vein and hepatic artery and bile duct**

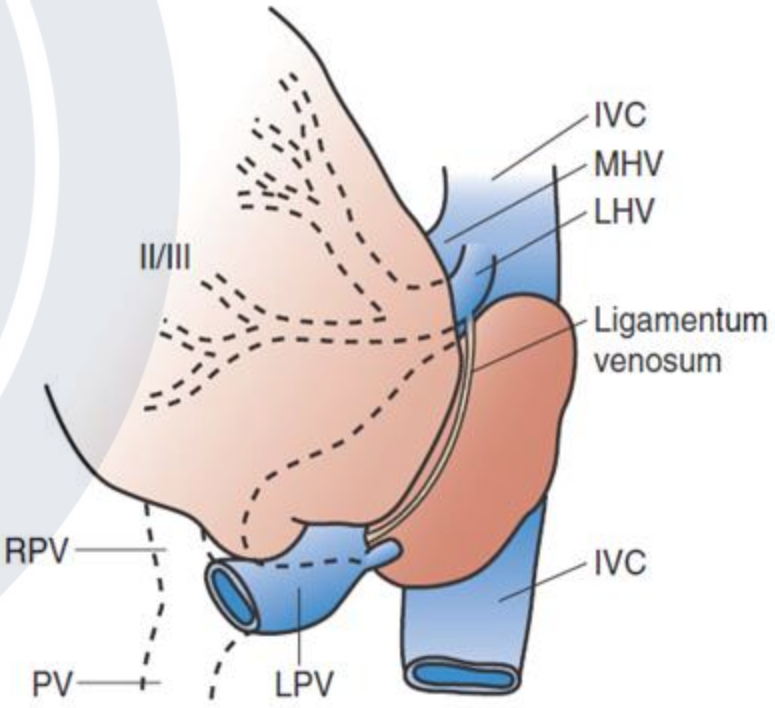
**TABLE 2.1** Brisbane Terminology of Liver Anatomy and Resections

| Anatomic Term | Couinaud Segments | Surgical Resection |
|---|---|---|
| Right hemiliver/ right liver | 5-8 | Right hepatectomy |
| Left hemiliver/left liver | 2-4 | Left hepatectomy |
| Right anterior section | 5, 8 | Right anterior sectionectomy |
| Right posterior section | 6, 7 | Right posterior sectionectomy |
| Left medial section | 4 | Left medial sectionectomy *or* Resection of segment 4 |
| Left lateral section | 2, 3 | Left lateral sectionectomy *or* Bisectionectomy 2, 3 |
| | 4, 5, 6, 7, 8 | Right trisectionectomy *or* Extended right hepatectomy |
| | 2, 3, 4, 5, 8 | Left trisectionectomy *or* Extended left hepatectomy |

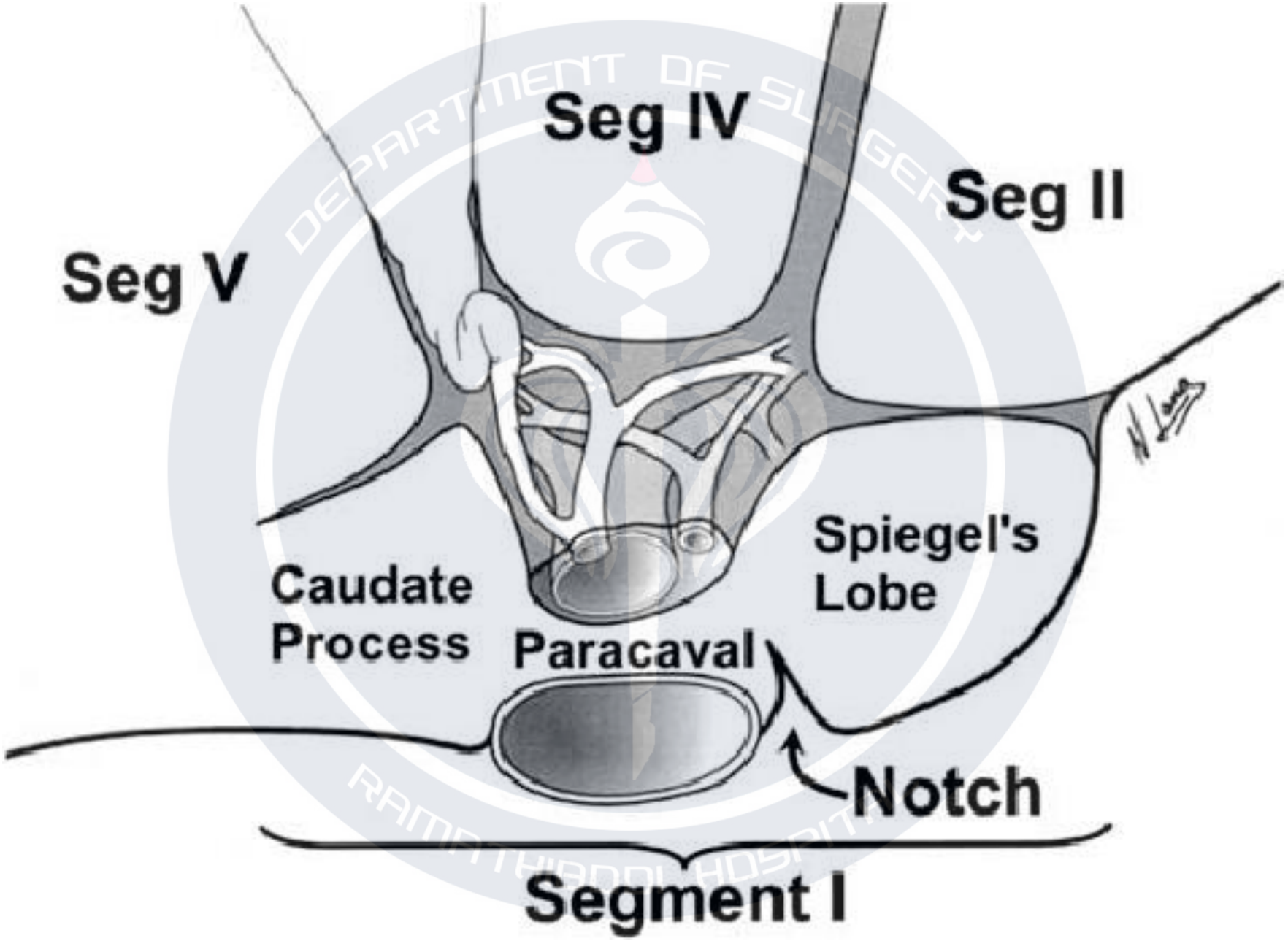
# Caudate lobe anatomy

- Spiegel lobe
- The paracaval portion
- The caudate process




Kogure K, Kuwano H, Yorifuji H, Ishikawa H, Takata K, Makuuchi M. The caudate processus hepatic vein: a boundary hepatic vein between the caudate lobe and the right liver. Ann Surg. 2008 Feb;247(2):288-93. doi: 10.1097/SLA.0b013e31815efd8d. PMID: 18216535.


Seg IV
Seg II
Seg V
Spiegel's
Lobe
Caudate
Process
Paracaval
Notch
Segment I

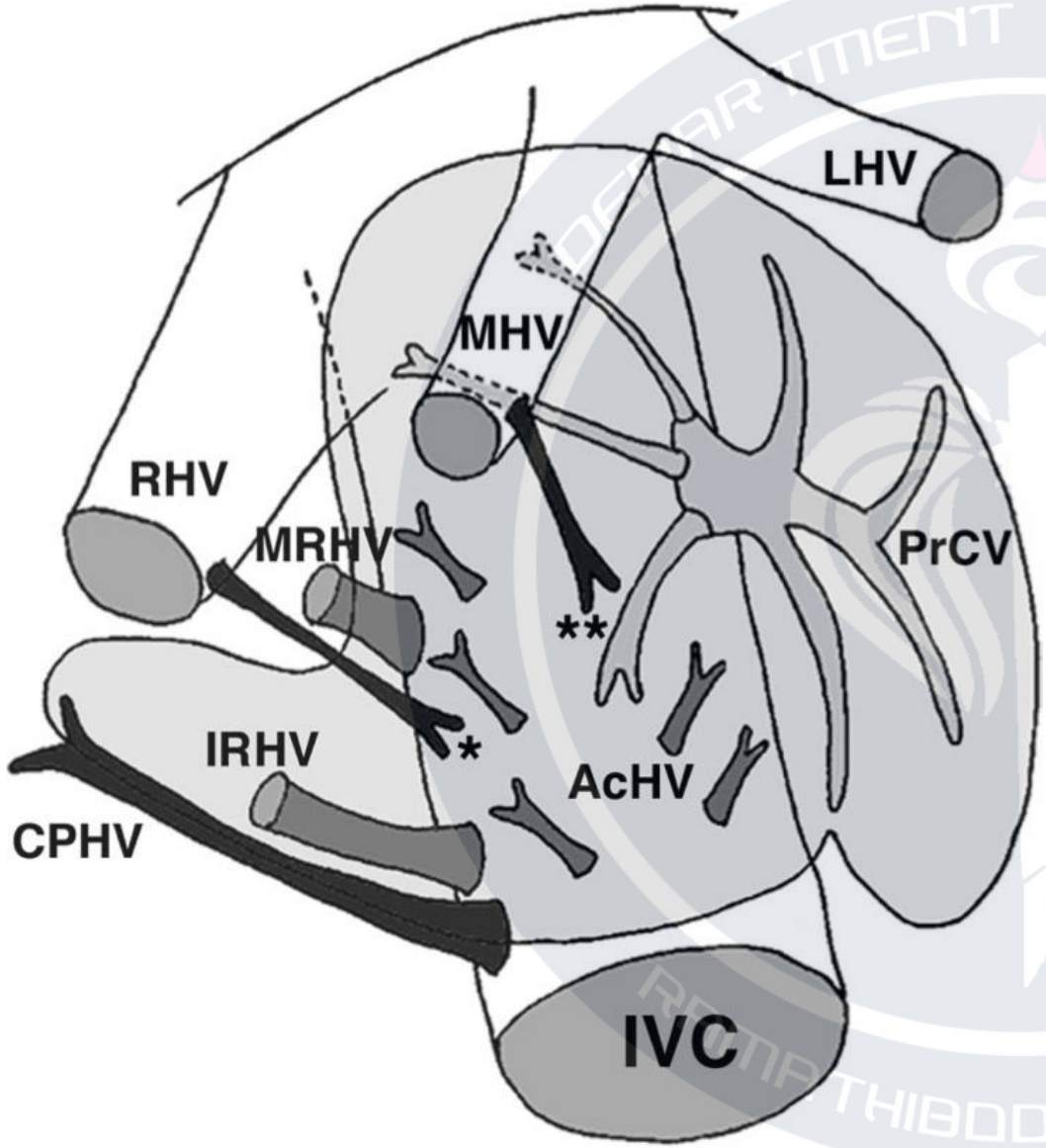
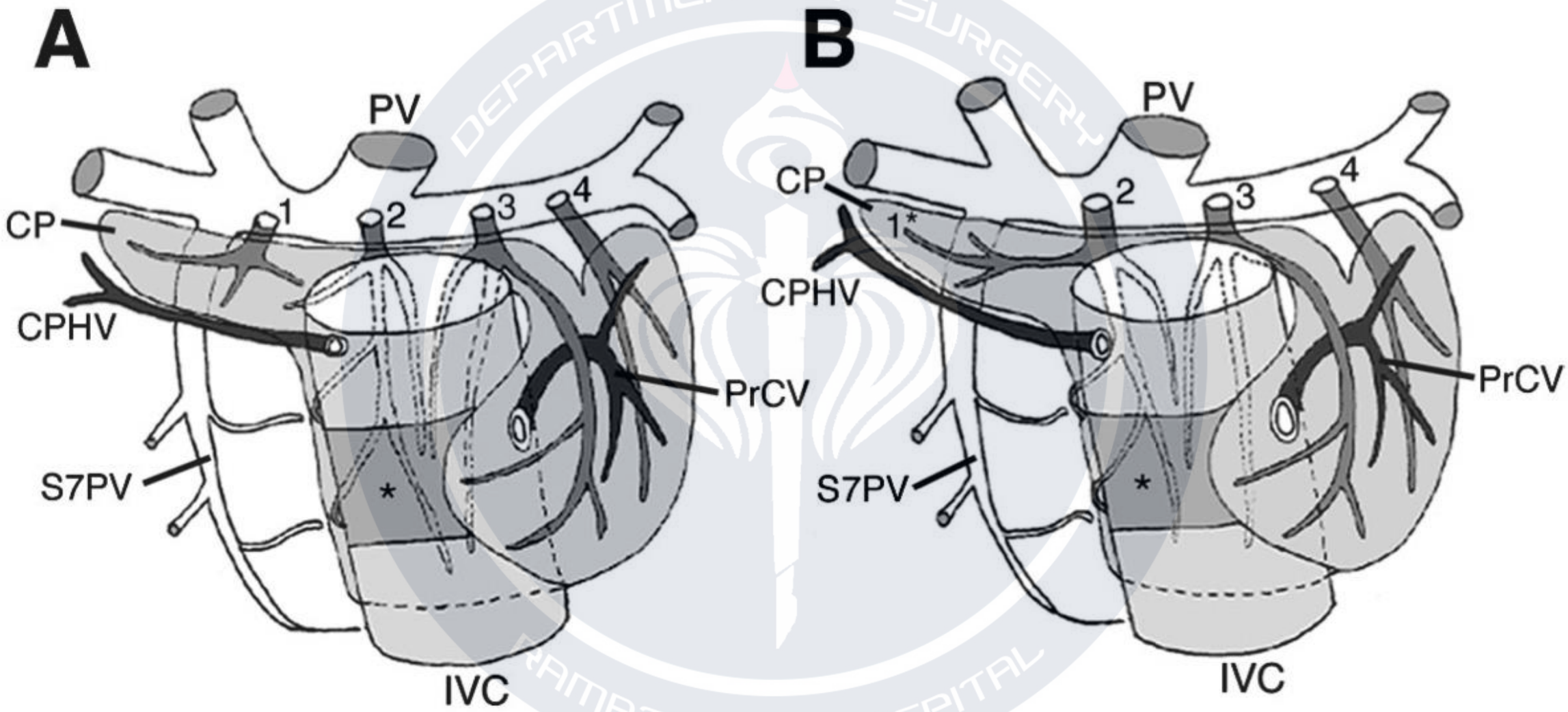



**FIGURE 3.** Hepatic venous system of the caudate lobe. This consists of the plural hepatic veins, the proper hepatic vein, accessory hepatic veins (ie, short hepatic vein), caudate processus hepatic vein, and sometimes of the tributaries of the right and middle hepatic veins. IVC, inferior vena cava; RHV, right hepatic vein; MHV, middle hepatic vein; LHV, left hepatic vein; CPHV, caudate processus hepatic vein; MRHV, middle right hepatic vein; SRHV, superior right hepatic vein; PrCV, proper hepatic vein of the caudate lobe; AcHV, accessory hepatic vein of the caudate lobe; *tributary of the right hepatic vein; **tributary of the middle hepatic vein.

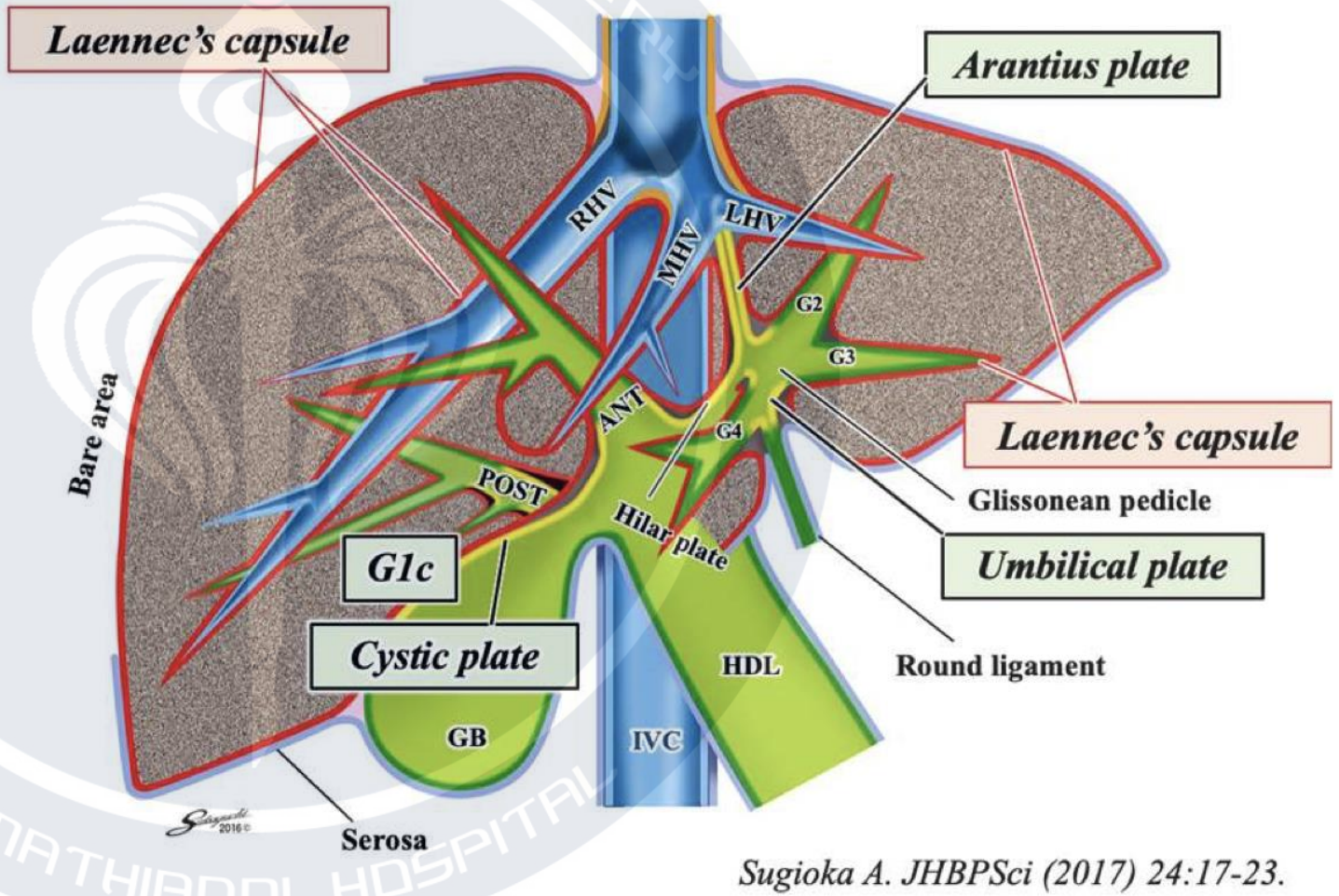
Kogure K, Kuwano H, Yorifuji H, Ishikawa H, Takata K, Makuuchi M. The caudate processus hepatic vein: a boundary hepatic vein between the caudate lobe and the right liver. Ann Surg. 2008 Feb;247(2):288-93. doi: 10.1097/SLA.0b013e31815efd8d. PMID: 18216535.



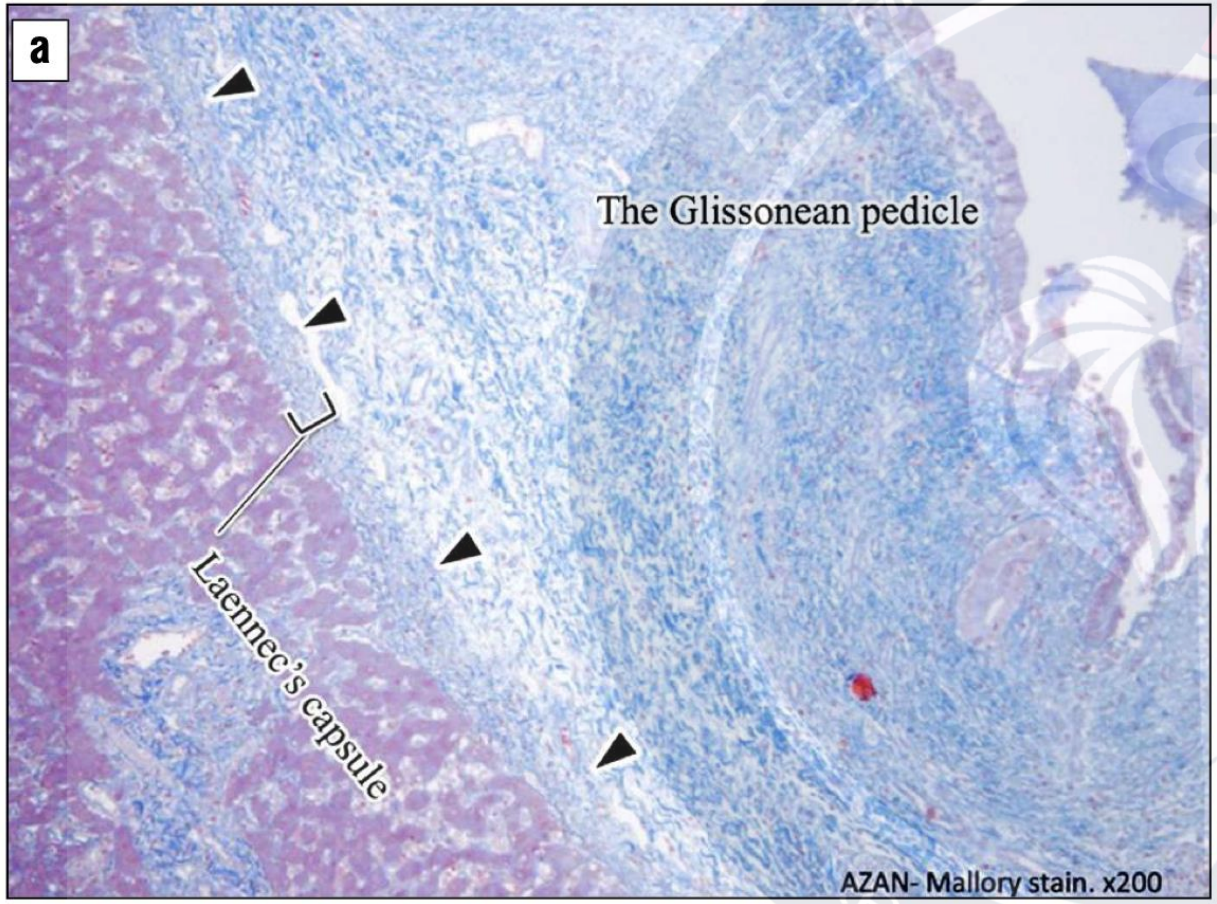

Kogure K, Kuwano H, Yorifuji H, Ishikawa H, Takata K, Makuuchi M. The caudate processus hepatic vein: a boundary hepatic vein between the caudate lobe and the right liver. Ann Surg. 2008 Feb;247(2):288-93. doi: 10.1097/SLA.0b013e31815efd8d. PMID: 18216535.

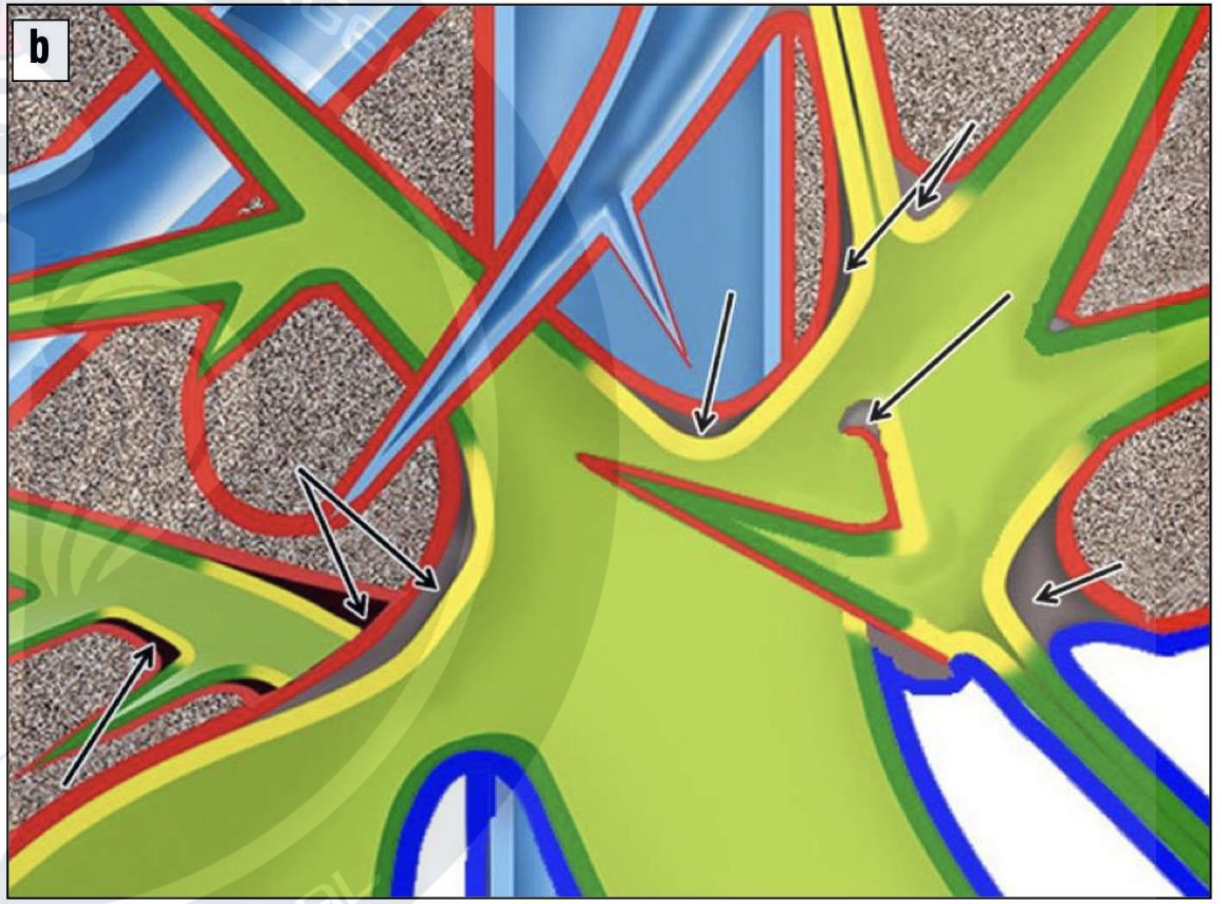
# Laennec’s capsule

- Discover by RTH Laennec, 1802
- Proper membrane covers not only the entire surface of the liver parenchyma including the bare area but also the intrahepatic liver parenchyma surrounding the Glissonean pedicles and the hepatic veins.



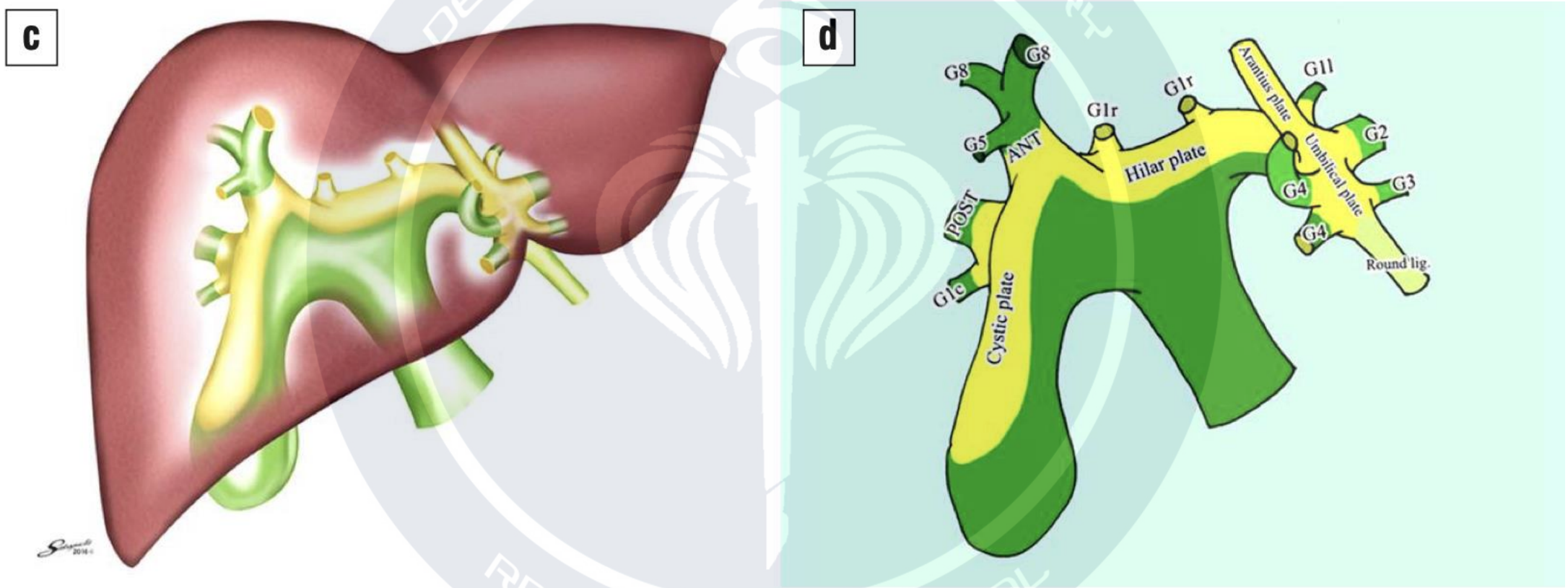

Sugioka A, Kato Y, Tanahasi Y et al. Standardization of Anatomic Liver Resection Based on Laennec's Capsule, Surgery, Gastroenterology and Oncology, 25 (2), 2020




Sugioka A, Kato Y, Tanahasi Y et al. Standardization of Anatomic Liver Resection Based on Laennec's Capsule, Surgery, Gastroenterology and Oncology, 25 (2), 2020

# The plate system

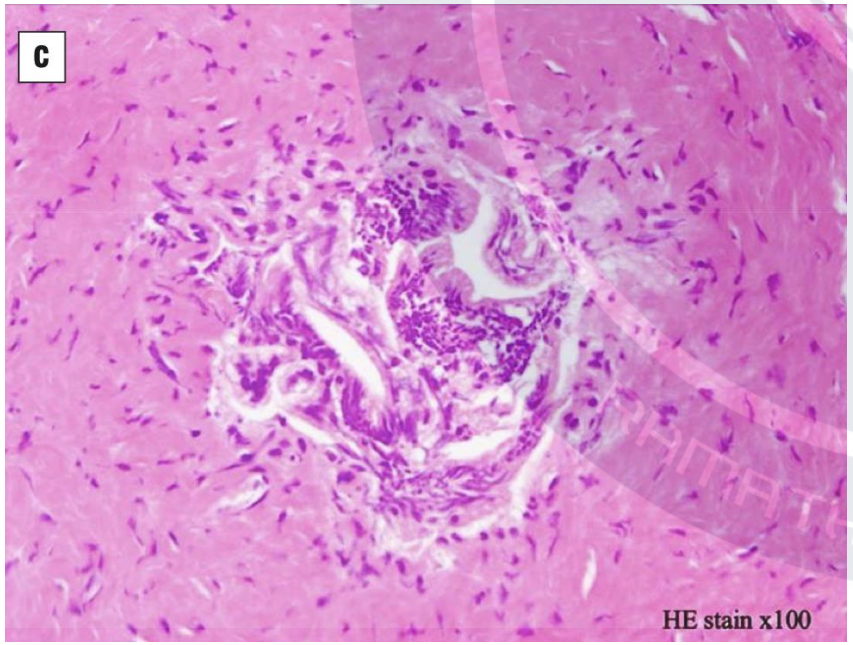


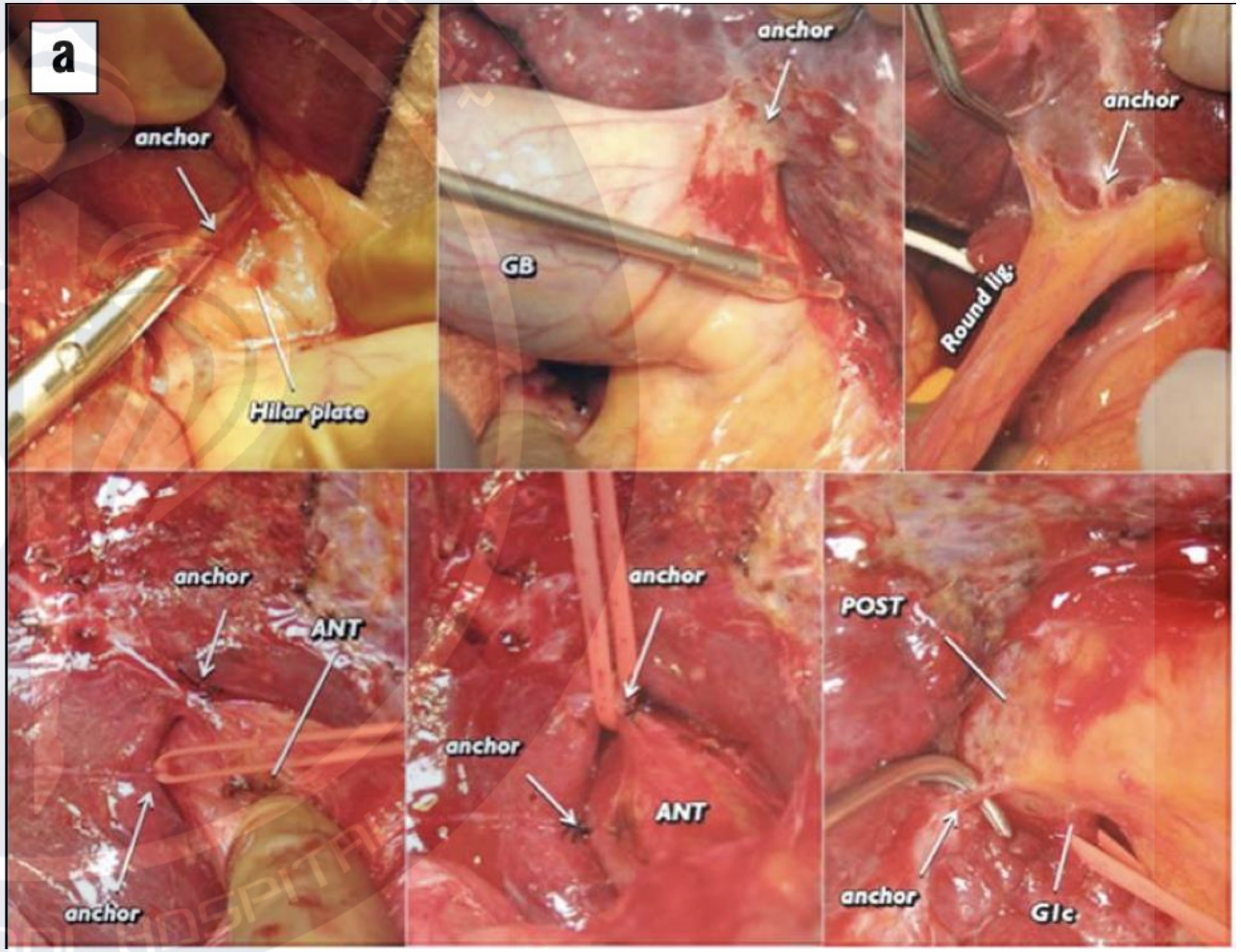

Liver and Biliary anatomy: Ativitch Asavachaisuvikom,MD.

Sugioka A, Kato Y, Tanahasi Y et al. Standardization of Anatomic Liver Resection Based on Laennec's Capsule, Surgery, Gastroenterology and Oncology, 25 (2), 2020

# Anchors

- Cord-like structure, connecting between Glissonean pedicle and Laennec's capsule
- Sometimes the anchors contain small bile duct

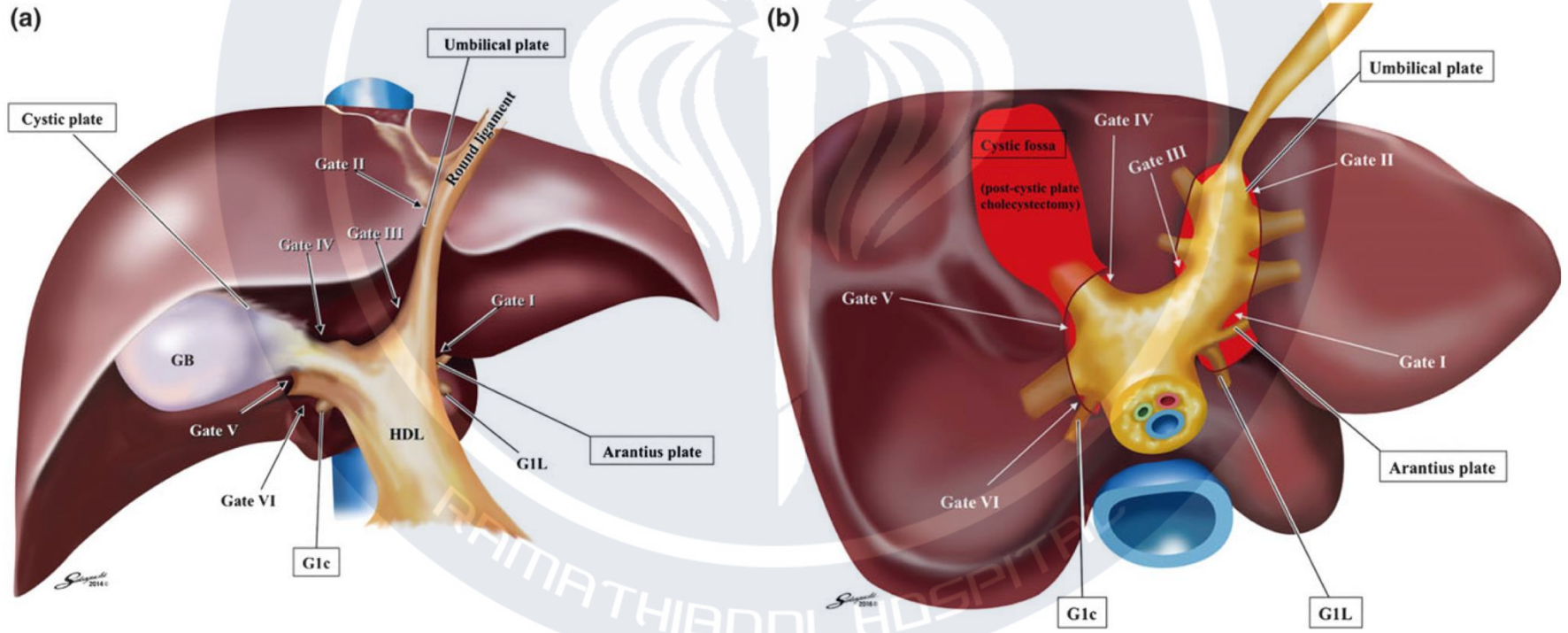



Sugioka A, Kato Y, Tanahashi Y. Systematic extrahepatic Glissonean pedicle isolation for anatomical liver resection based on Laennec's capsule: proposal of a novel comprehensive surgical anatomy of the liver. J Hepatobiliary Pancreat Sci. 2017 Jan;24(1):17-23. doi: 10.1002/jhbp.410. PMID: 28156078; PMCID: PMC5299460.

# Extrahepatic Glissonean isolation

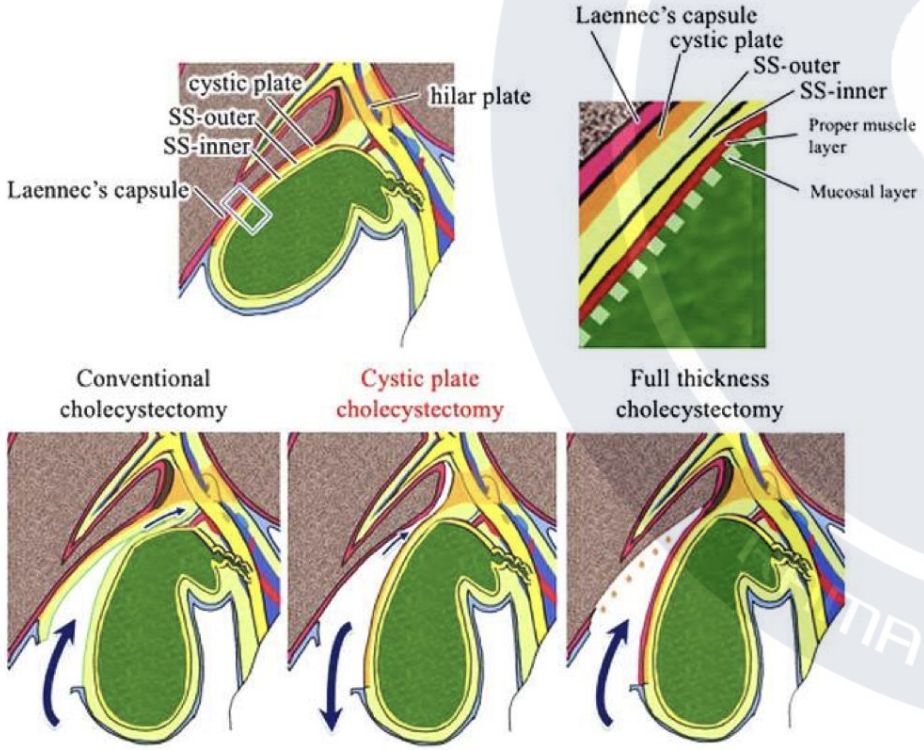
- Entry point : Arantius plate, umbilical plate, cystic plate and Glissonean pedicle(Caudate process; G1c)

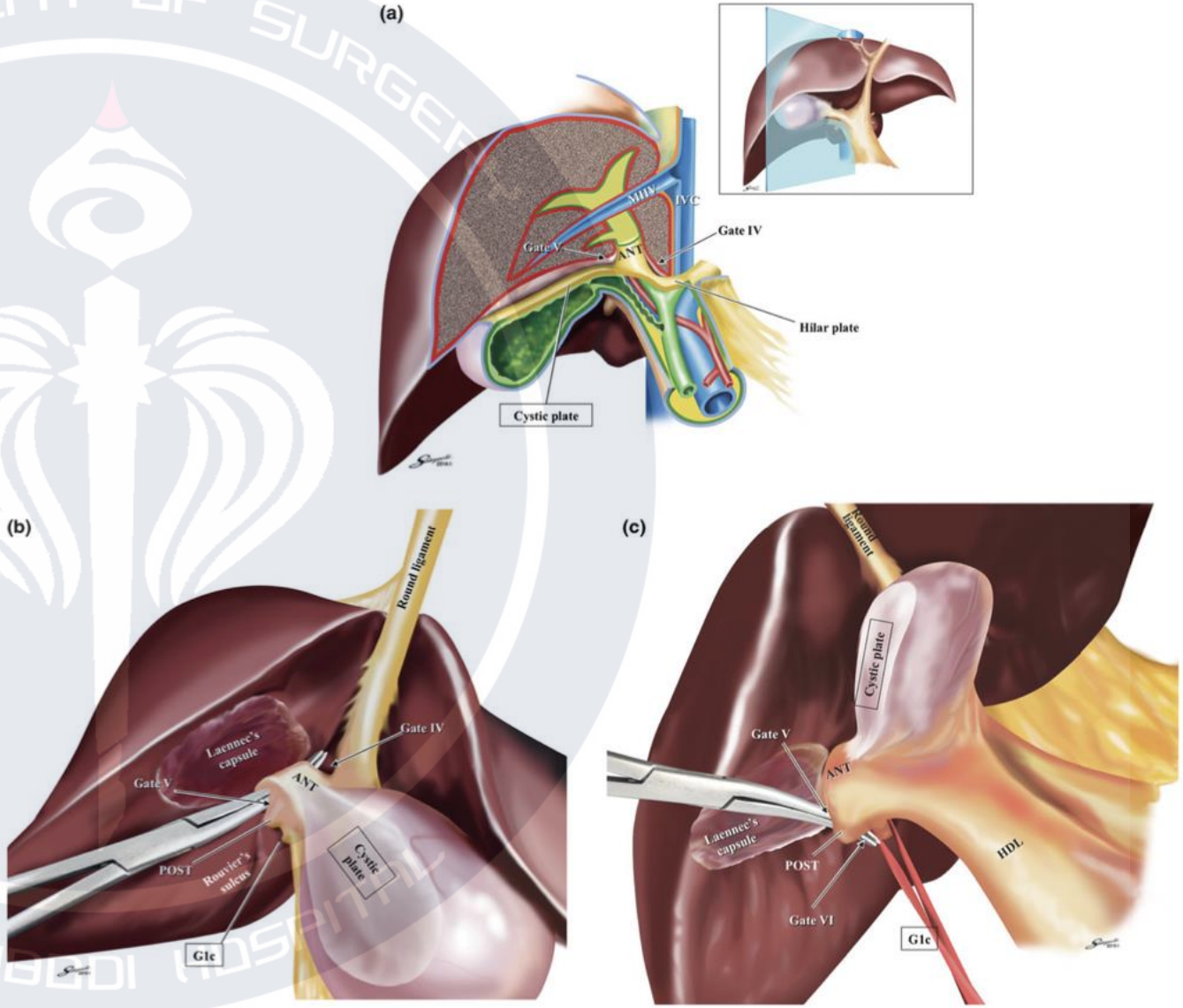



Sugioka A, Kato Y, Tanahashi Y. Systematic extrahepatic Glissonean pedicle isolation for anatomical liver resection based on Laennec's capsule: proposal of a novel comprehensive surgical anatomy of the liver. J Hepatobiliary Pancreat Sci. 2017 Jan;24(1):17-23. doi: 10.1002/jhbp.410. PMID: 28156078; PMCID: PMC5299460.

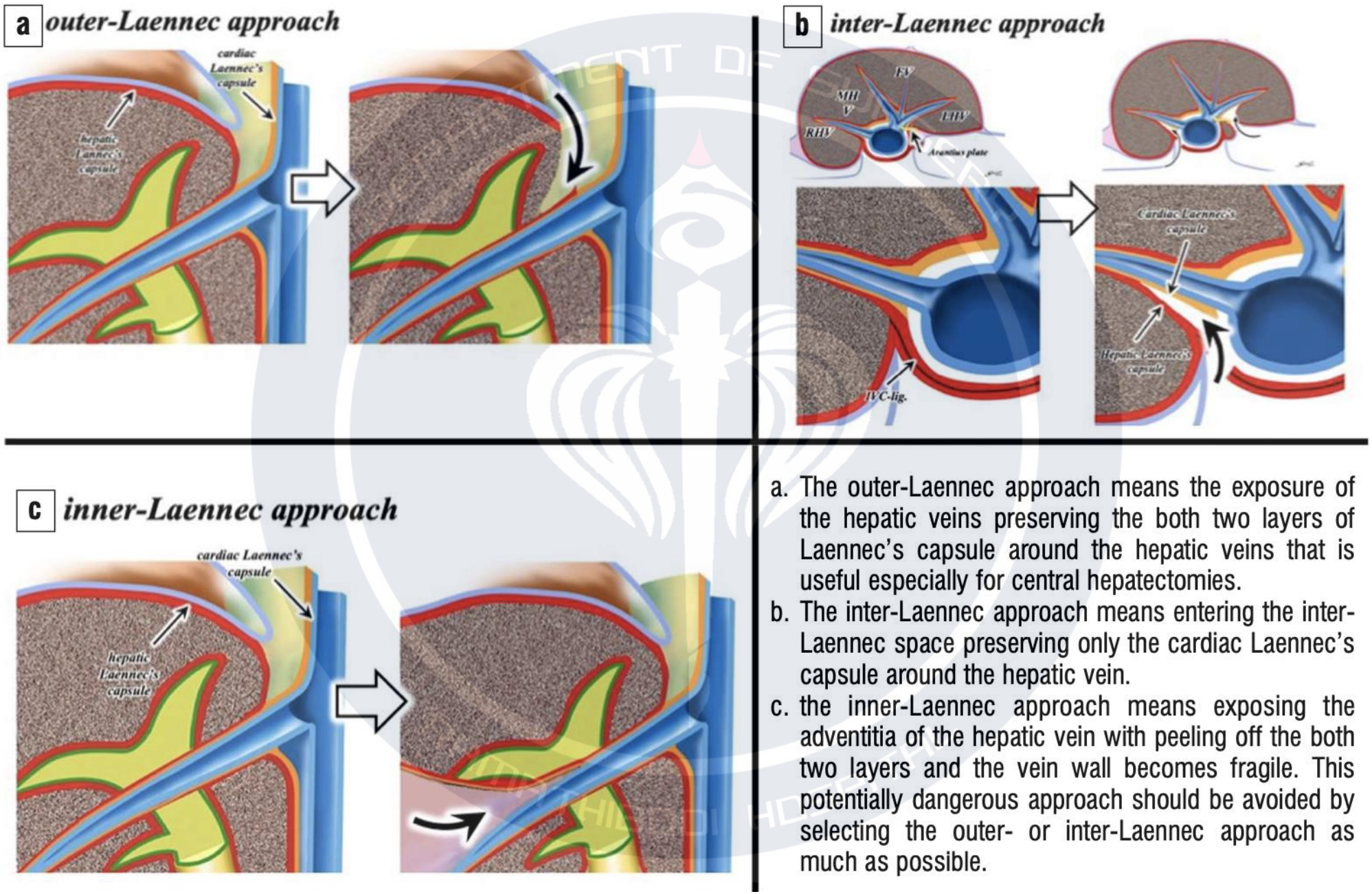
# Cystic plate cholecystectomy

Developed for standardization of the anterior glissonean pedicle




Sugioka A, Kato Y, Tanahasi Y et al. Standardization of Anatomic Liver Resection Based on Laennec's Capsule, Surgery, Gastroenterology and Oncology, 25 (2), 2020

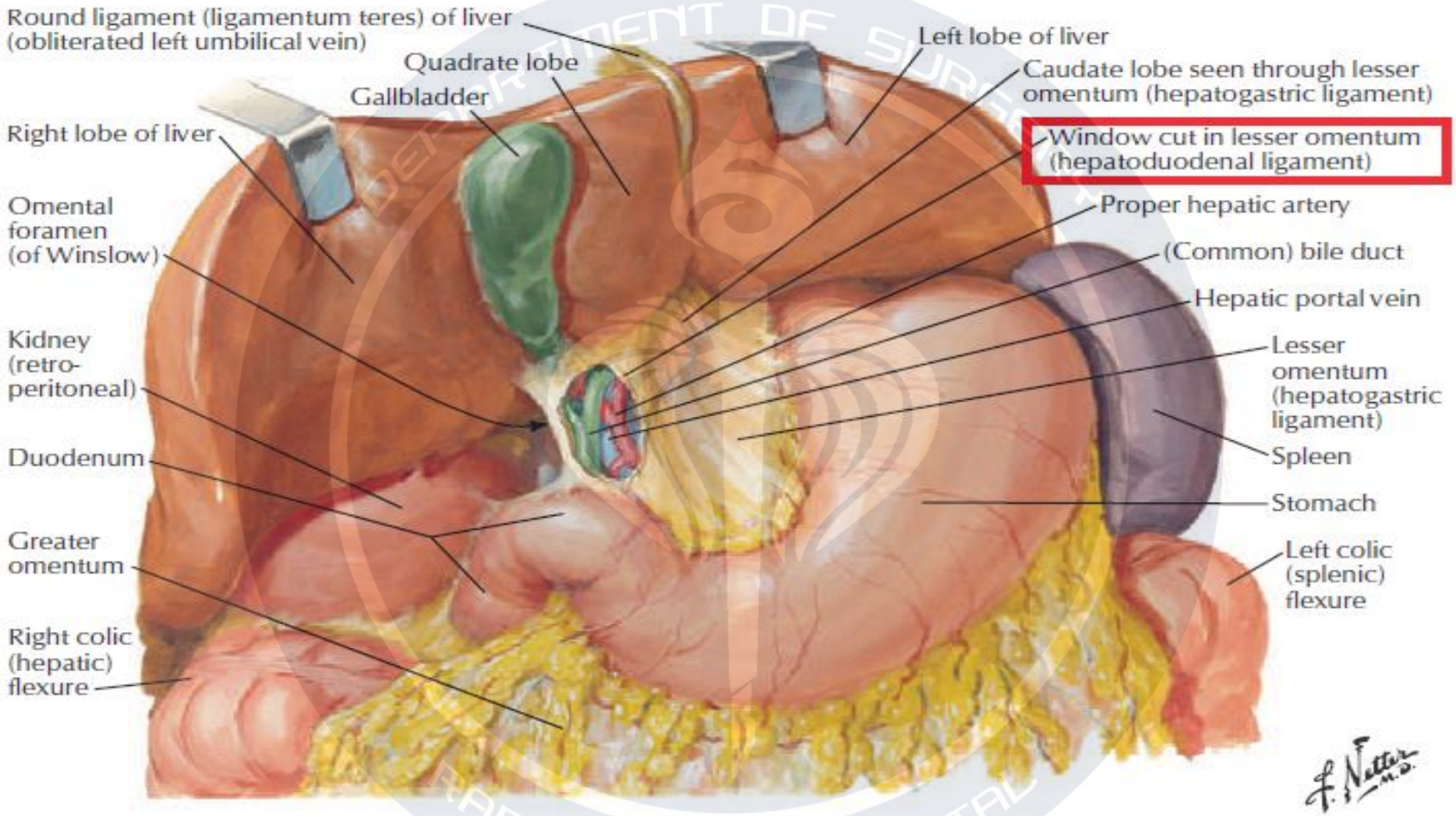



a. The outer-Laennec approach means the exposure of the hepatic veins preserving the both two layers of Laennec's capsule around the hepatic veins that is useful especially for central hepatectomies.
b. The inter-Laennec approach means entering the inter-Laennec space preserving only the cardiac Laennec's capsule around the hepatic vein.
c. the inner-Laennec approach means exposing the adventitia of the hepatic vein with peeling off the both two layers and the vein wall becomes fragile. This potentially dangerous approach should be avoided by selecting the outer- or inter-Laennec approach as much as possible.

# Portal pedicles, hepatic vein and variation

- Portal pedicle
  - Portal vein → Loose connective tissue sheath
  - Hepatic artery → Fibrous tissue
  - Bile duct → Fibrous tissue

- Intrahepatic part → Glisson capsule
- Extrahepatic part → Hepatoduodenal ligament




HEPATODUODENAL LIGAMENT “ PORTAL HEPATIS”- CBD , HEPATIC ARTERY , PORTAL VEIN

allows complete vascular inflow control to the liver when the hepatoduodenal ligament is clamped using the Pringle maneuver.

# BLOOD SUPPLY

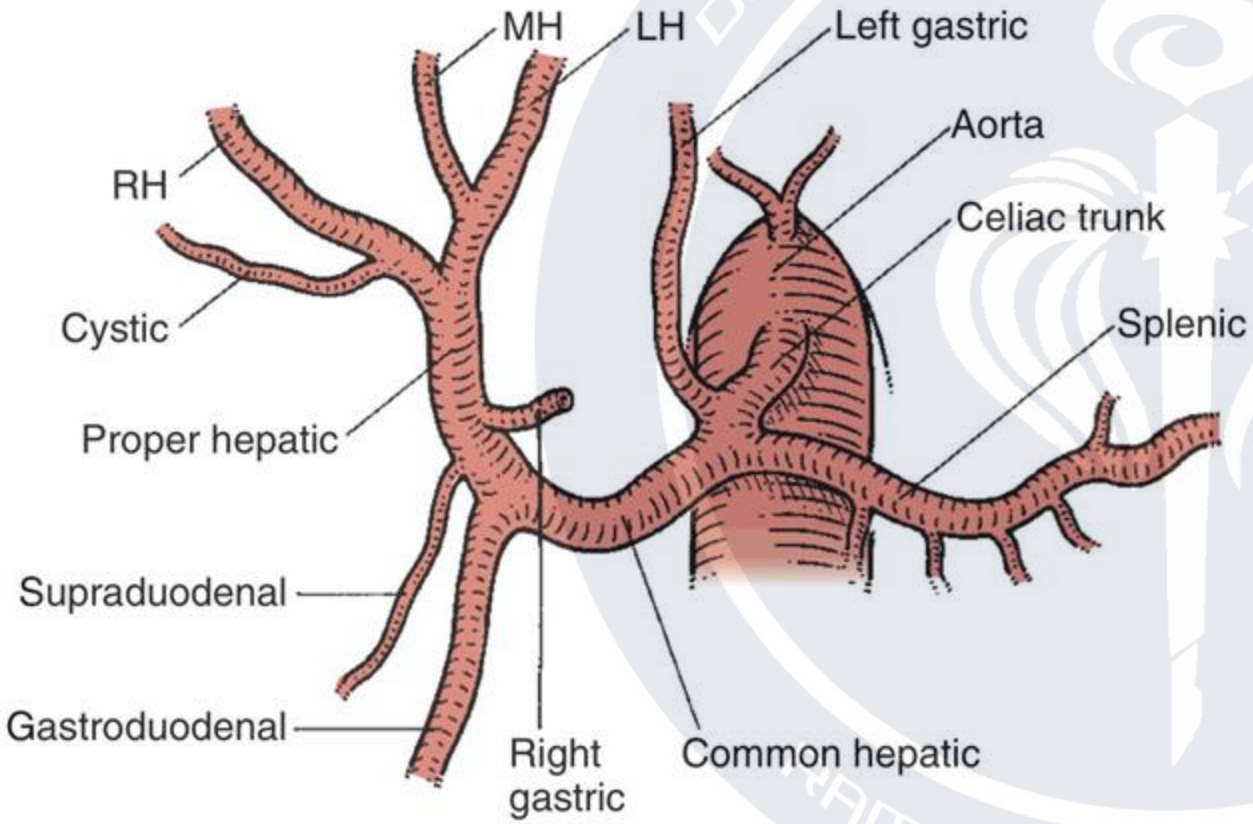
## INFLOW

- Hepatic artery (25 %)
- Portal vein (75%)

## OUTFLOW

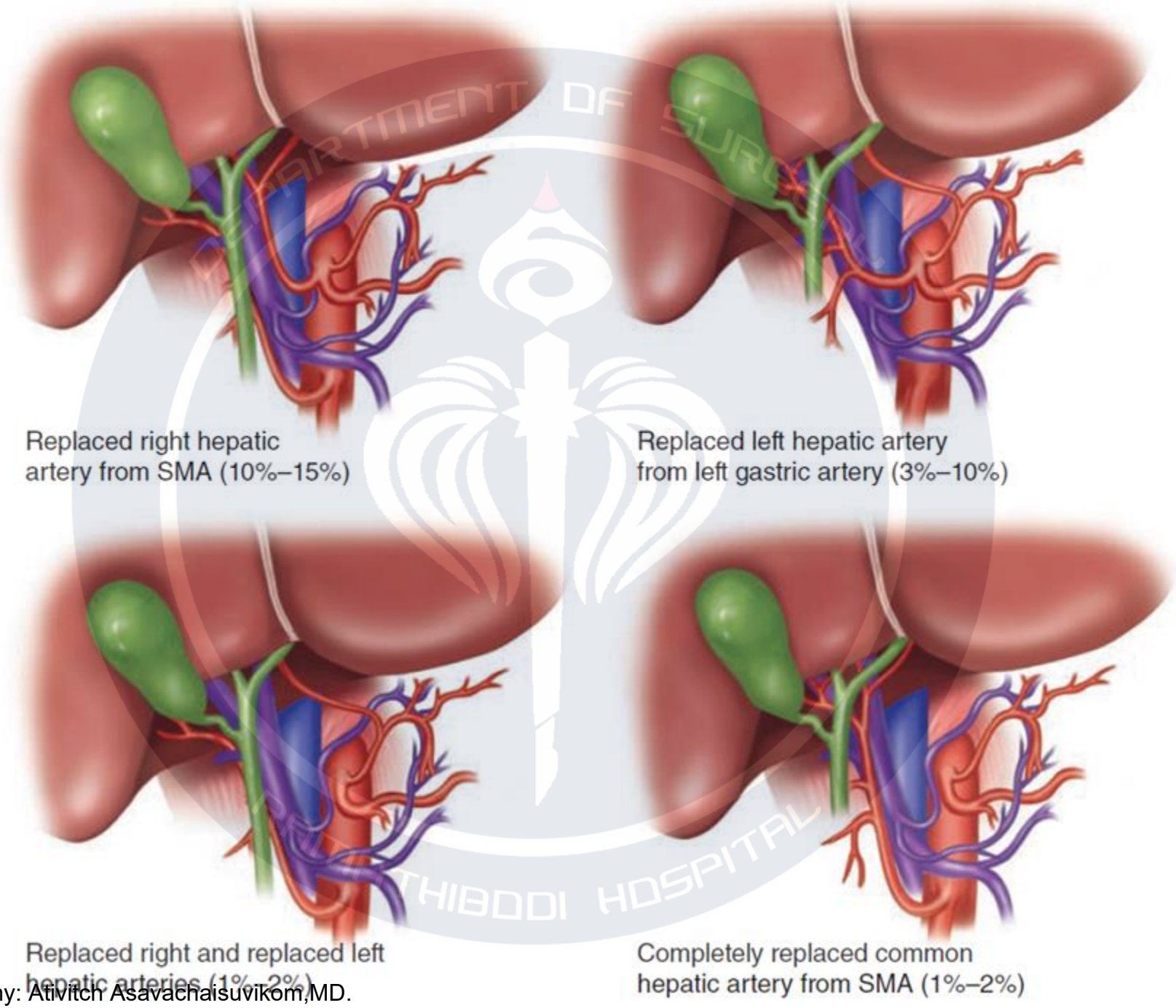
- Hepatic vein

# HEPATIC ARTERY



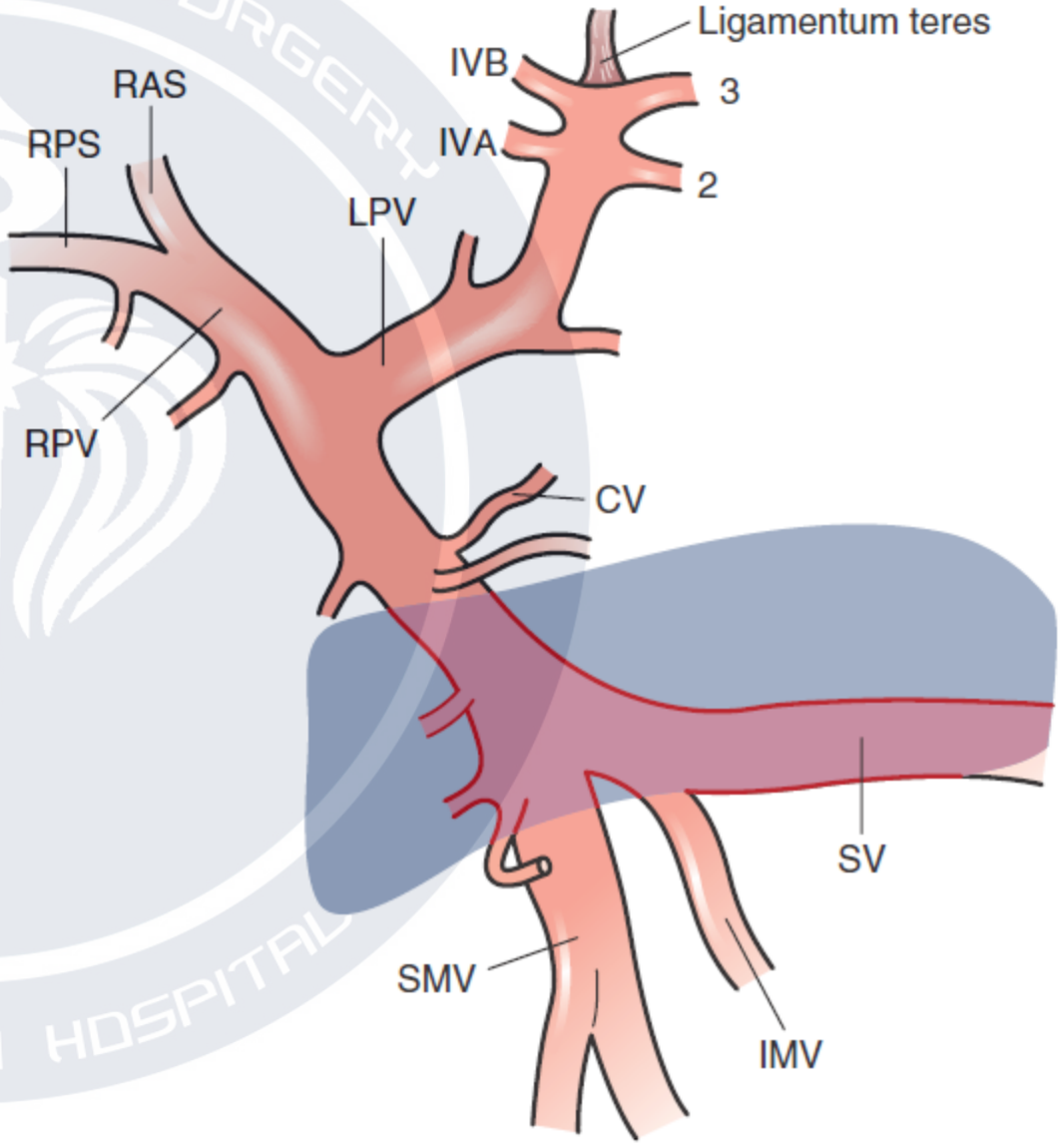

Classic arterial anatomy

75 %


Replaced right hepatic artery from SMA (10%–15%)
Replaced left hepatic artery from left gastric artery (3%–10%)
Replaced right and replaced left hepatic arteries (1%–2%)
Completely replaced common hepatic artery from SMA (1%–2%)

# PORTAL VEIN

- Confluence of the splenic vein and SMV
- Drainage from stomach , pancreas , spleen , small intestine , colon
- At hilus of liver dividing into left and right branches
- Right portal vein : Shorter in length before entry the liver , consists of 2 branch : Posterior and Anterior
- Left portal vein entry into umbilical fissure :supply segment II-IV



# PORTAL VEIN

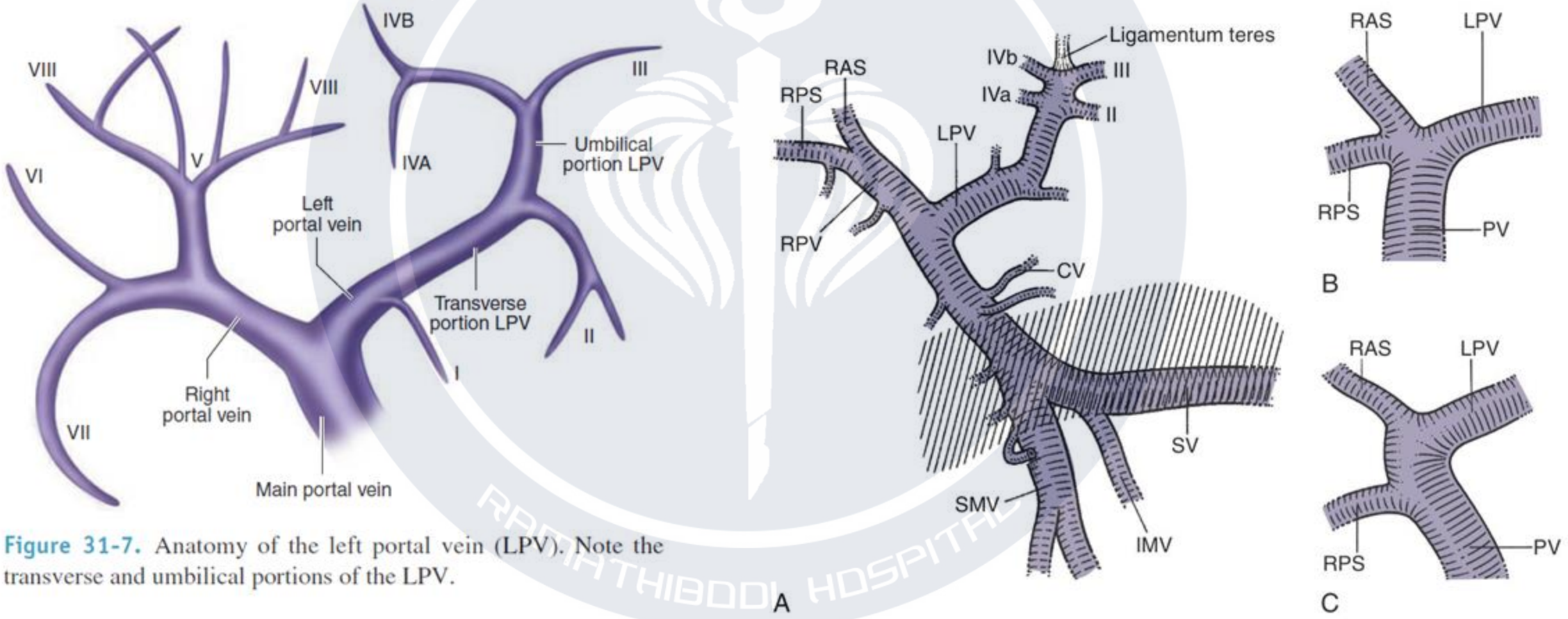
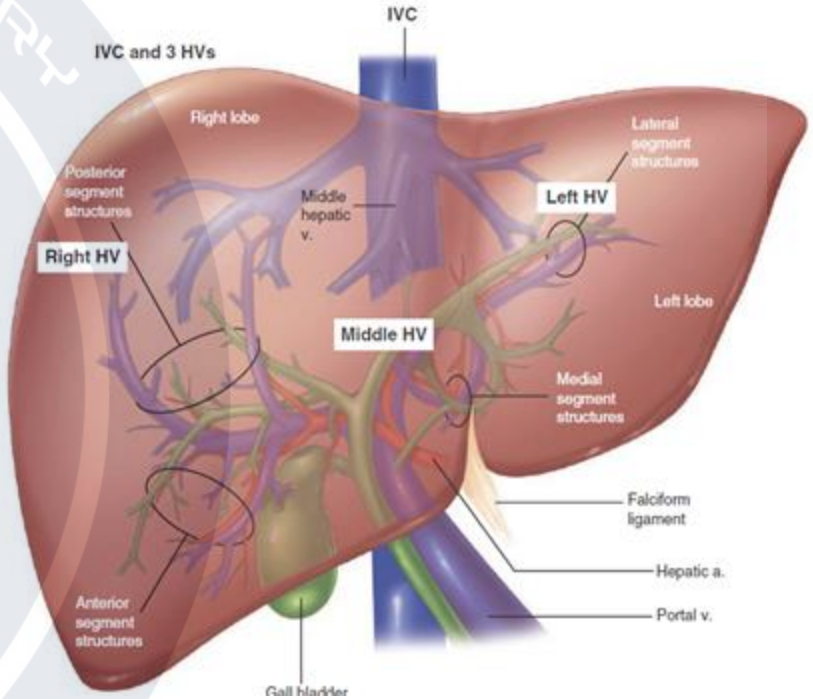
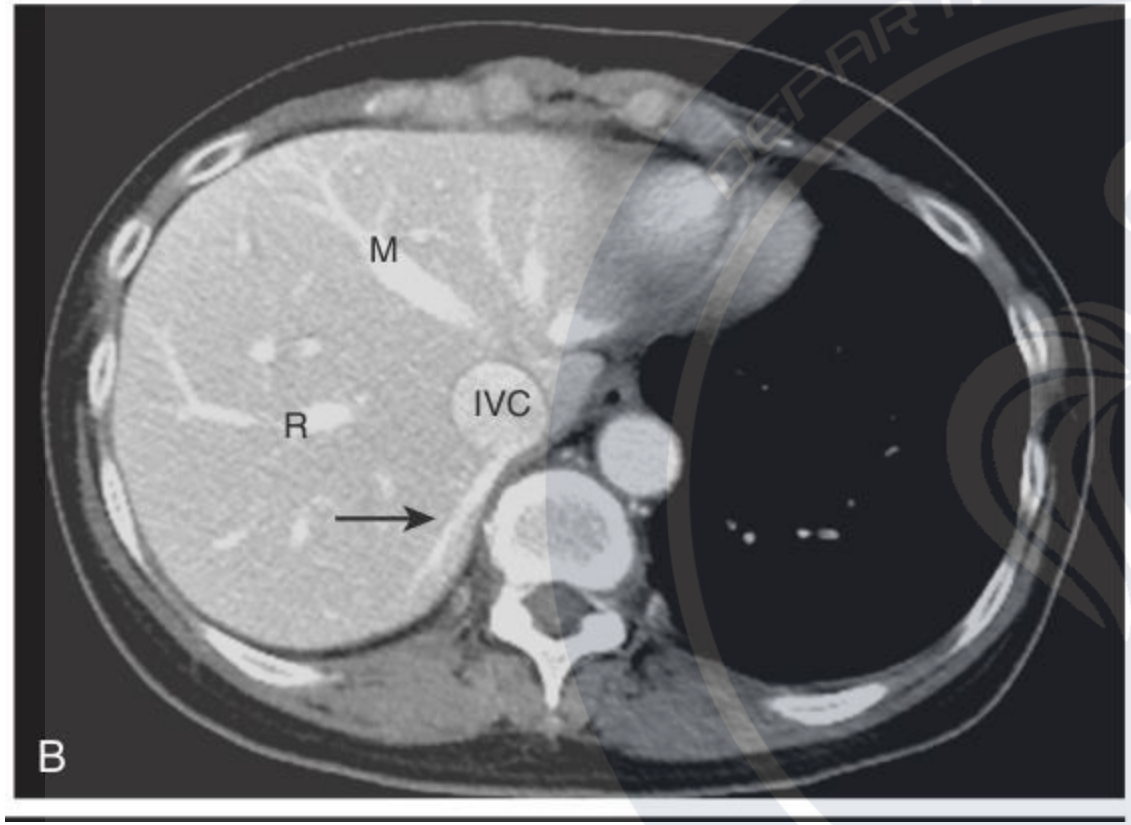


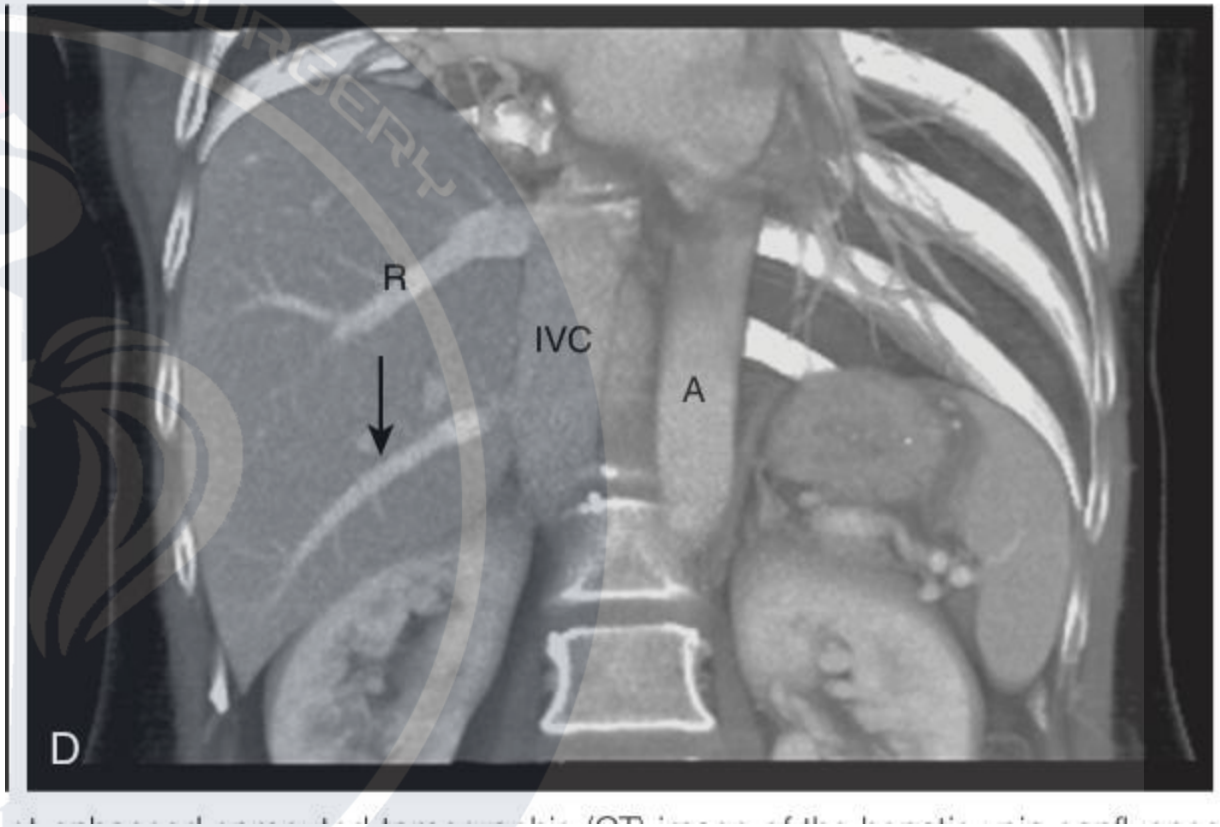

**Figure 31-7.** Anatomy of the left portal vein (LPV). Note the transverse and umbilical portions of the LPV.

# HEPATIC VEIN

- Drain blood to IVC
- Hepatic vein 3 branch
  - 1. RHV drain Rt lobe ( Segment 5,6,7,8)
  - 2. LHV drain Lt lobe ( Segment 2,3 )
  - 3. Middle HV drain Rt anterior sector (5,8) and Lt medial sector (4)
- 95 % middle and left HV drain into a common trunk before entering IVC
- Caudate lobe drain direct to IVC
- There is an inferior accessory right hepatic vein in 15-20% of case -> run in the hepatic caval ligament





# NEURAL INNERVATION AND LYMPHATIC DRAINAGE

- The parasympathetic innervation
  - left vagus → gives off the anterior hepatic branch
  - right vagus → gives off the posterior hepatic branch
- The sympathetic innervation
  - greater thoracic splanchnic nerves
  - the celiac ganglia
- A common source of referred pain to the right shoulder and scapula which is stimulated by tumors is the right phrenic nerve that stretch Glisson's capsule or by diaphragmatic irritation

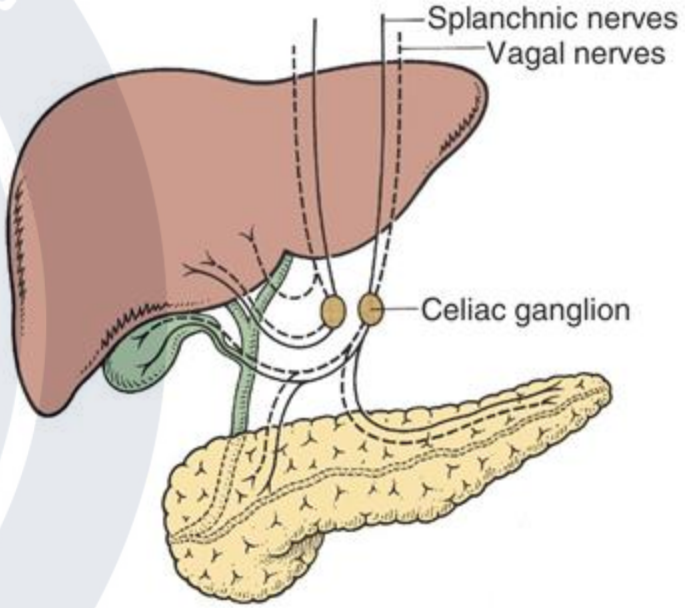
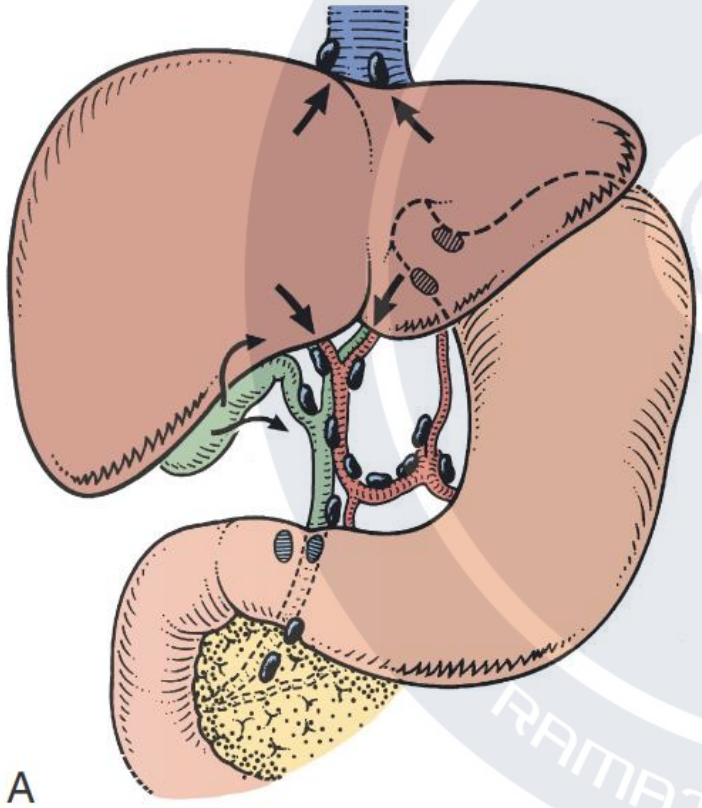
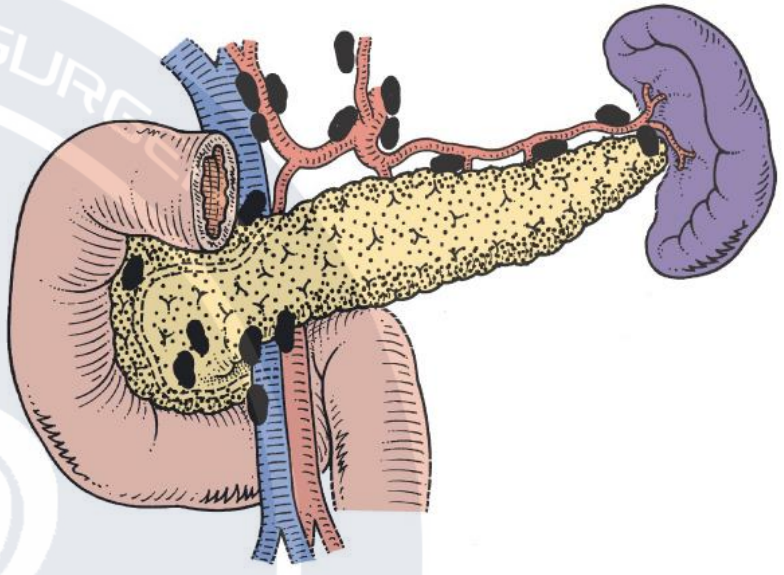



**FIGURE 2.50.** Note the distribution of sympathetic and parasympathetic nerves to the liver and pancreas from the celiac ganglion, mainly in association with major arteries.

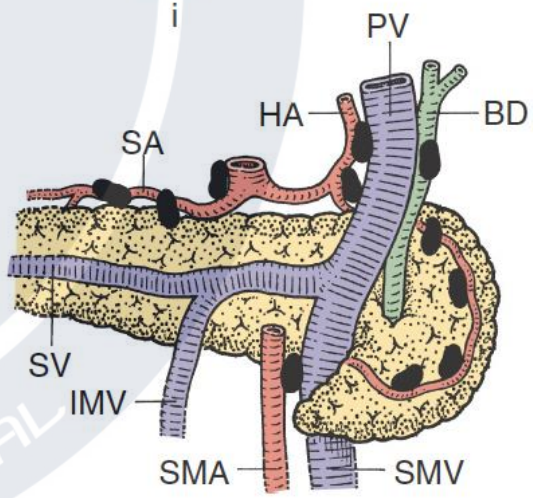
# LYMPHATIC DRAINAGE



A



i

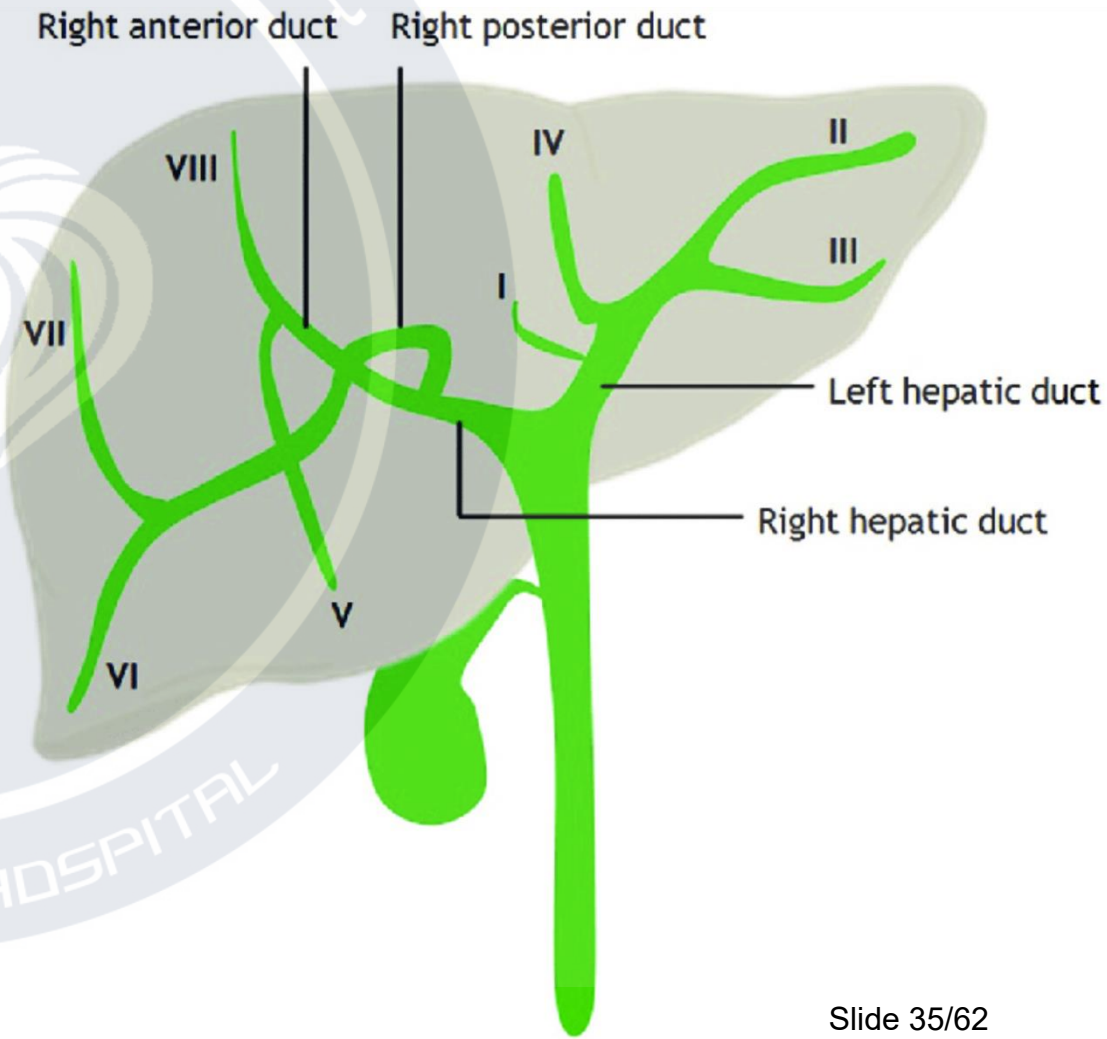



ii

B

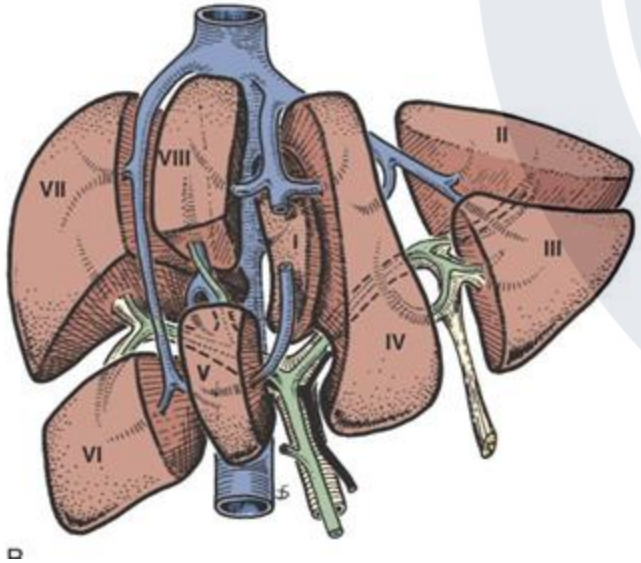
# BILIARY TRACT

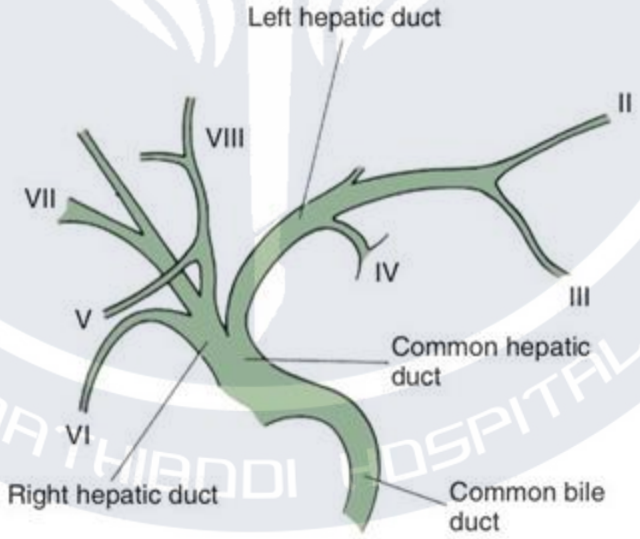
- Intrahepatic duct
- Extrahepatic duct

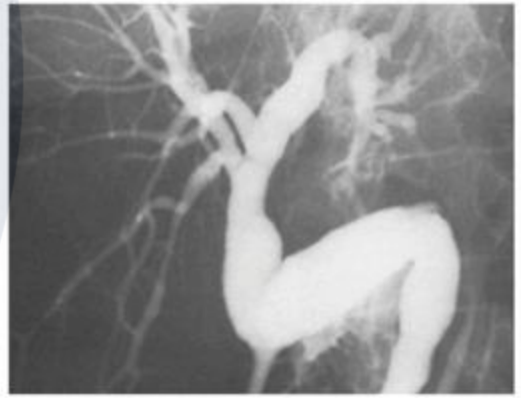


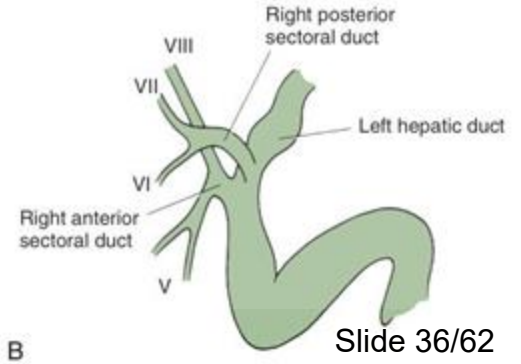
# Intrahepatic Bile Duct Anatomy

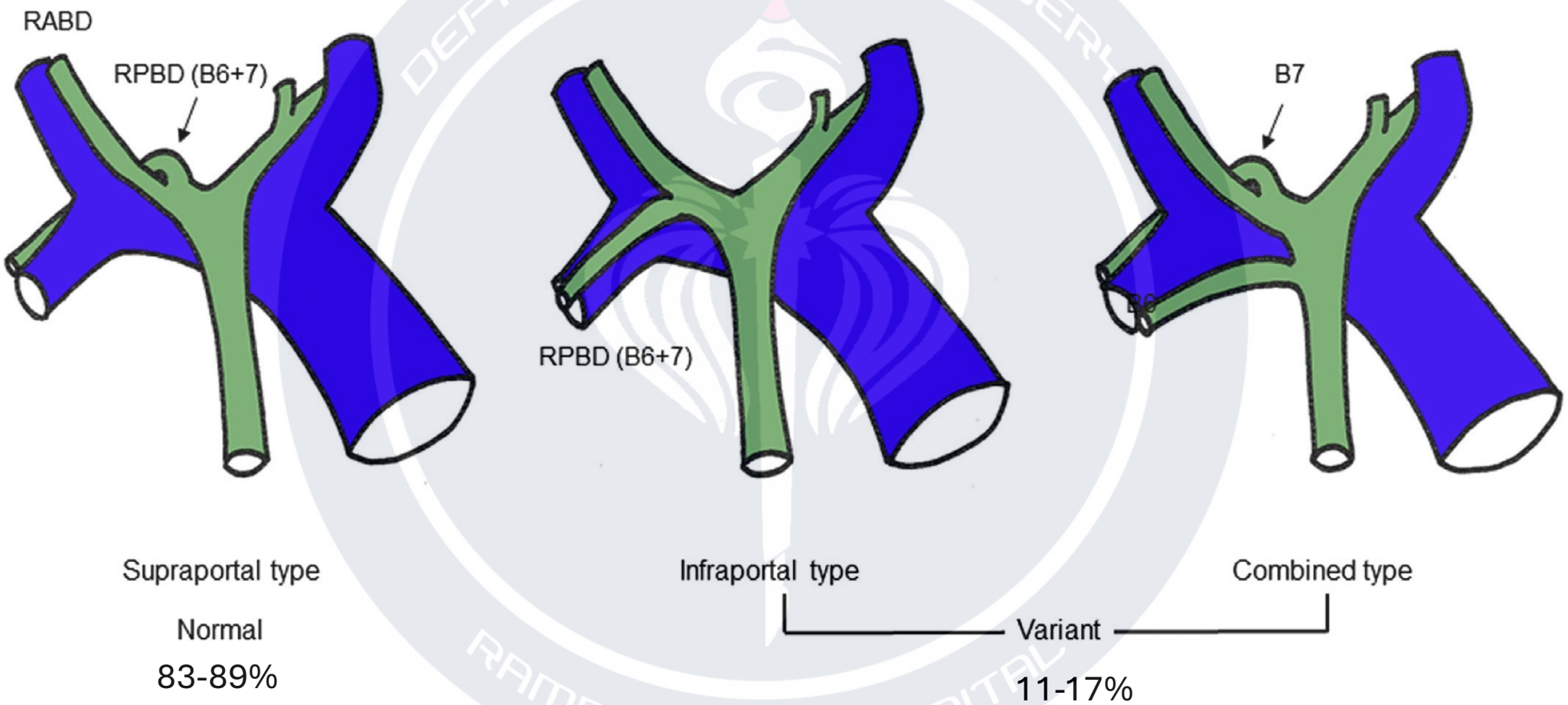
- The left hepatic duct drains the three segments II, III, and IV
- The duct that drains segment III is located slightly behind the left horn of the umbilical recess
- The left hepatic duct traverses beneath the left liver at the base of segment IV








Watanabe N, Ebata T, Yokoyama Y, Igami T, Sugawara G, Mizuno T, Yamaguchi J, Nagino M. Anatomic features of independent right posterior portal vein variants: Implications for left hepatic trisectionectomy. Surgery. 2017 Feb;161(2):347-354. doi: 10.1016/j.surg.2016.08.024. Epub 2016 Sep 28. PMID: 27692569.

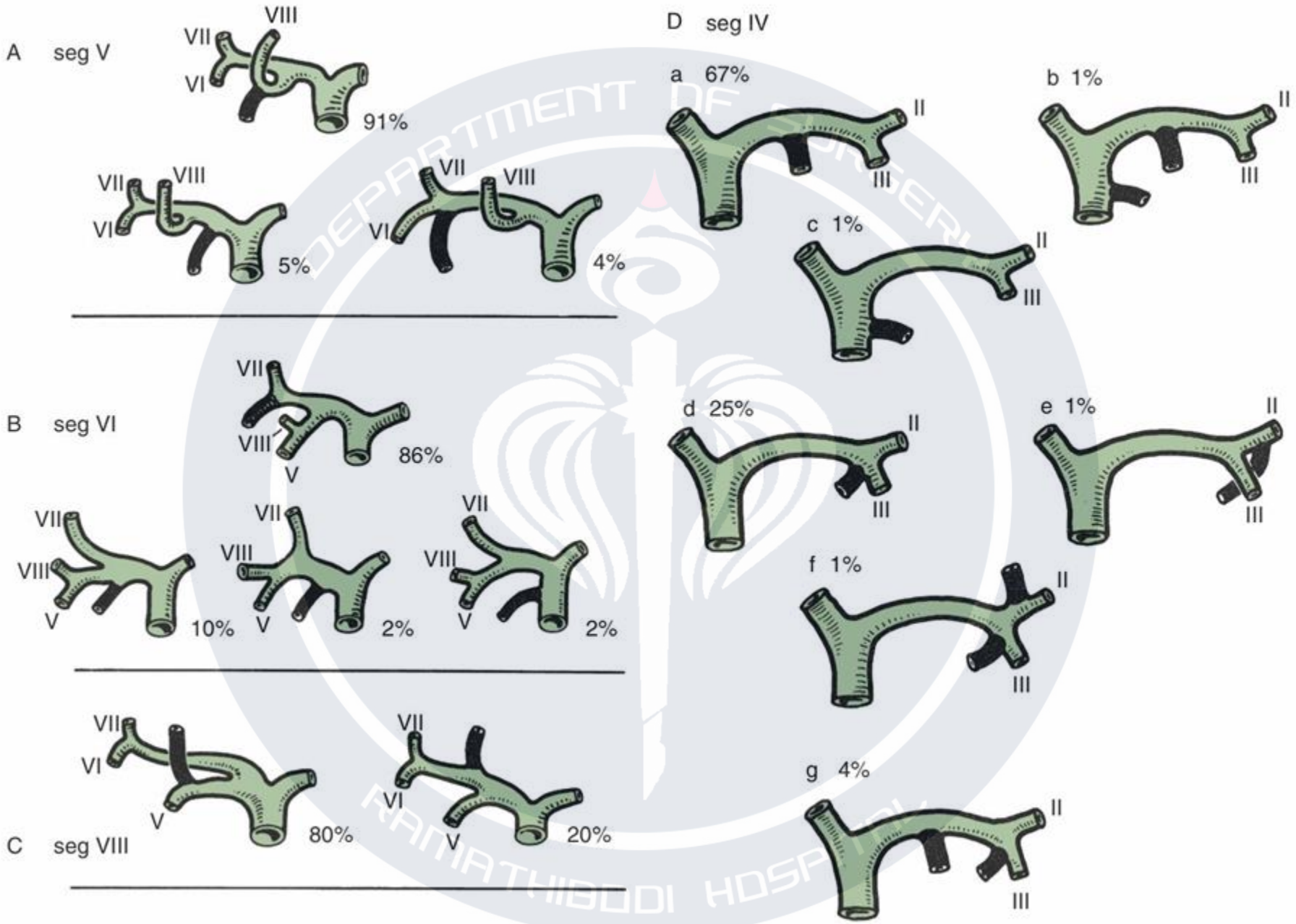
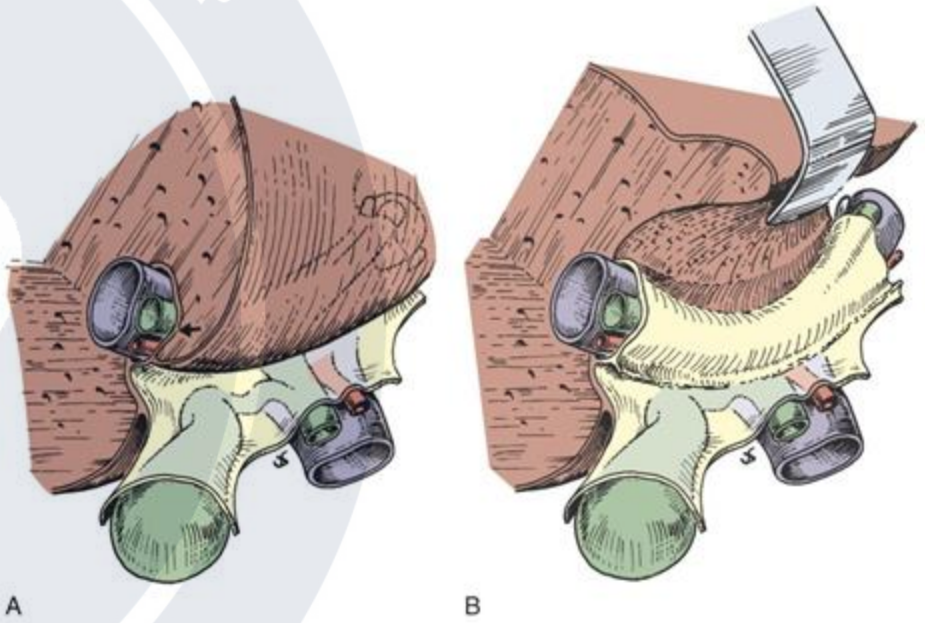



**FIGURE 2.26.** The main variations of the intrahepatic ductal system. **A,** Variations of segment V. **B,** Variations of segment VI. **C,** Variations of segment VIII. **D,** Variations of segment IV. There is no variation of drainage of segments II, III, and VII. *seg*, Segment.

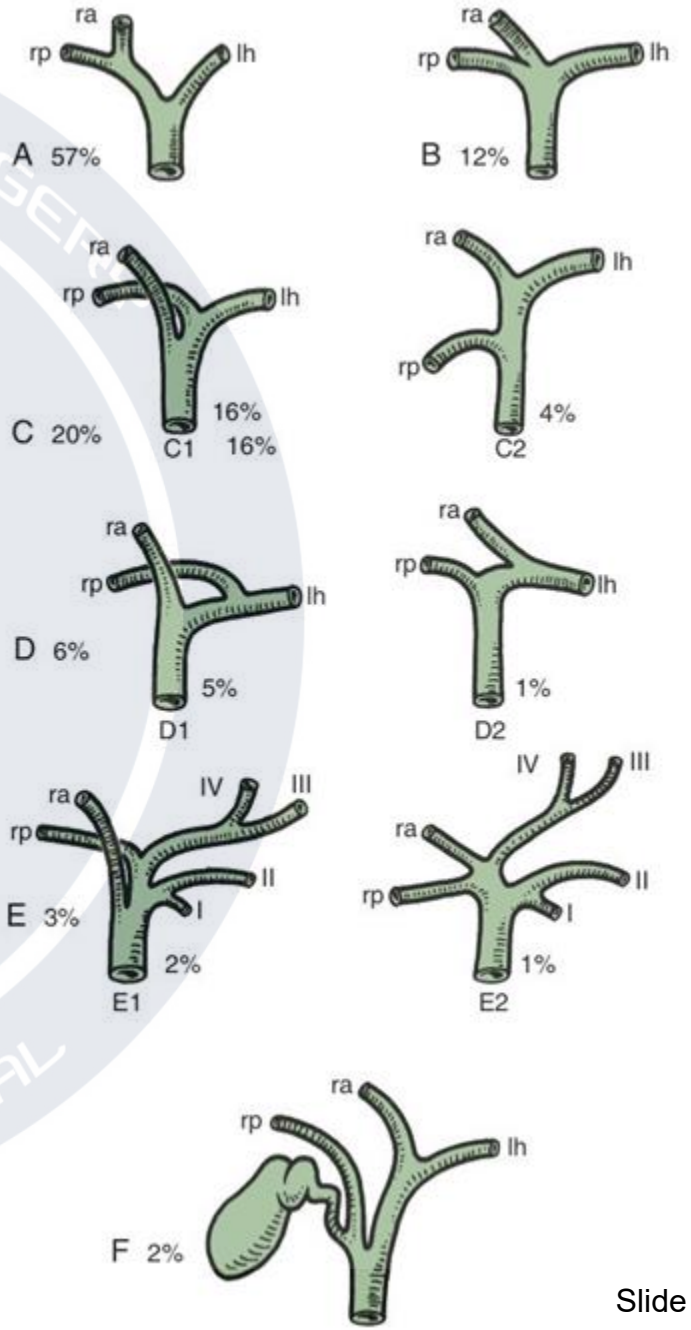
# Extrahepatic Bile Duct Anatomy

- The extrahepatic segment of the right duct is short, but the left duct has a much longer extrahepatic course
- The biliary confluence is separated from the posterior aspect of segment IVB of the liver by the hilar plate, which is the fusion of connective tissue enclosing the biliary and vascular elements with the Glisson capsule
- It is possible to open the connective tissue(lowering of the hilar plate) constituting the hilar plate at the inferior border of segment IV and, by elevating it, to display the biliary confluence and left hepatic duct



# Variations of the hepatic duct confluence

**FIGURE 2.25.** Main variations of the hepatic duct confluence. **A,** Typical anatomy of the confluence. **B,** Triple confluence. **C,** Ectopic drainage of a right sectional duct into the common hepatic duct. *C1*, Right anterior *(ra)* duct draining into the common hepatic duct; *C2*, right posterior *(rp)* duct draining into the common hepatic duct. **D,** Ectopic drainage of a right sectional duct into the left hepatic ductal system. *D1*, Right posterior sectional duct draining into the left hepatic *(lh)* ductal system; *D2*, right anterior sectional duct draining into the left hepatic ductal system. **E,** Absence of the hepatic duct confluence. **F,** Absence of right hepatic duct and ectopic drainage of the right posterior duct into the cystic duct. *(From Couinaud C:* Le Foi: Études Anatomogiques et Chirurgicales. *Paris, 1957, Masson.)*



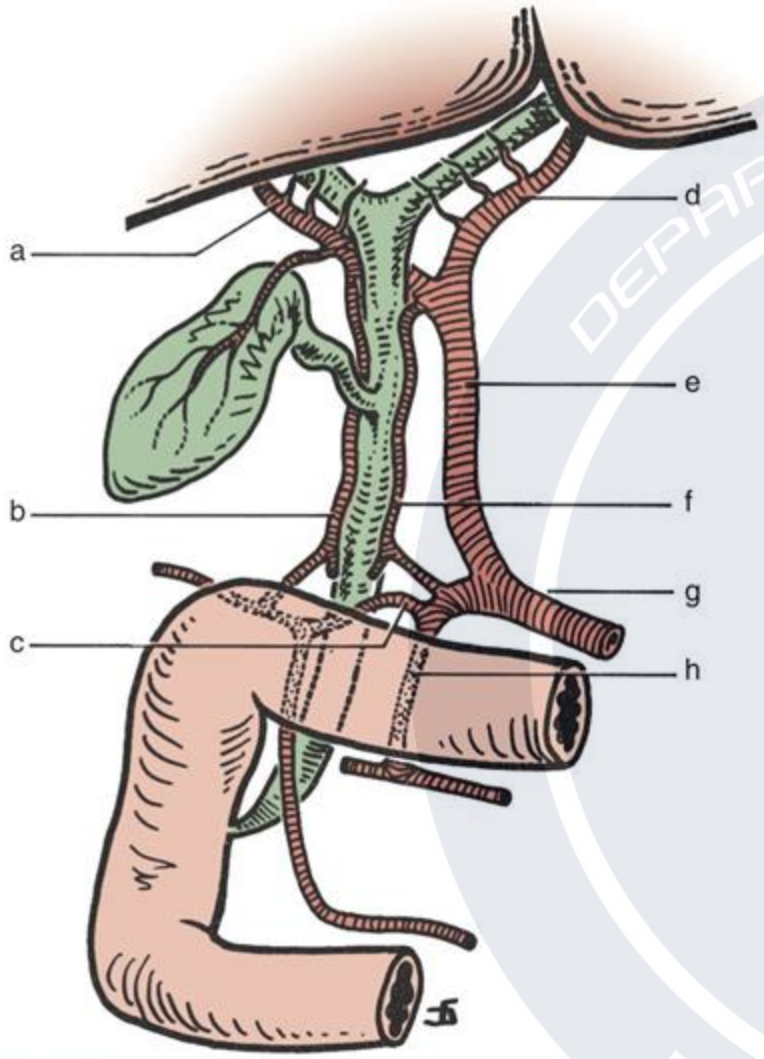
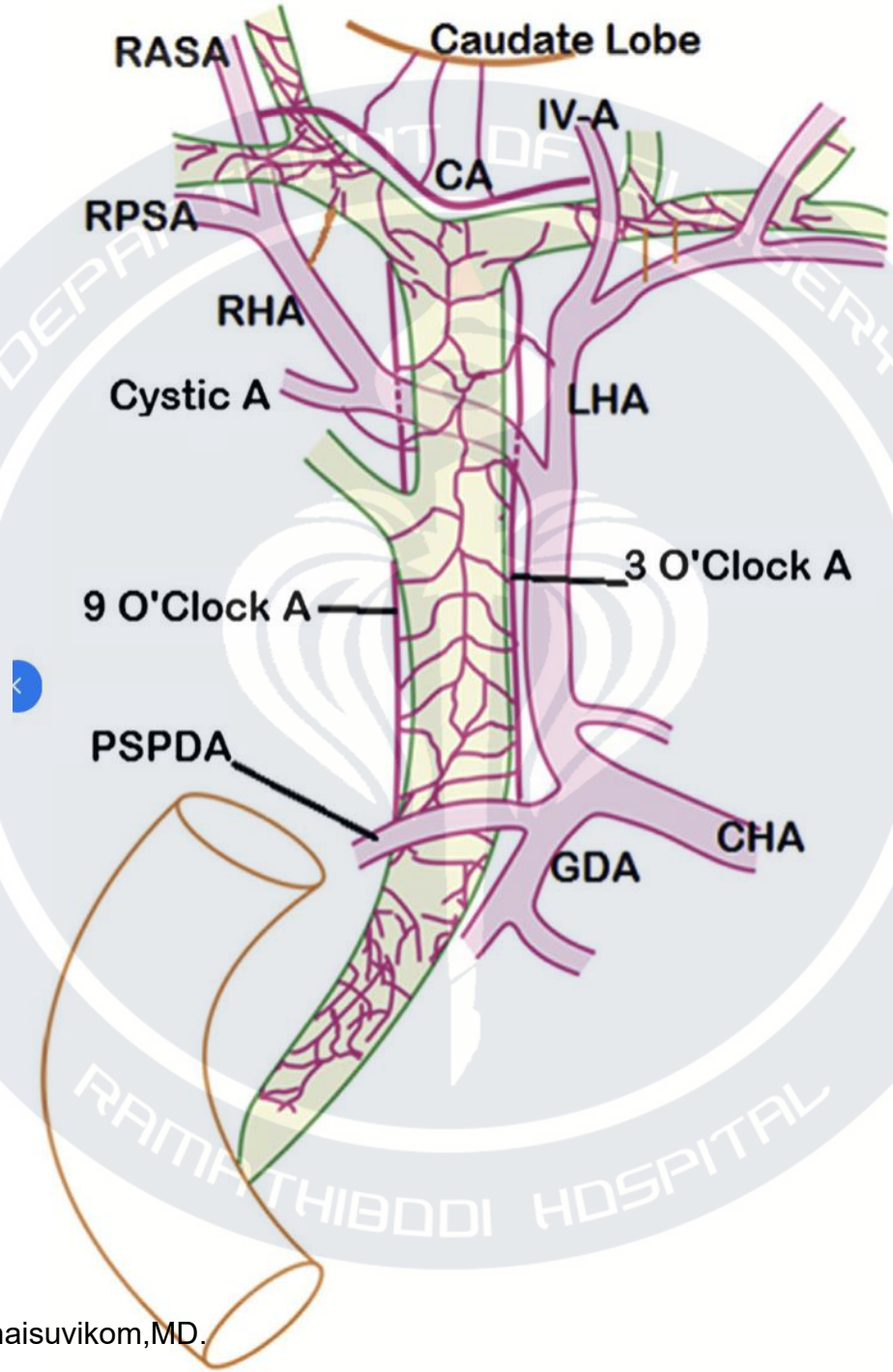



**FIGURE 2.29.** The bile duct blood supply. Note the axial arrangement of the vasculature of the supraduodenal portion of the main bile duct and the rich network enclosing the right and left hepatic ducts: right branch of the hepatic artery *(a)*, 9 o'clock artery *(b)*, retroduodenal artery *(c)*, left branch of the hepatic artery *(d)*, hepatic artery *(e)*, 3 o'clock artery *(f)*, common hepatic artery *(g)*, gastroduodenal artery *(h)*.

- The most important of these vessels run along the lateral borders of the duct and have been called the 3 o'clock and 9 o'clock arteries
- 60% run upward from the major inferior vessels, and only 38% of arteries run downward
- 2% of the arterial supply is nonaxial, arising directly from the main trunk of the hepatic artery

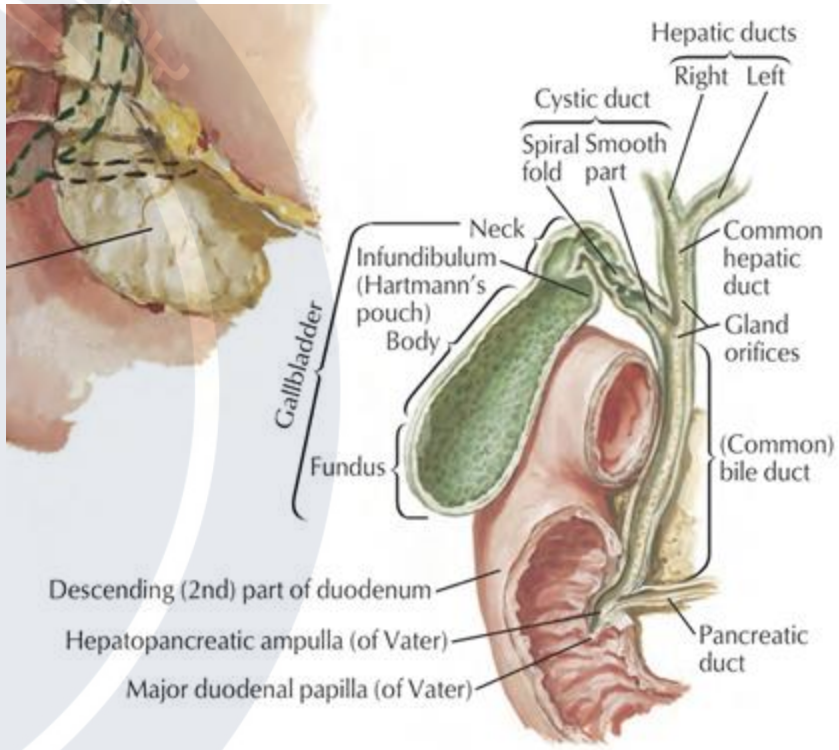

RASA
Caudate Lobe
IV-A
CA
RPSA
RHA
Cystic A
LHA
3 O'Clock A
9 O'Clock A
PSPDA
CHA
GDA

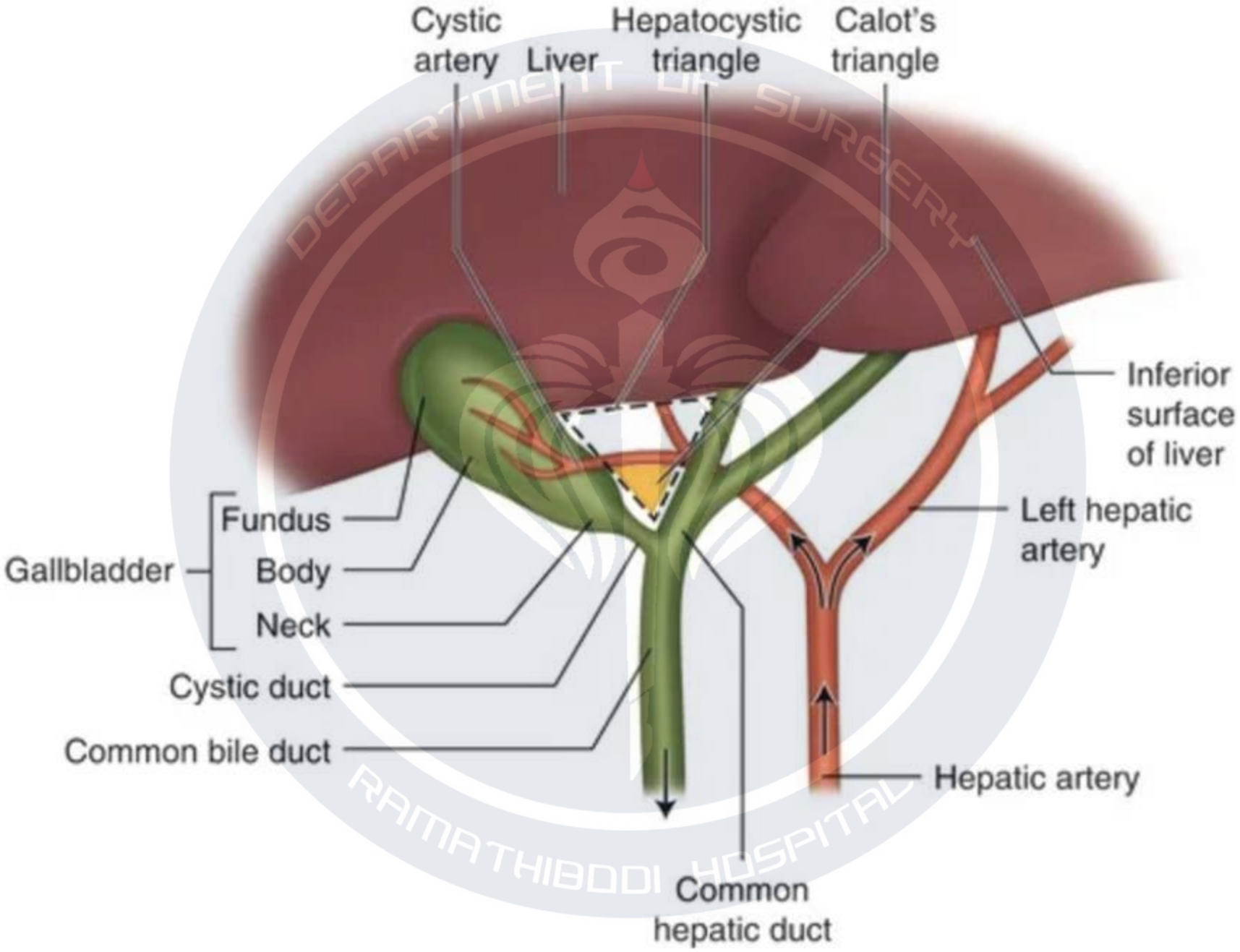
# Gallbladder and Cystic Duct

-The gallbladder is a reservoir located on the undersurface of the right lobe of the liver

-The cystic fossa is a precise anterior landmark to the main liver incisura

-The neck of the gallbladder makes an angle with the fundus and creates Hartmann's pouch, which may obscure the common hepatic duct and constitute a real danger point during cholecystectomy.



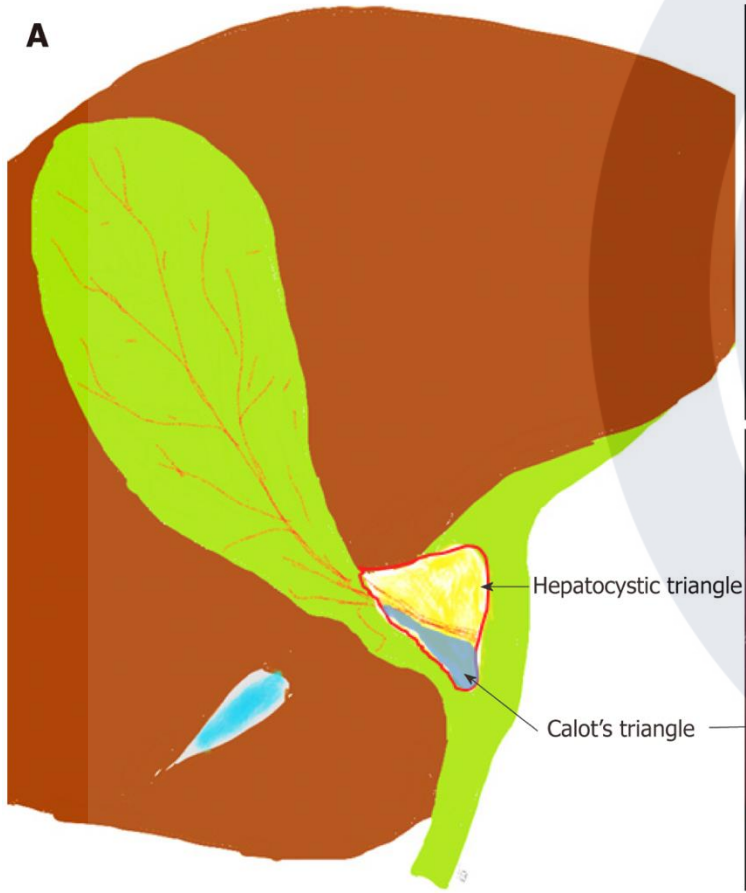

Cystic artery
Liver
Hepatocystic triangle
Calot's triangle
Inferior surface of liver
Left hepatic artery
Gallbladder
Fundus
Body
Neck
Cystic duct
Common bile duct
Hepatic artery
Common hepatic duct

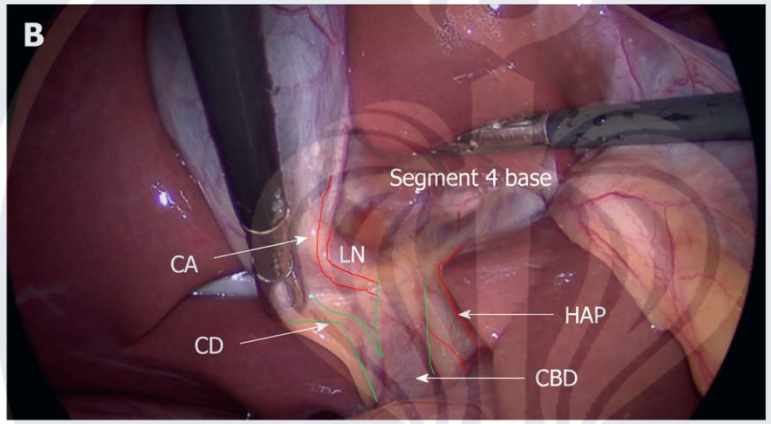
# Safe laparoscopic cholecystectomy: Adoption of universal culture of safety in cholecystectomy

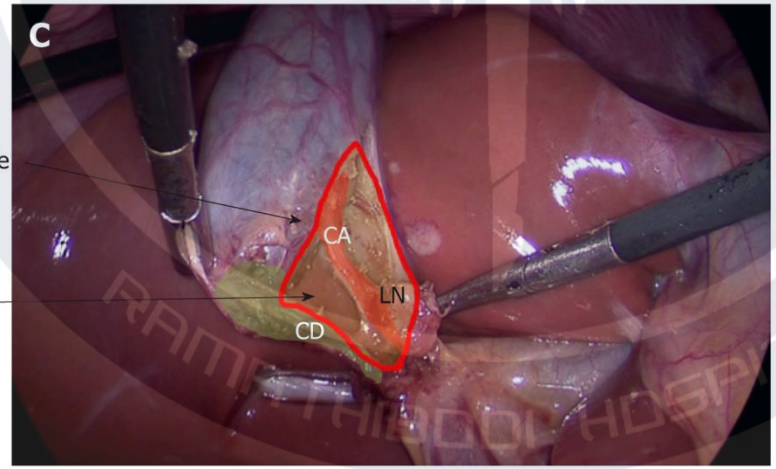
*World J Gastrointest Surg* 2019 February 27; 11(2): 62-84

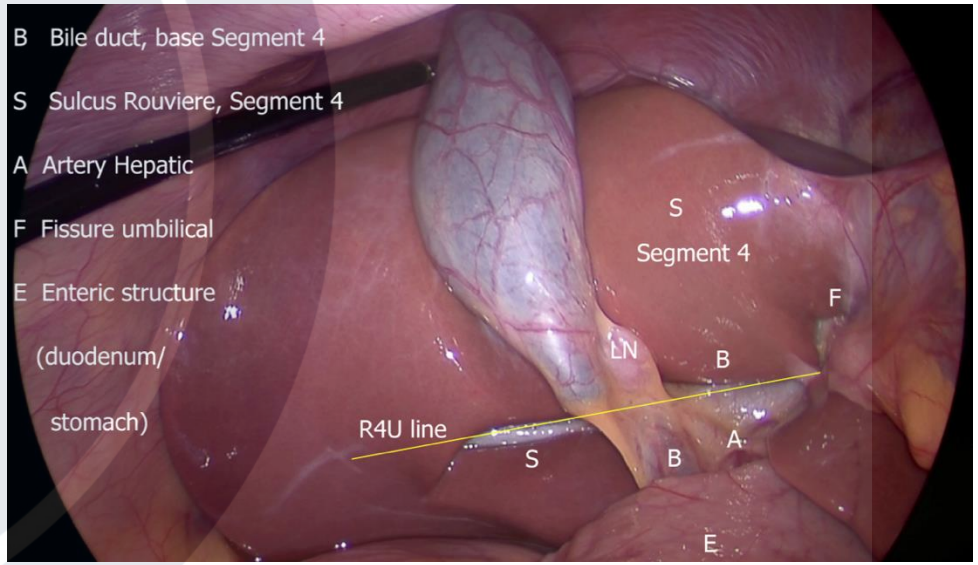
ISSN 1948-9366 (online)

Vishal Gupta, Gaurav Jain




Liver and Biliary anatomy: Ativitch Asavachaisuvikom,MD.

Gupta V, Jain G. Safe laparoscopic cholecystectomy: Adoption of universal culture of safety in cholecystectomy. World J Gastrointest Surg. 2019 Feb 27;11(2):62-84. doi: 10.4240/wjgs.v11.i2.62. PMID: 30842813; PMCID: PMC6397793.

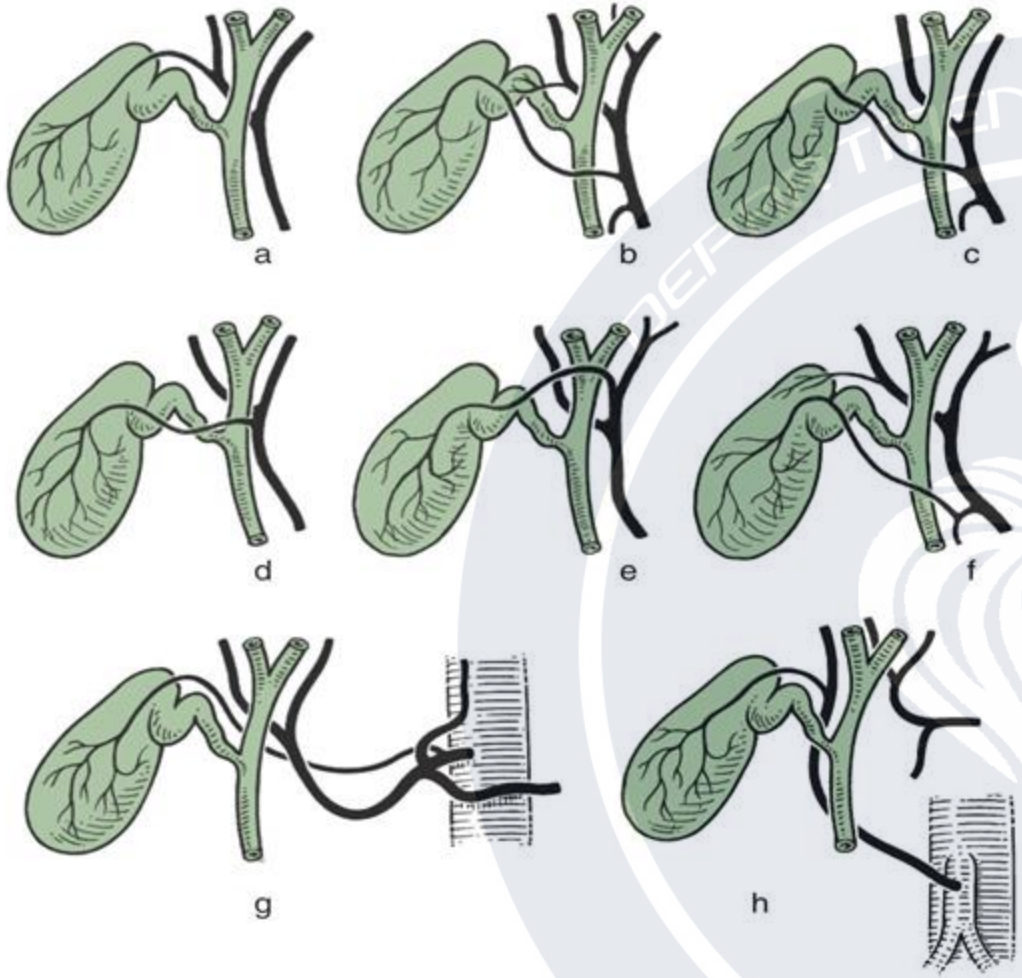



**FIGURE 2.22.** The main variations of the cystic artery: typical course *(a)*, double cystic artery *(b)*, cystic artery crossing anterior to main bile duct *(c)*, cystic artery originating from the right branch of the hepatic artery and crossing the common hepatic duct anteriorly *(d)*, cystic artery originating from the left branch of the hepatic artery *(e)*, cystic artery originating from the gastroduodenal artery *(f)*, cystic artery arising from the celiac axis *(g)*, cystic artery originating from a replaced right hepatic artery *(h)*.

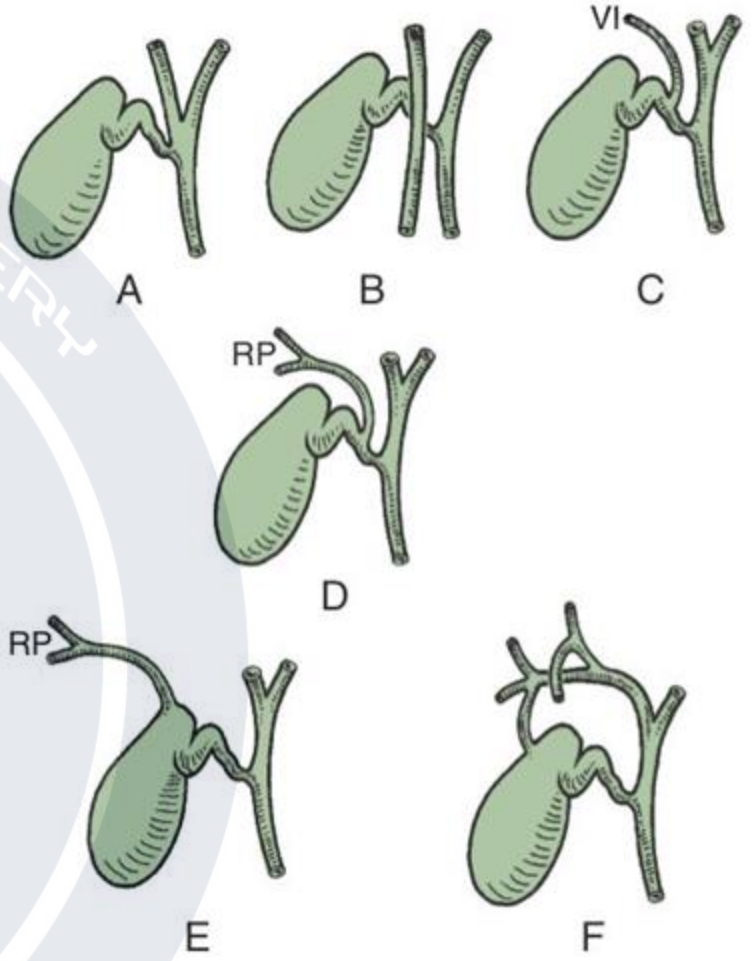



**FIGURE 2.27.** The main variations of ectopic drainage of the intrahepatic ducts into the gallbladder and cystic duct. **A,** Drainage of the cystic duct into the biliary confluence. **B,** Drainage of cystic duct into the left hepatic duct, associated with no biliary confluence. **C,** Drainage of segment VI duct into the cystic duct. **D,** Drainage of the right posterior *(RP)* sectional duct into the cystic duct. **E,** Drainage of the distal part of the right posterior sectional duct into the neck of the gallbladder. **F,** Drainage of the proximal part of the right posterior sectional duct into the body of the gallbladder.

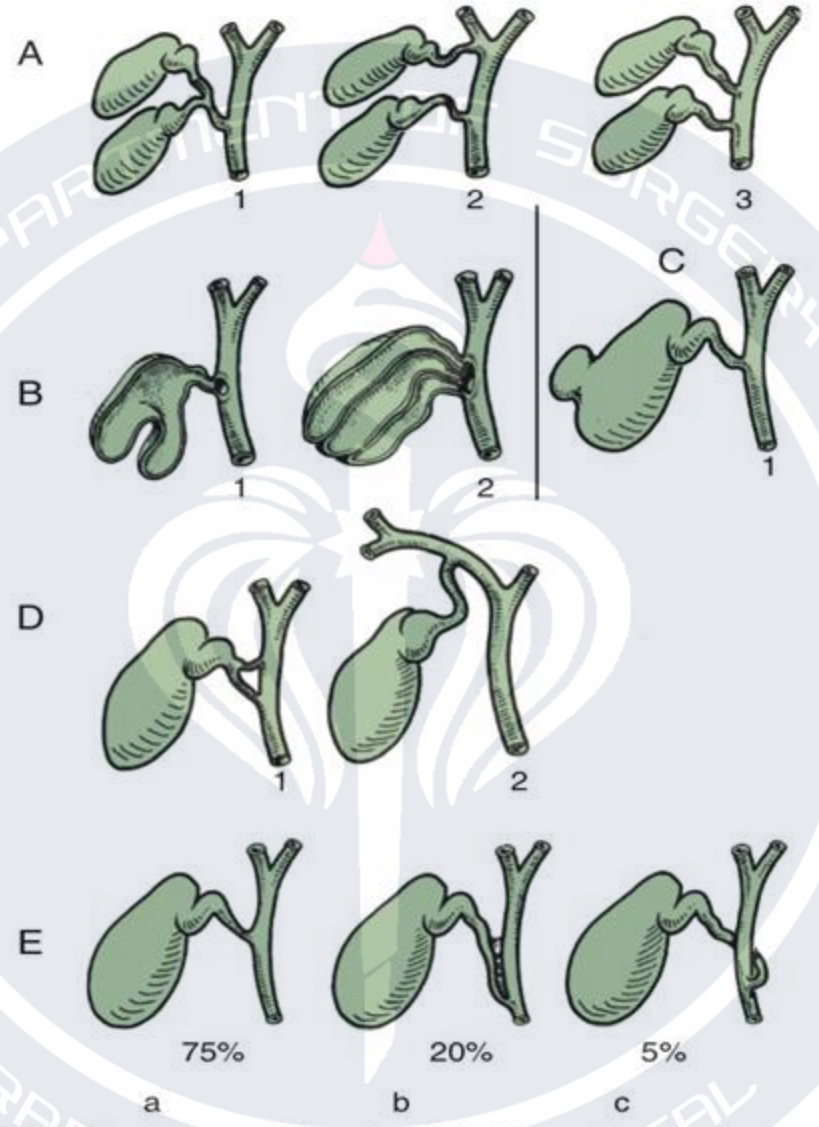
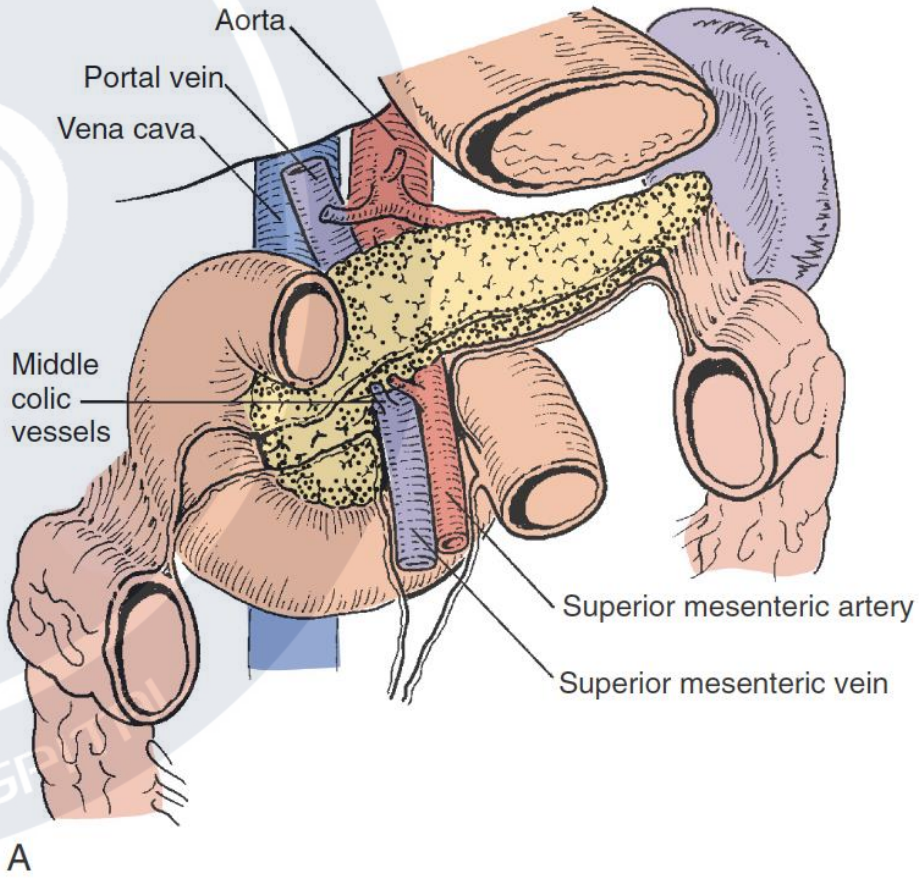



**FIGURE 2.28.** Main variations in gallbladder and cystic duct anatomy. **A,** Duplicated gallbladder. **B,** Septum of the gallbladder. **C,** Diverticulum of the gallbladder. **D,** Variations in cystic ductal anatomy. **E,** Different types of union of the cystic duct and common hepatic duct: angular union *(a)*, parallel union *(b)*, spiral union *(c)*.

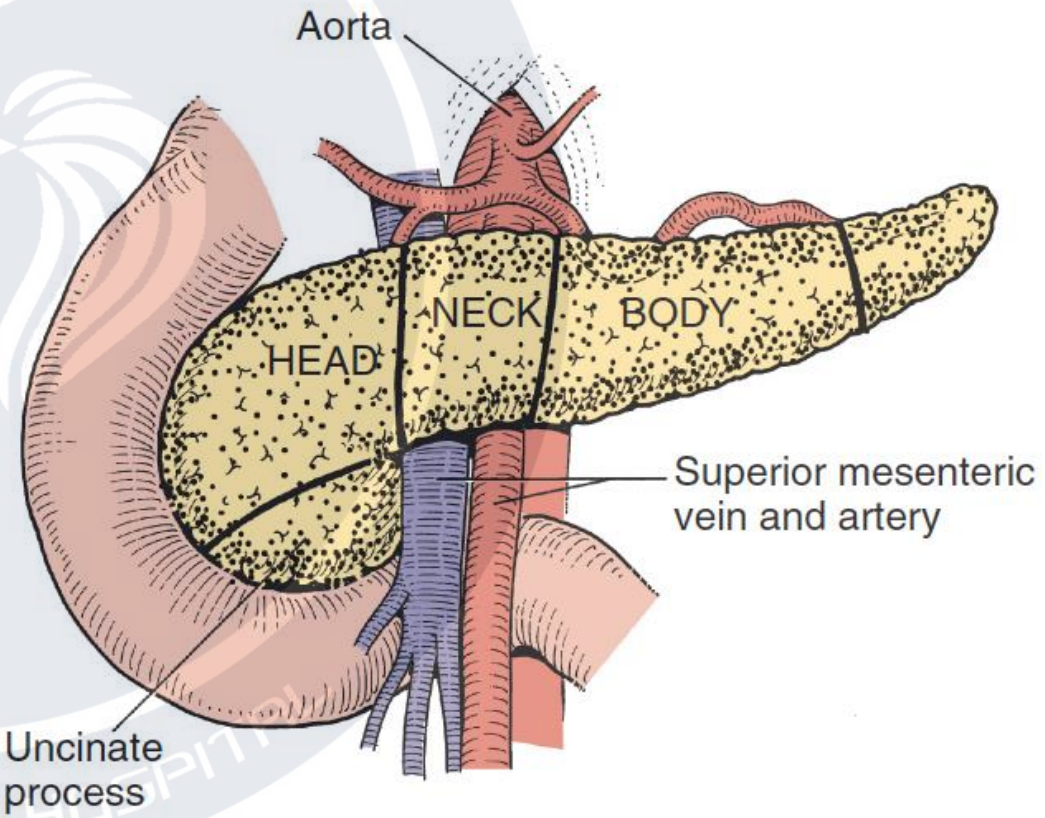
# PANCREASE

- Retroperitoneal organ
- Lies obliquely, upward
- C-loop of duodenum to splenic hilum
- 75 – 100 g



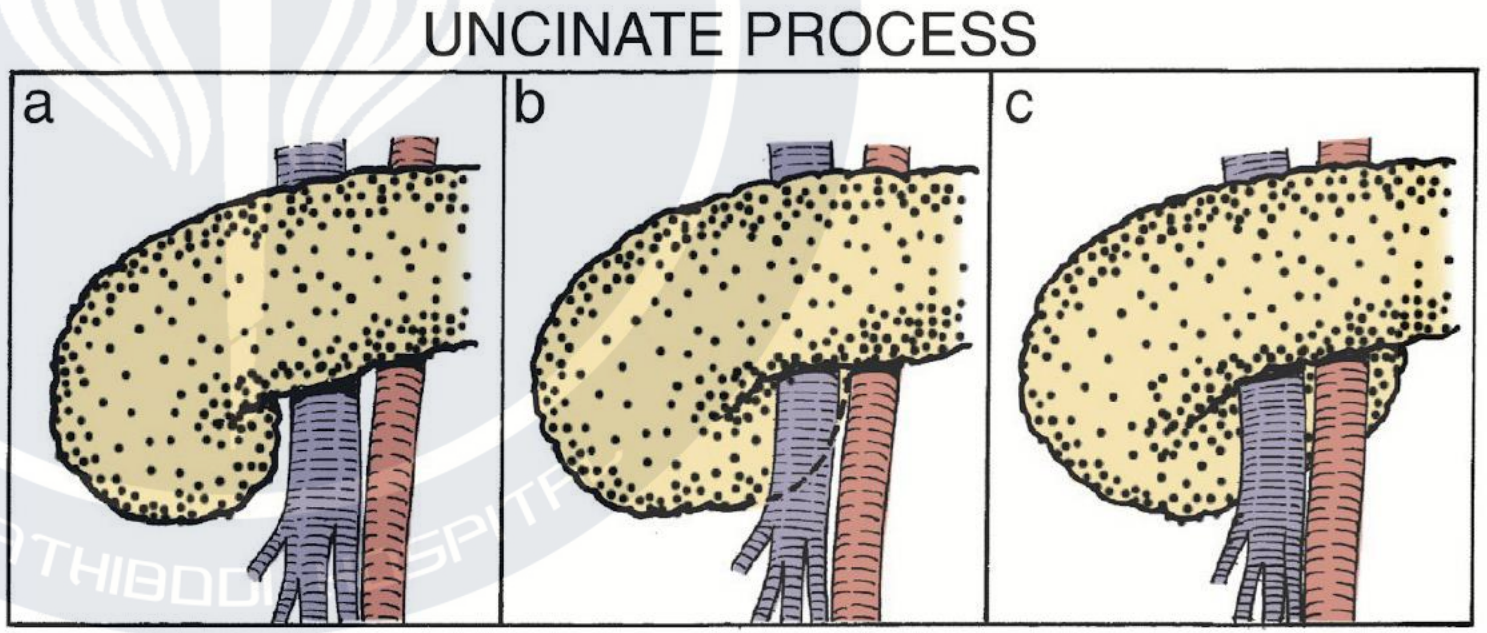
# Regions of pancrease

- Head
- Neck
- Body
- Tail



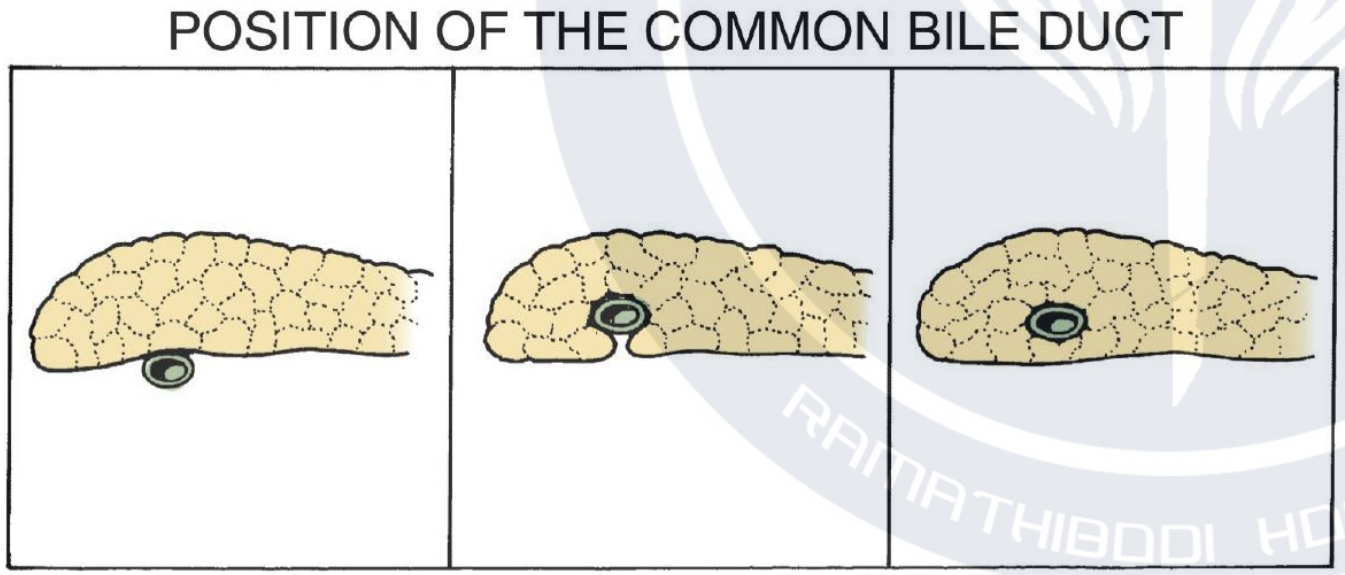
# Head

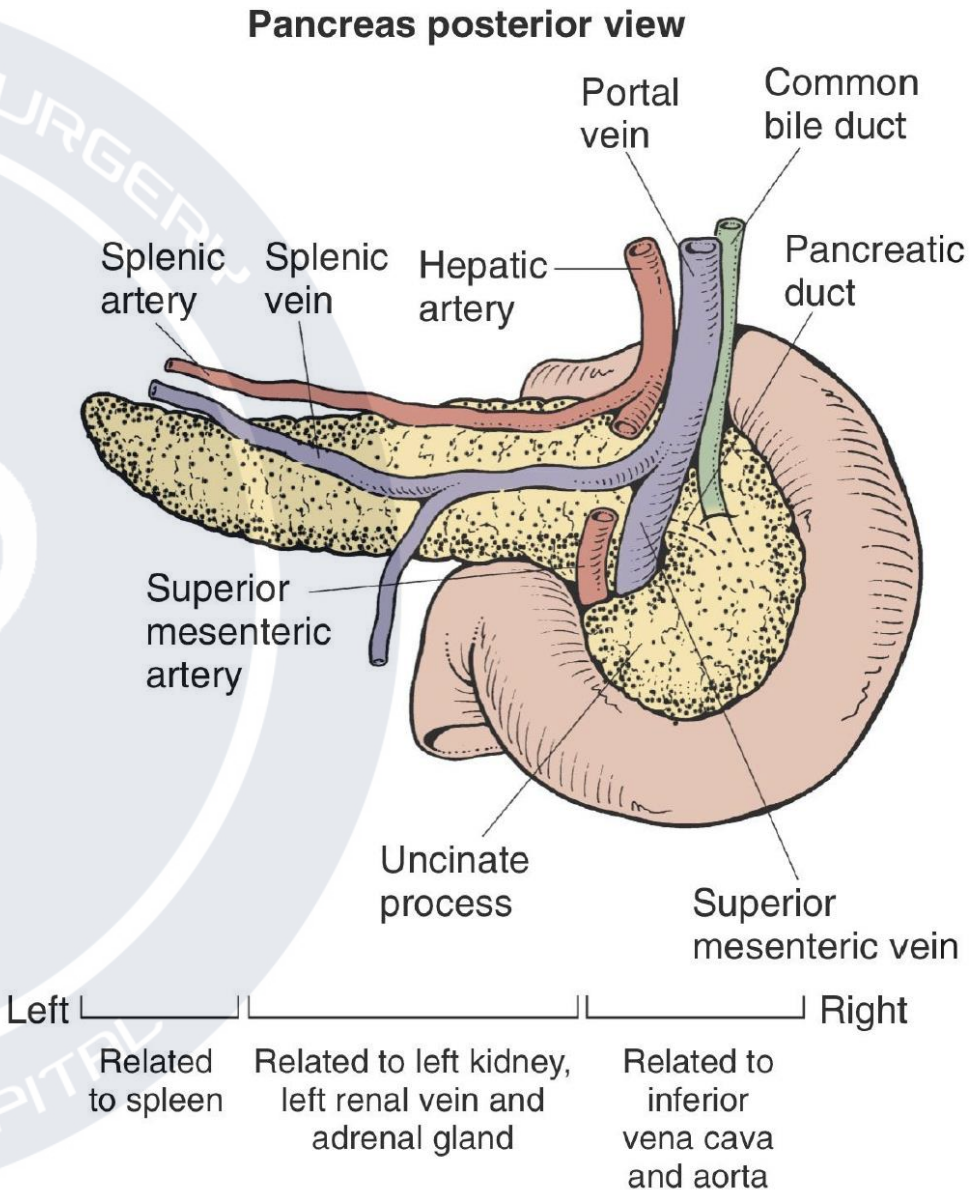
- Nestled in C-loop of the duodenum
- Transverse mesocolon attach across anterior surface of head
- Mainly at L2 level, just anterior to IVC/Rt. Renal artery/Both renal vein




A

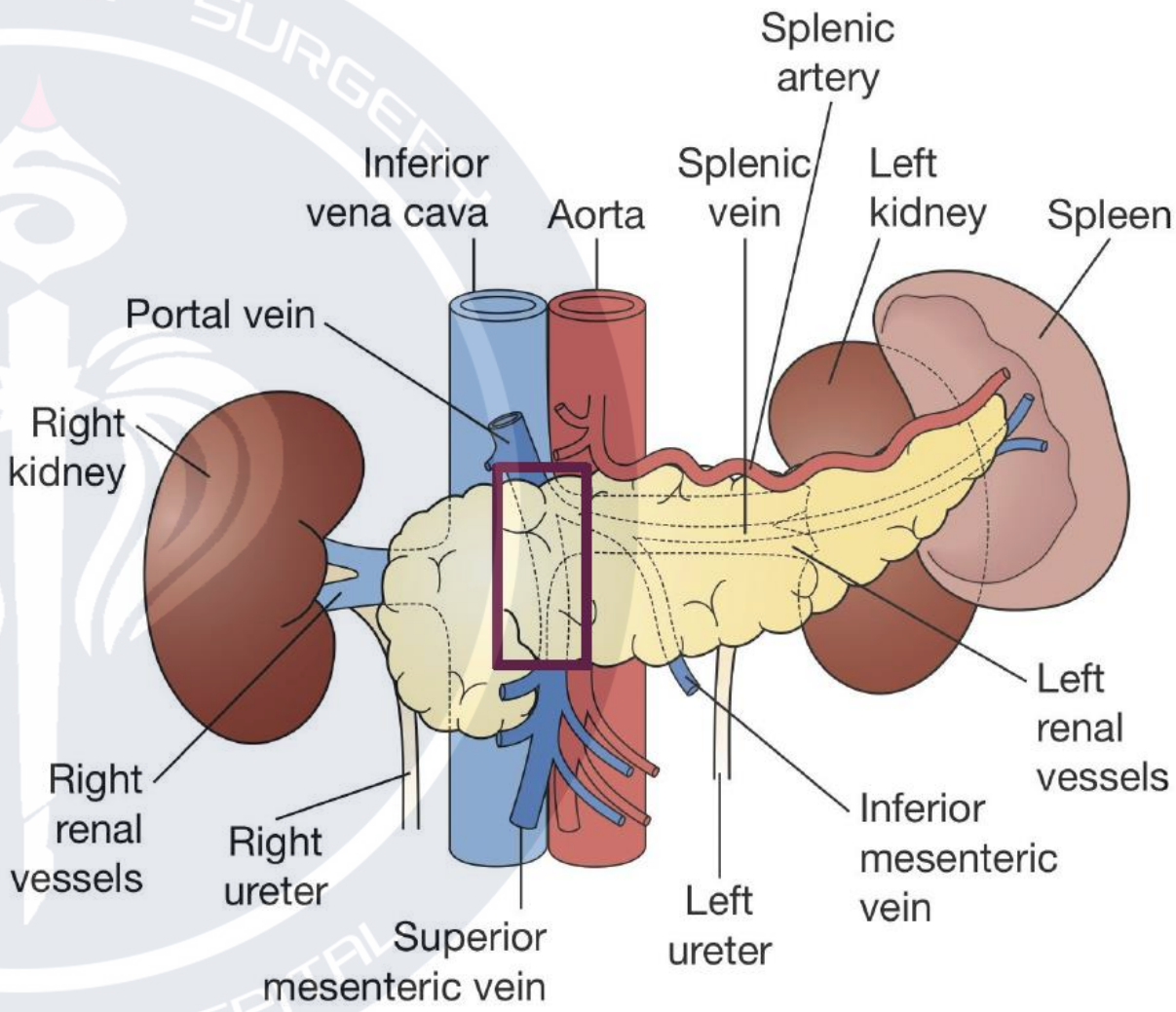
CBD Run in a deep groove on posterior aspect of pancreatic head



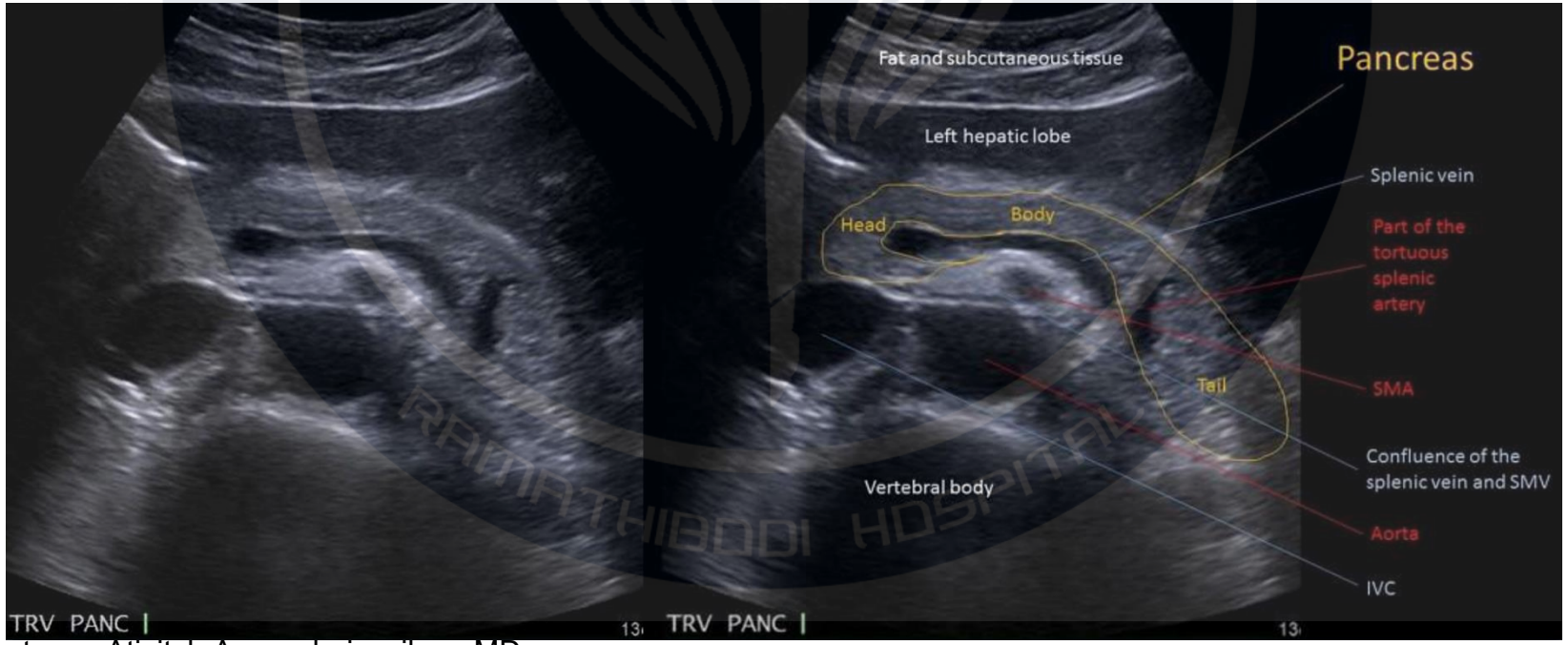
# Neck

- Behind the neck, SMV joins the splenic vein to form the PV
- Pancreatic neck lies anterior to L1-2 vertebral body, can be damage from blunt anteroposterior trauma

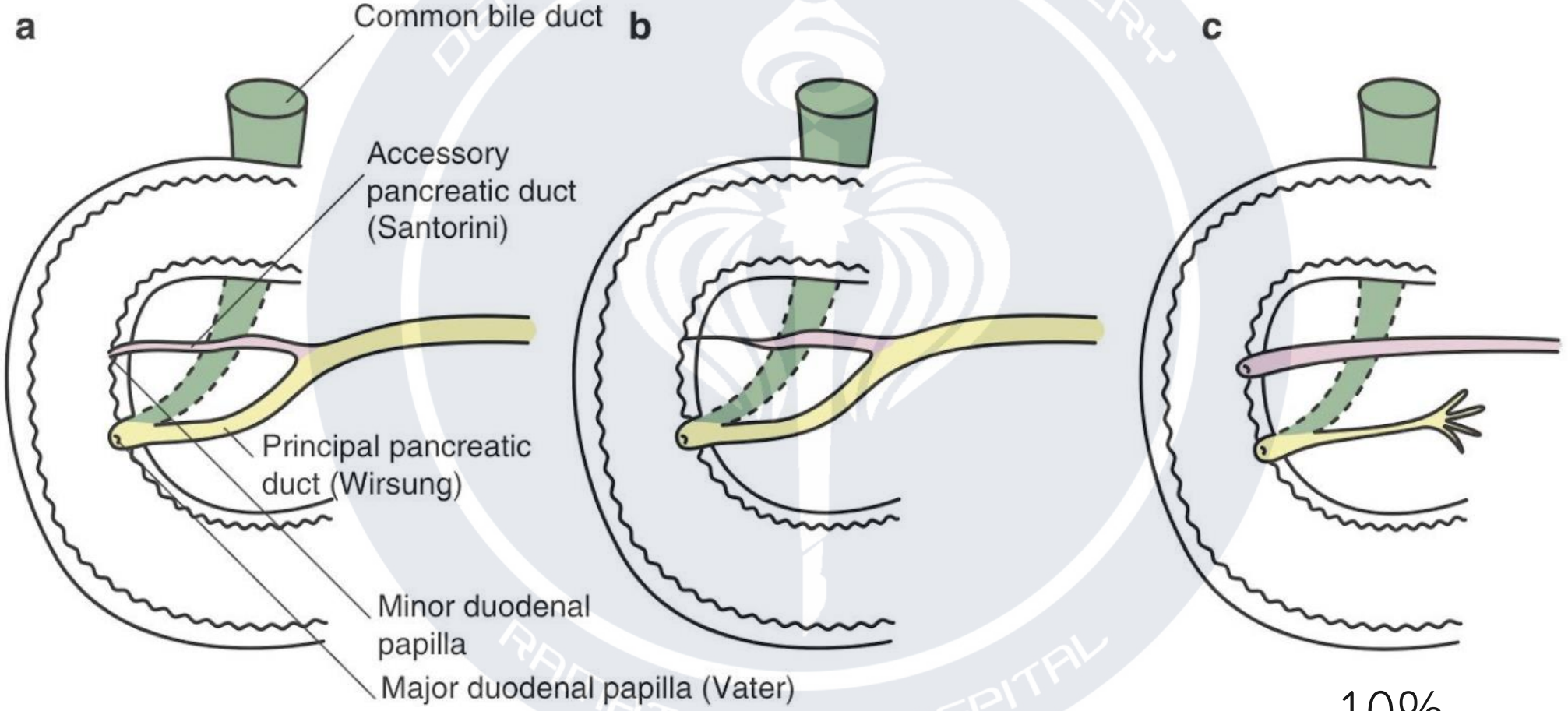


# Body and tail

- Body anterior to aort at origin of SMA
- The origin of the celiac trunk is superior border of body
- Tail nested in the splenic hilum



# Pancreatic duct variation

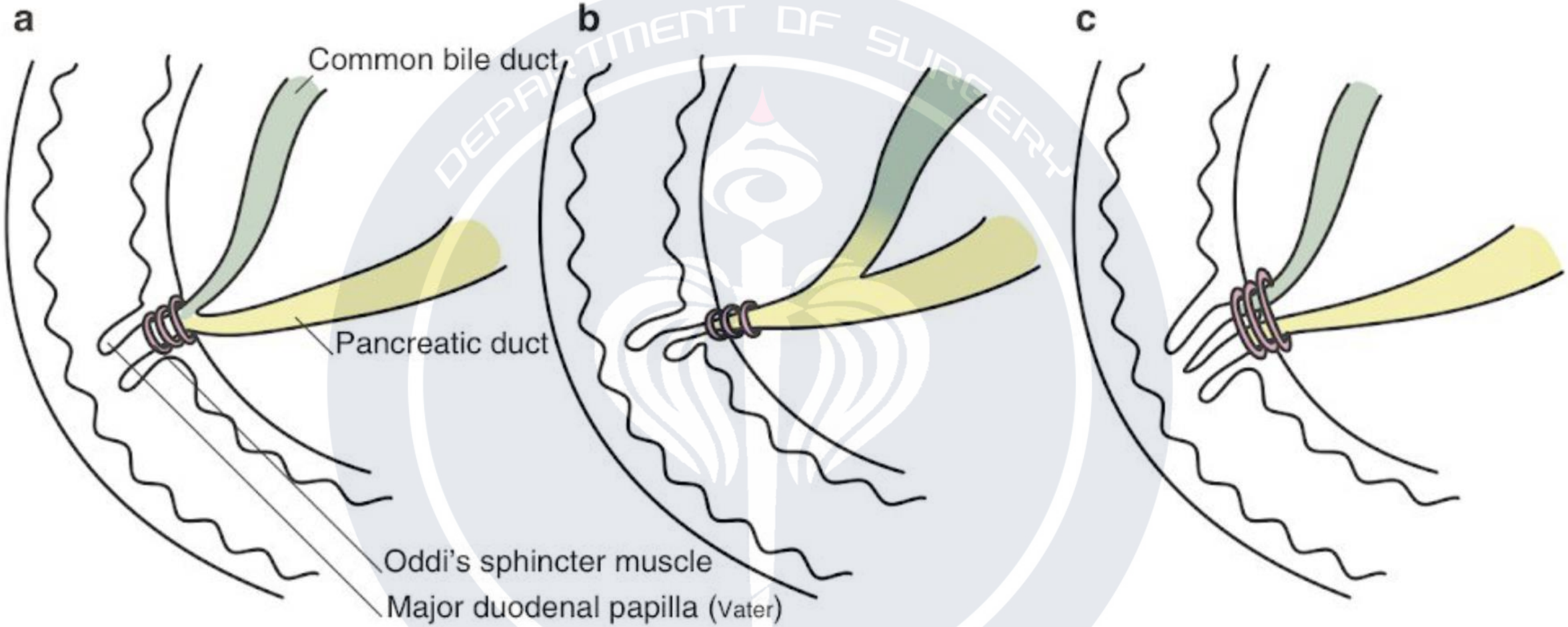



60%

30%

10%

(Pancreatic divisum)




1/3

Two duct merge within papilla

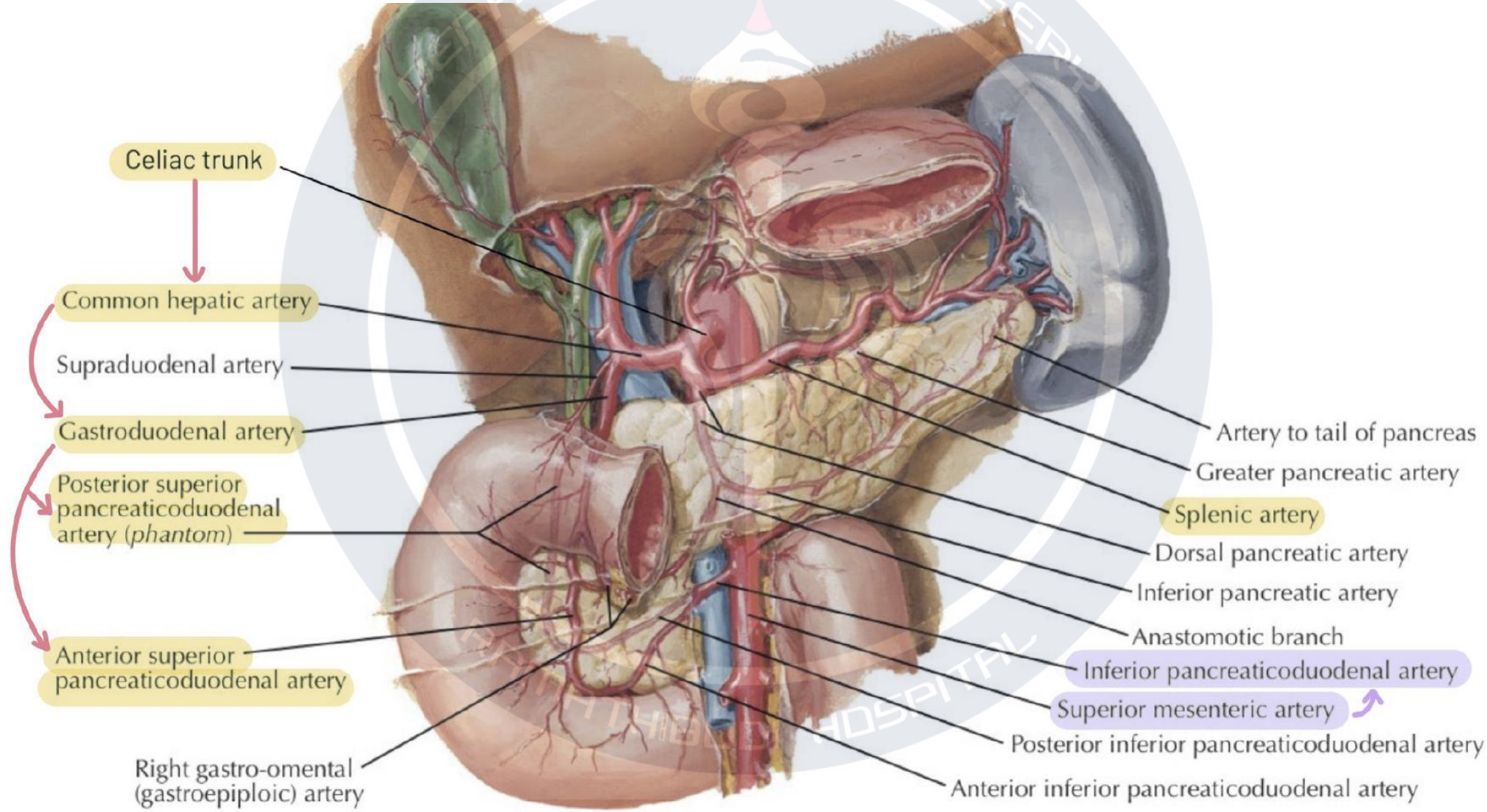
1/3

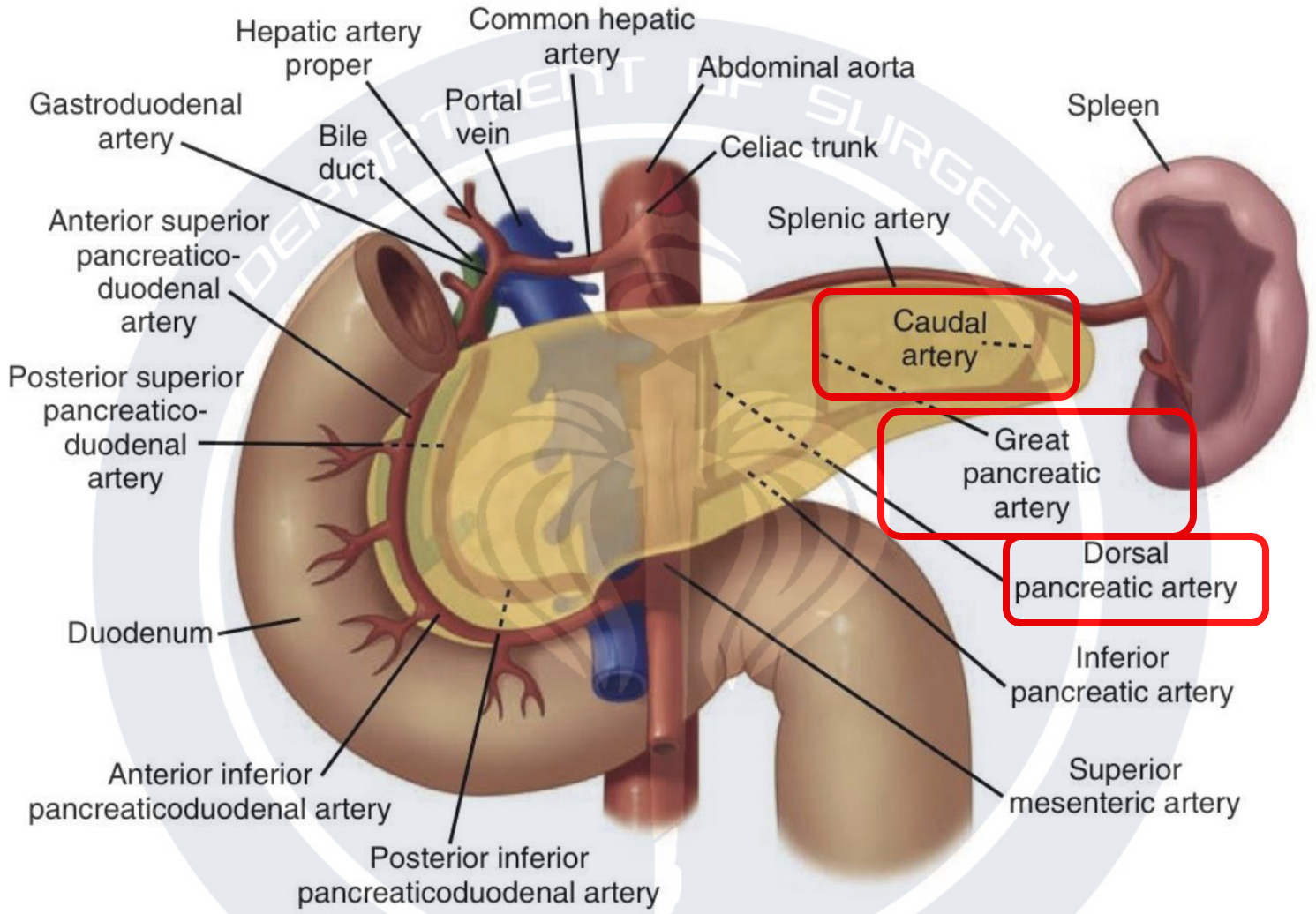
Two duct merge outside duodenal wall

1/3

Two duct remain distinct at the end of papilla

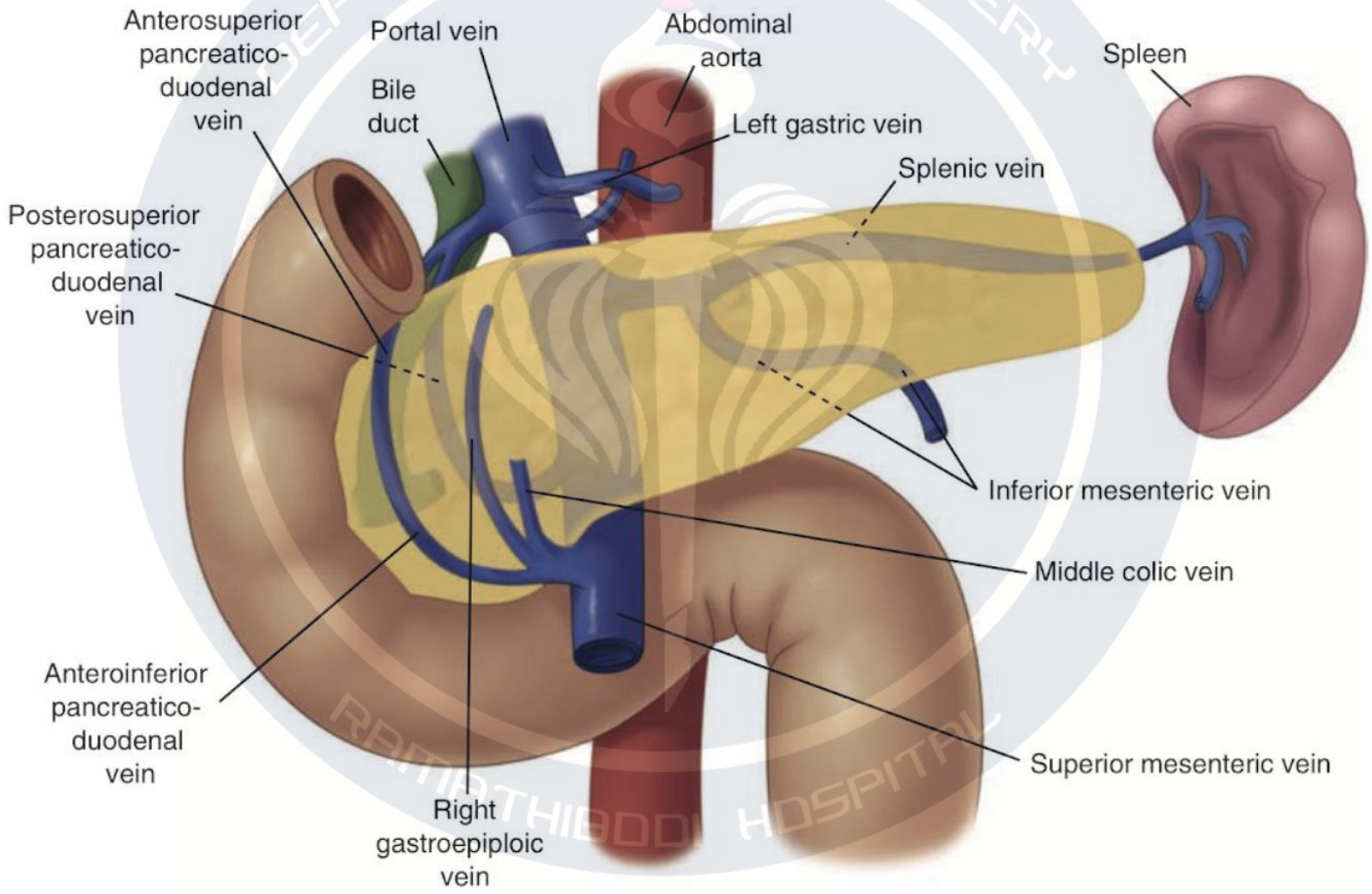
# ARTERY


Celiac trunk
Common hepatic artery
Supraduodenal artery
Gastroduodenal artery
Posterior superior pancreaticoduodenal artery (*phantom*)
Anterior superior pancreaticoduodenal artery
Right gastro-omental (gastroepiploic) artery
Artery to tail of pancreas
Greater pancreatic artery
Splenic artery
Dorsal pancreatic artery
Inferior pancreatic artery
Anastomotic branch
Inferior pancreaticoduodenal artery
Superior mesenteric artery
Posterior inferior pancreaticoduodenal artery
Anterior inferior pancreaticoduodenal artery

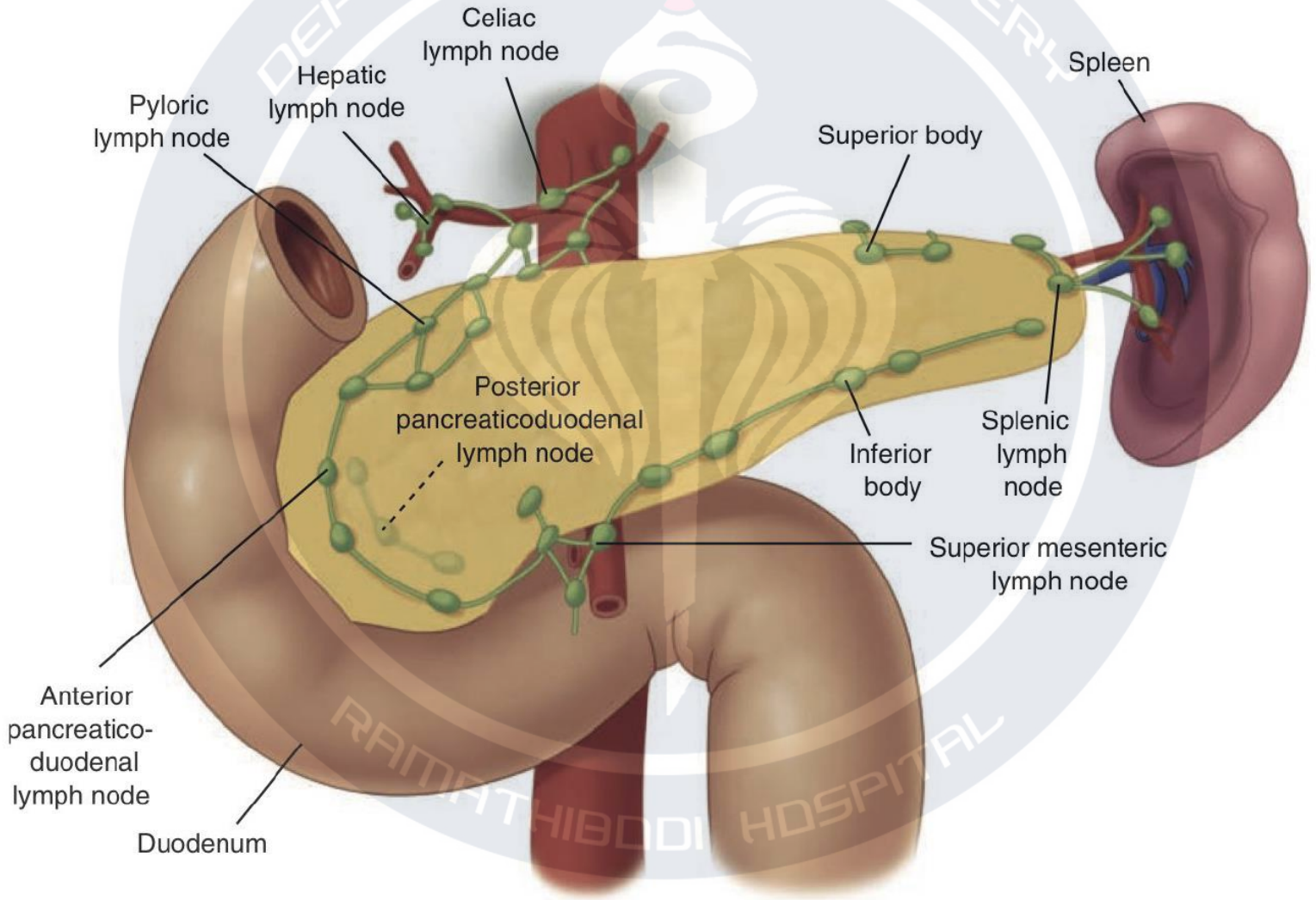



3 perpendicular branches connect the splenic artery and inferior pancreatic artery

# VEIN


Anterosuperior pancreatico-duodenal vein
Portal vein
Abdominal aorta
Spleen
Bile duct
Left gastric vein
Splenic vein
Posterosuperior pancreatico-duodenal vein
Inferior mesenteric vein
Middle colic vein
Anteroinferior pancreatico-duodenal vein
Superior mesenteric vein
Right gastroepiploic vein

# Lymphatic


Celiac
lymph node
Hepatic
lymph node
Pyloric
lymph node
Spleen
Superior body
Posterior
pancreaticoduodenal
lymph node
Inferior
body
Splenic
lymph
node
Superior mesenteric
lymph node
Anterior
pancreatico-
duodenal
lymph node
Duodenum

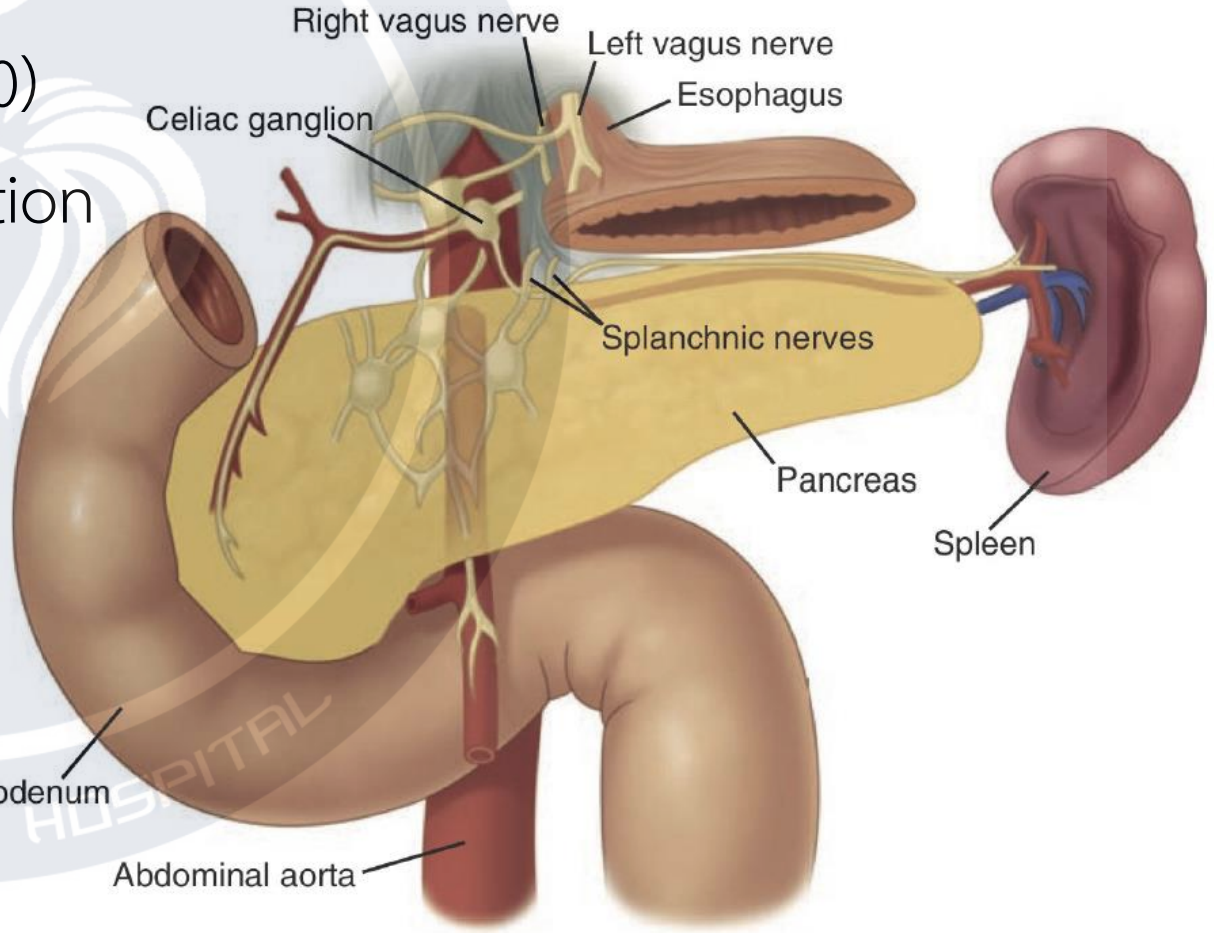
# NERVE

Sympathetic

- The greater splanhnich nerves(T6-T10)
- Inhibit endocrine and exocrine secretion

Parasympathetic

- Vagus nerve
- Stimulates secretion



# Clinical Anatomy of the Liver: Review of the 19th Meeting of the Japanese Research Society of Clinical Anatomy

Yoshihiro Sakamoto[a] Norihiro Kokudo[a] Yoshikuni Kawaguchi[a]
Keiichi Akita[b]

[a]Hepato-Biliary-Pancreatic Surgery Division, Artificial Organ and Transplantation Division, Department of Surgery, Tokyo University Hospital, and [b]Department of Clinical Anatomy, Tokyo Medical and Dental University, Tokyo, Japan

# The Caudate Processus Hepatic Vein

## *A Boundary Hepatic Vein Between the Caudate Lobe and the Right Liver*

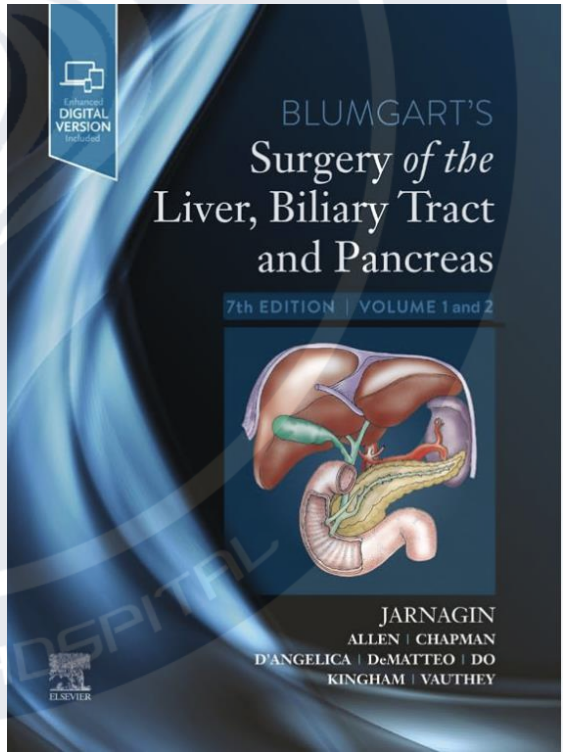
*Kimitaka Kogure, MD,* Hiroyuki Kuwano, MD,* Hiroshi Yorifuji, MD,† Harunori Ishikawa, MD,† Kuniaki Takata, MD,† and Masatoshi Makuuchi, MD‡*

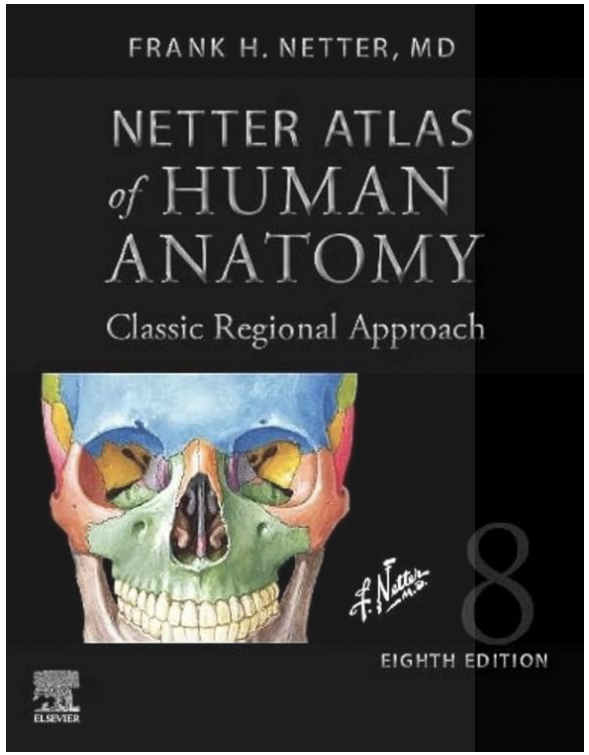
# Standardization of Anatomic Liver Resection Based on Laennec's Capsule

Atsushi Sugioka, Yutaro Kato, Yoshinao Tanahashi, Jun-ichi Yoshikawa, Gozo Kiguchi, Masayuki Kojima, Akira Yasuda, Sanae Nakajima, Ichiro Uyama

# Systematic extrahepatic Glissonean pedicle isolation for anatomical liver resection based on Laennec's capsule: proposal of a novel comprehensive surgical anatomy of the liver

**Atsushi Sugioka · Yutaro Kato · Yoshinao Tanahashi**



# Thank you