

Therapeutic Endoscopy

10/6/2005

Text and Atlas of ERCP; Silvis, 1995
Interpretation of ERCP; Taylor, 1997
ERCP Atlas: Pott, 1989

Goals

- Overview of embryologic development of biliary/pancreatic systems
- Anomalies of pancreaticobiliary ductal systems
- Normal ERC
- Normal ERP
- Radiographic technique
- Pitfalls in ERCP film interpretation

Embryology Liver/Biliary /Pancreatic System

- All begins in 3rd-5th weeks of embryonic gestation.
- Two endodermal diverticulum from the foregut, which will ultimately form the 2nd portion of the duodenum, provide the substrate for the formation of liver, biliary tree, and pancreas.

Hepatic Diverticulum

- Arises from the ventral aspect of the foregut.
- Largest, most cranial portion is the pars hepatica, which will develop into the liver, IHBD, and CHB to the cystic duct.
- Gallbladder and cystic duct (CD) arise from the small pars cystica.
- The attachment between the pars cystica and the foregut develops into the CBD.

Liver and IHBD

- Form from endodermal cells of the pars hepatica.
- Initially a web-like pattern with multiple connections between the developing GB, CD, and EHBD.
- These connections are usually lost giving formation to a single extra hepatic ductal system.
- Variable development at this time leads to normal variation in ductal anatomy and occasionally to persistent anomalous ducts.

Pancreas

- The pancreas is formed from two separate diverticulum
- Ventral pancreas forms from the caudal portion of the hepatic diverticulum
- Dorsal pancreatic diverticulum of the foregut gives rise dorsal pancreas
- Through the differential growth rates of the duodenum and rotation of the midgut the ventral pancreas will oppose the dorsal pancreas in the coronal plane

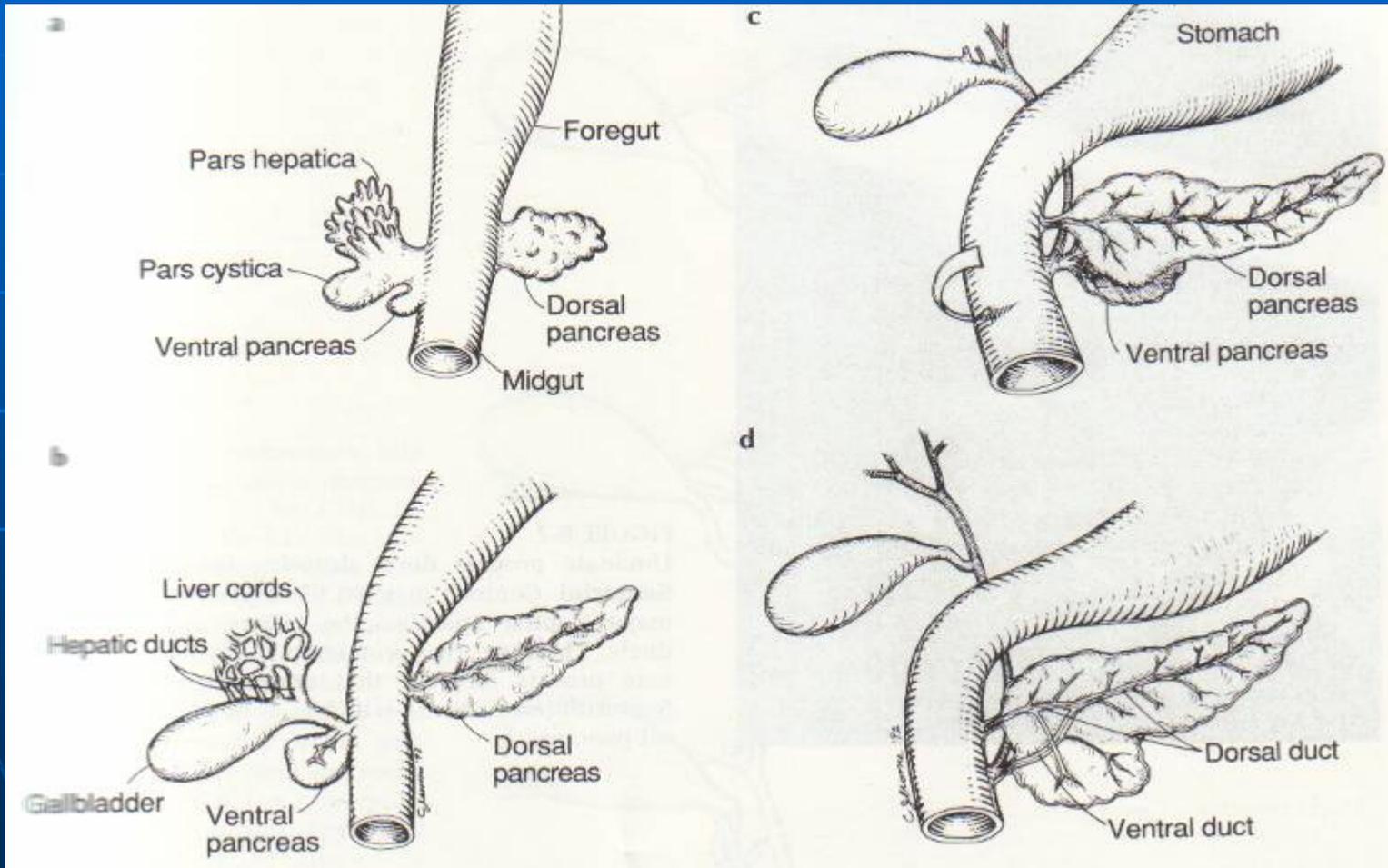
Pancreatic Fusion

- The two pancreatic portions fuse near the 7th week of gestation
- Dorsal gives rise to the tail, body, and anterior portion of the head of the pancreas
- Ventral pancreatic bud forms the posterior portion of the head of pancreas
- Head and uncinete process appear to be derived from both the dorsal and ventral pancreatic diverticulum

Pancreatic Ducts

- Develop in approximately the 6th week
- Ventral duct in concert with the CBD in what will become the major ampulla
- Dorsal duct will empty to the minor ampulla
- Duct from dorsal pancreas becomes the main PD in the body and tail (duct of Santorini). Distal to the site of fusion the duct becomes the accessory duct of Santorini
- The duct from the ventral pancreas becomes a continuation of the main PD in the head of the pancreas. (Wirsung)

Embryology of the Biliary and Pancreatic Ducts



Anomalous Bile Ducts

- Occur in 15-20% of the population
- Are normal variants of development and are of no clinical significance, other than for potential of operative injury
- Anomalous bile ducts most often arise in the right lobe of the liver and extend across to drain into the LHD or CHD
- Cystohepatic ducts are rare, <1-2%

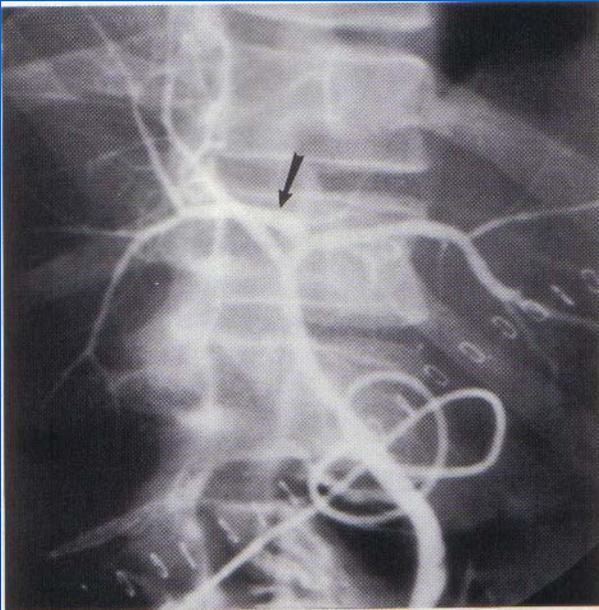


FIGURE 6-4
Anomalous bile duct. The right posterior segmental duct (arrow) drains into the LHD.



FIGURE 6-5
Anomalous bile duct. A major duct from the right lobe of the liver (arrow) drains into the CHD near the CD insertion.

Sub vesicle Ducts

- Occur in 35% of autopsy cases
- <2mm in caliber
- Usually drain to the RHD
- Most penetrate the GB wall but do not communicate to the lumen
- Described by Luschka

Sub vesicle Ducts

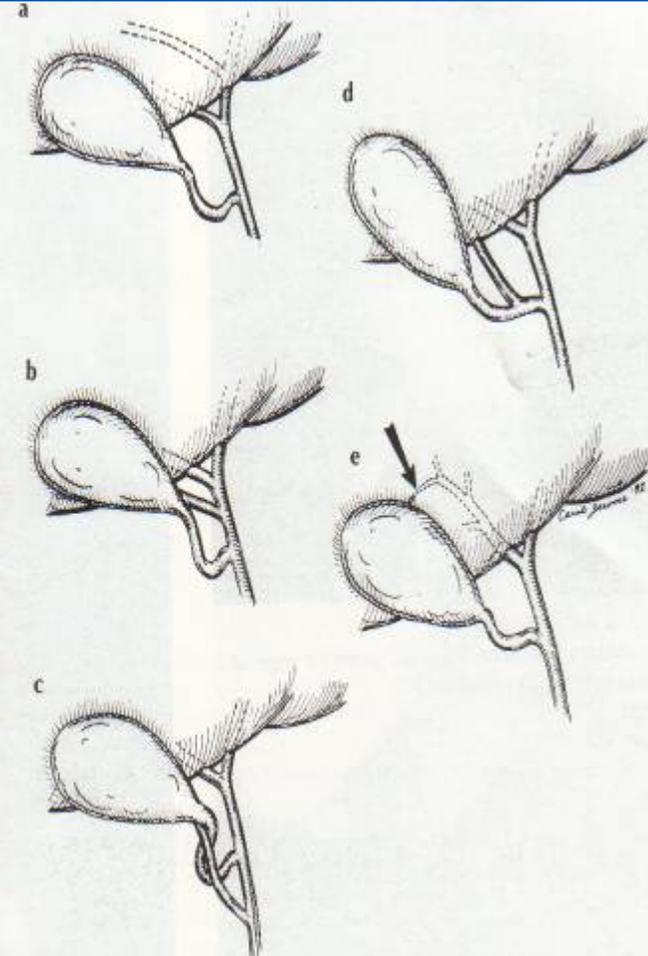
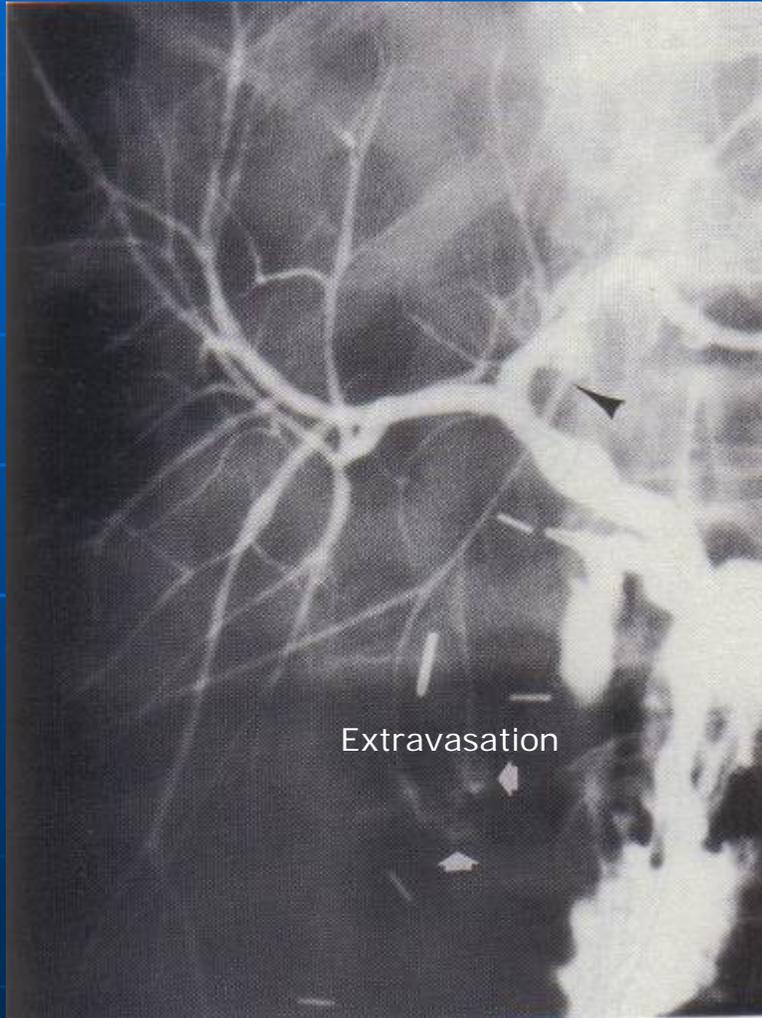


FIGURE 6-3
Anomalous and subvesicle bile ducts. Anomalous ducts draining into (a) the LHD, (b) the CHD, (c) the CBD, and (d) the CD. The subvesicle duct (e) (arrow) begins in or adjacent to the wall of the GB and drains into the RHDs, not in an anomalous pattern. (Reprinted with permission from Schulte SJ: *Embryology, normal variation and congenital anomalies of the gallbladder and biliary tract*. In Freeny PC, Stevenson GW [eds]: *Margulis and Burhenne's Alimentary Tract Radiology*, ed. 5, St Louis, CV Mosby, 1994, p 1257.)

Congenital Anomalies of the Pancreatic Ducts

- Ductal fusion anomalies
- Pancreatic divisum
- Incomplete divisum
- Fusion narrowing of the main PD

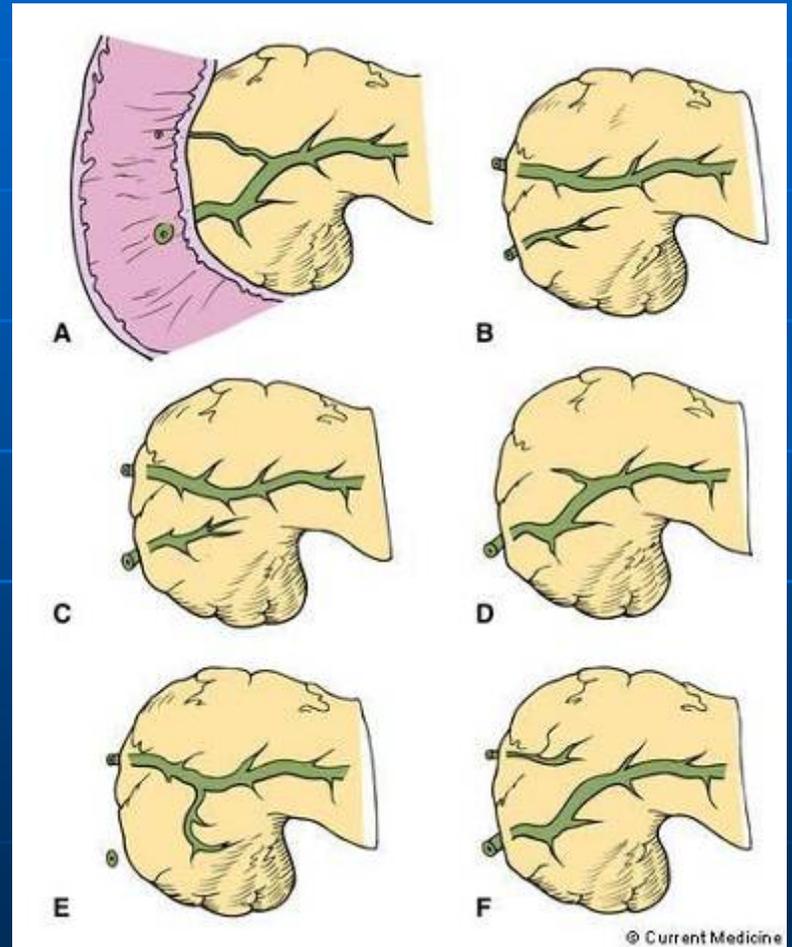


TABLE 6 - 3. ANATOMIC CATEGORIZATION OF CONGENITAL PANCREATIC ANOMALIES AND VARIANTS

Ventral - dorsal ductal malfusion

Pancreas divisum

Incomplete pancreas divisum

Isolated dorsal segment

Rotation - migration problems

Annular pancreas

Ectopic pancreas

Ectopic papillae

Quantitative underdevelopment

Agenesis

Hypoplasia

Duplication

Ductal

Total

Partial—tail, body

Accessory papilla

Atypical ductal configuration

Ansa

Spiral

Horseshoe

Miscellaneous

Anomalous pancreatobiliary
junction

Cystic malformations

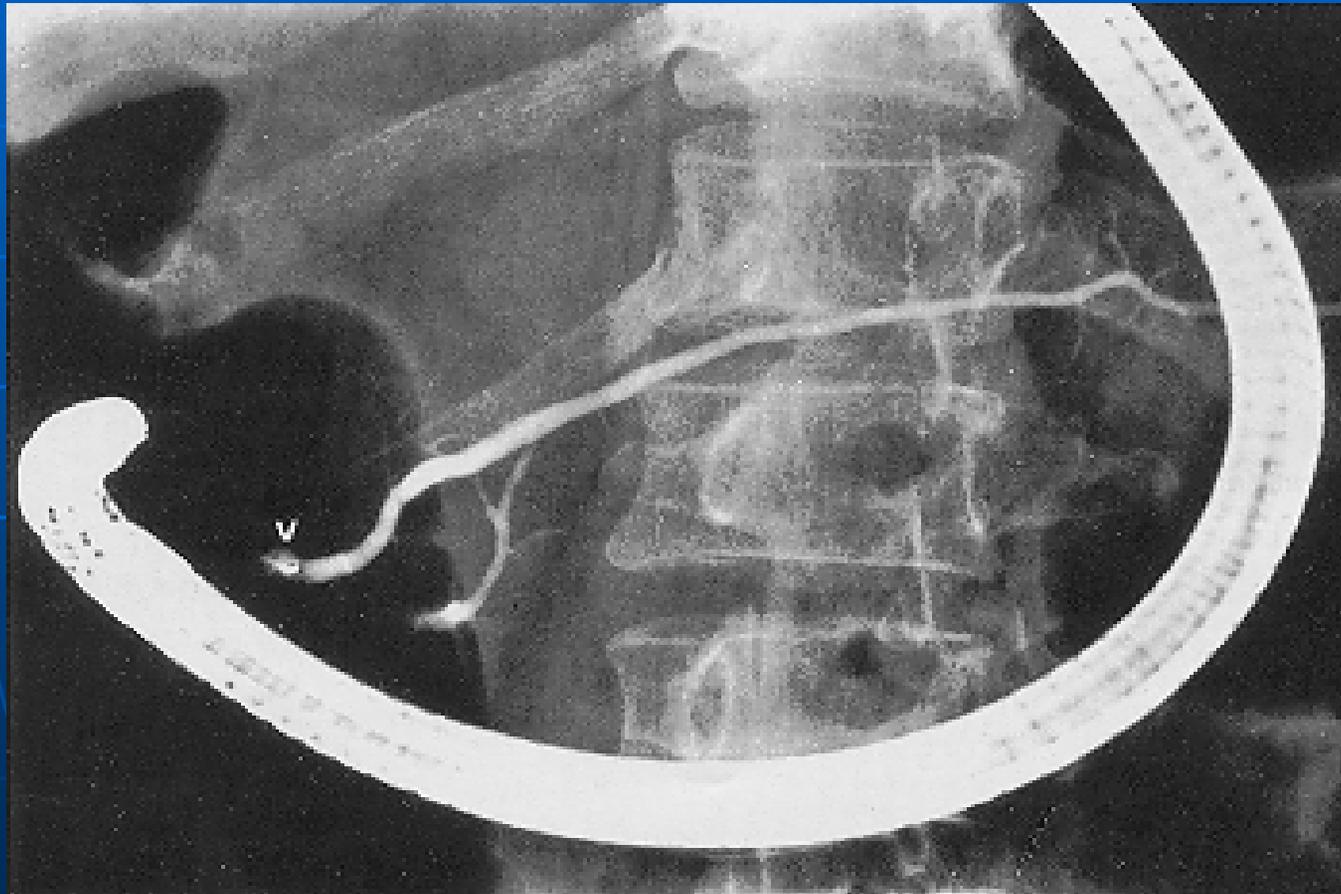
Single

Polycystic

Pancreas Divisum

- Normal variant where the dorsal and ventral PD fail to fuse
- Results in two isolated ductal systems
- 7-10% prevalence
- Ducts of the ventral pancreas have a complete but smaller caliber ductal system
- P. divisum must be differentiated from obstruction of the main PD by neoplasm, pancreatitis, or trauma.

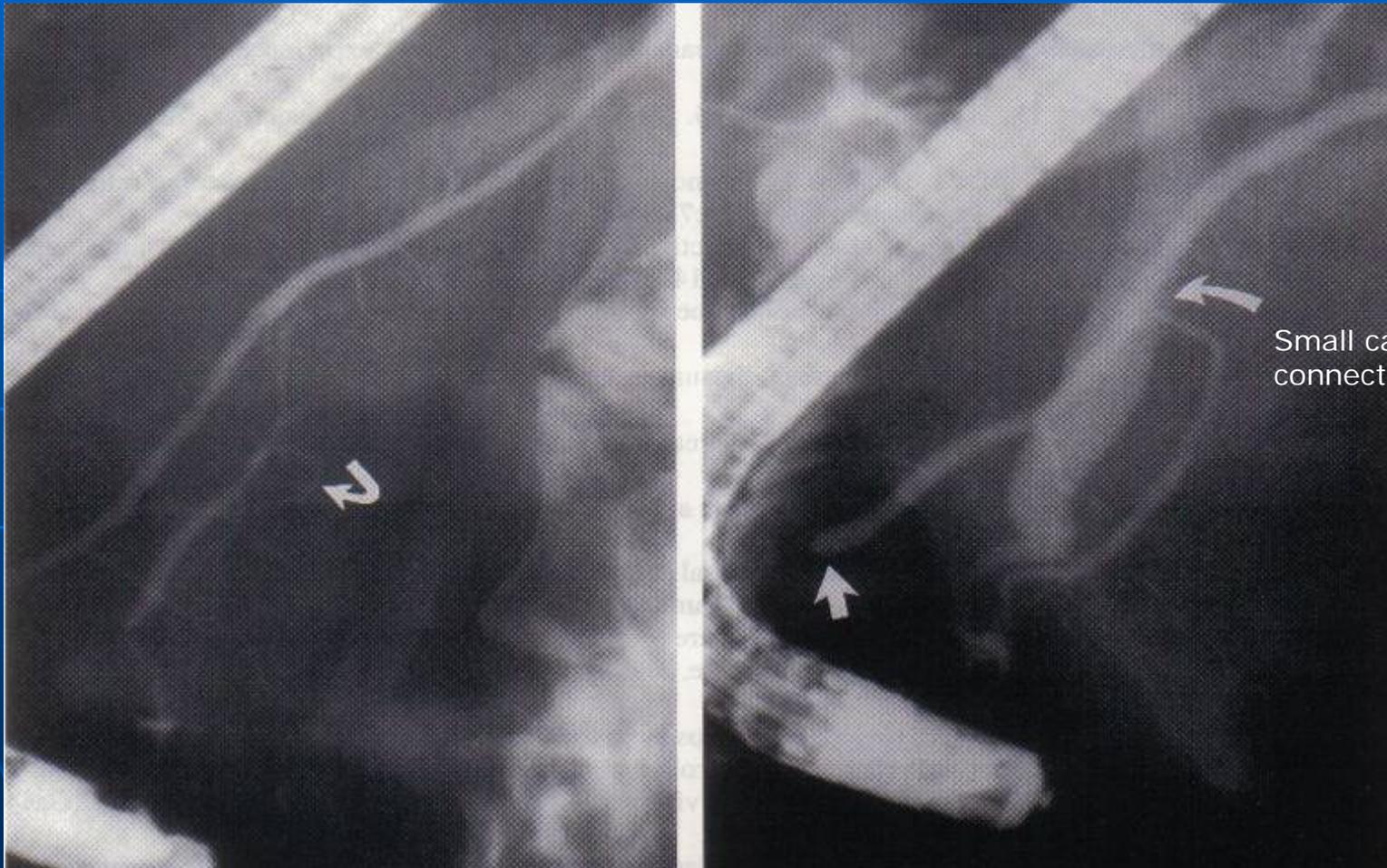
P divisum



Incomplete Divisum

- Near total separation of the dorsal and ventral duct systems
- Small caliber connection
- Results in dorsal dominant system
- Must again differentiate from pathologic obstruction

Incomplete P. divisum

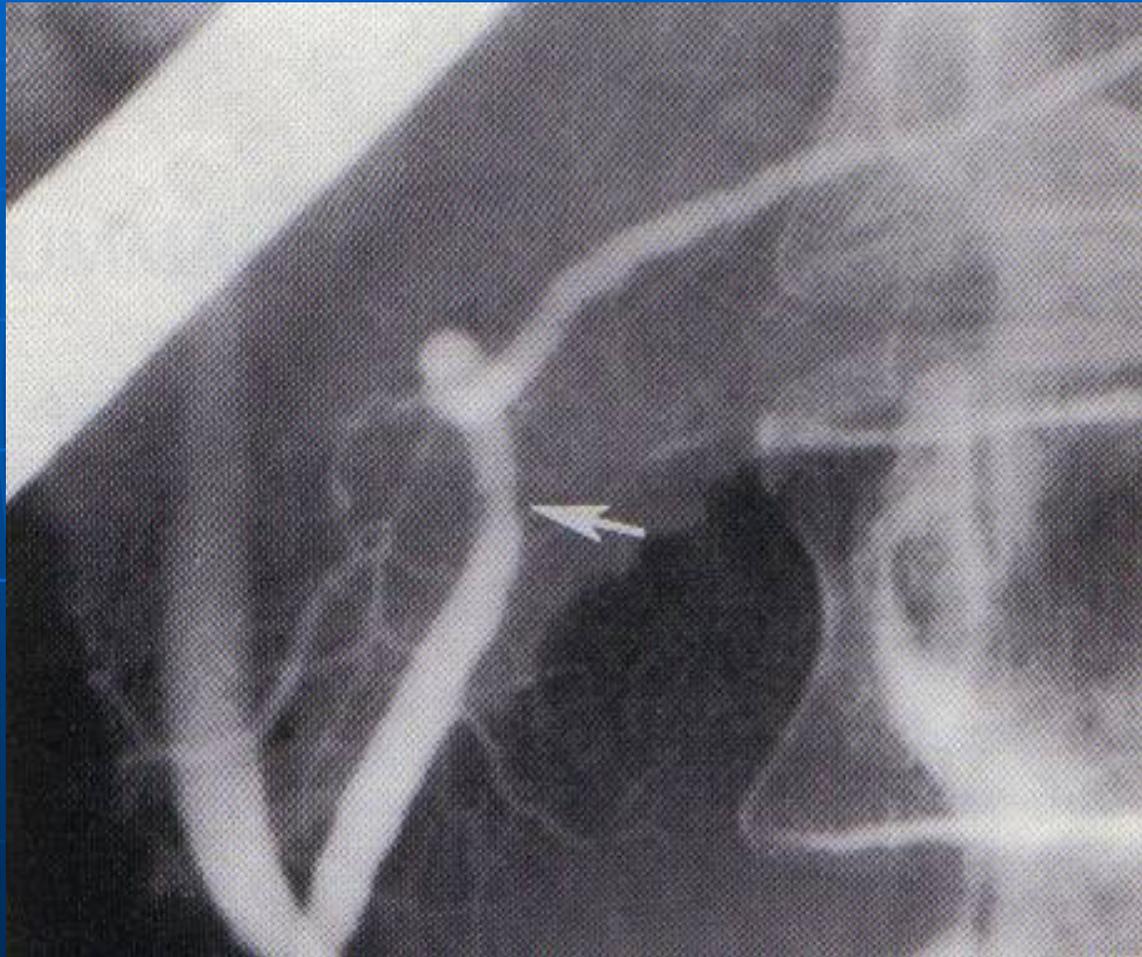


Small caliber
connection

Fusion Narrowing of Main PD

- Focal narrowing at the main PD near the junction of fusion of dorsal and ventral PD
- No evidence of pancreatic disease
- Lack of proximal dilation, abnormal side branches differentiate from pathologic stenosis

Fusion Narrowing



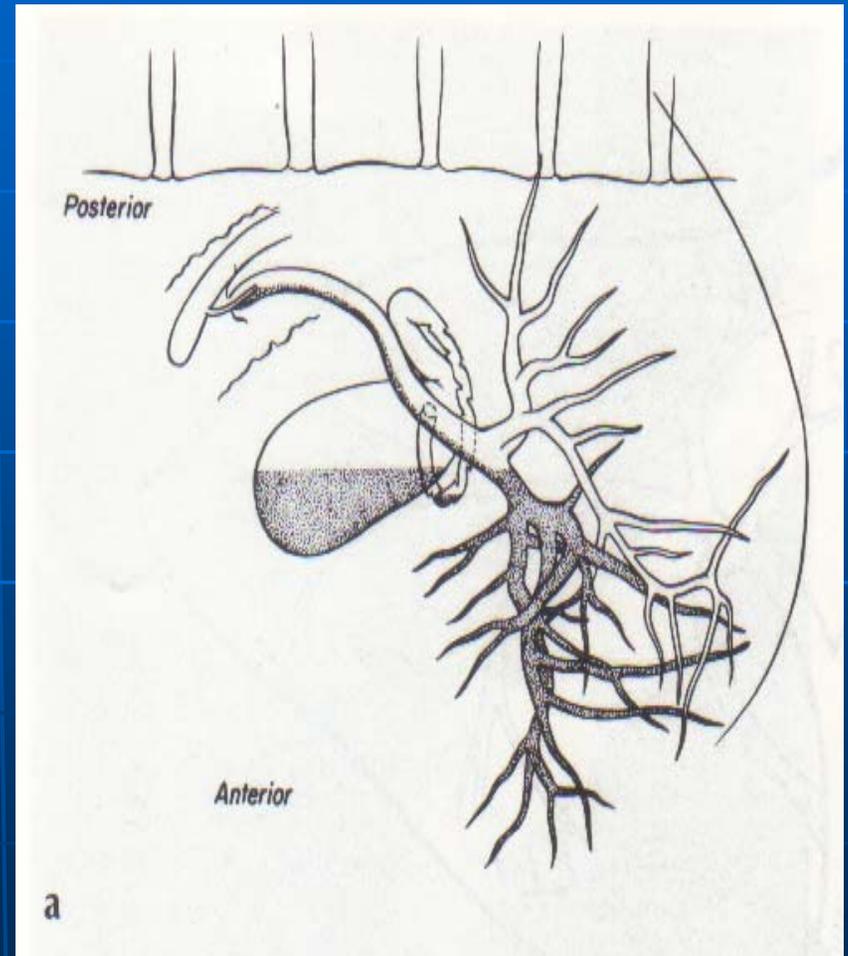
Normal Anatomy of the Biliary Tree

- Must have a basic knowledge of normal and variant anatomy of the IHD/EHD systems to perform ERC studies.
- Ducts to all territories at ERC should be accounted for.



Left Hepatic Duct

- Has an anterior relationship to the RHD.
- The A-P relationship is maintained in the IHD network.
- ERC prone position the L ductal system preferentially will fill.
- Increased injection/ position changes may be needed to opacify the R ductal system.



Right Ductal Anatomy

- More variance than the left ductal system
- As ducts penetrate deeper into the liver parenchyma the ducts taper in diameter and maintain a smooth appearance.



Extrahepatic Biliary tree

- CHD courses distally on a variable course, 2-3cm long, prior to combining with the CD to form the CBD.
- CBD is 10-15 cm in length, courses posterior/inferior to penetrate the duodenum at ampulla
- Distal 3rd runs on posterior aspect or within the parenchyma of the pancreas.
- Size variation can be normal variant based on portion of CBD visualized

EHBD Diameter

- Most agree the EHD widen with age
- Not everyone accepts that the CBD enlarges after CCK
- CBD $< 5-8\text{mm}$ is likely without pathology
- CBD $> 10\text{mm}$ is likely a pathologic dilation
- Point is do not assume CBD dilation is secondary to post-CCK

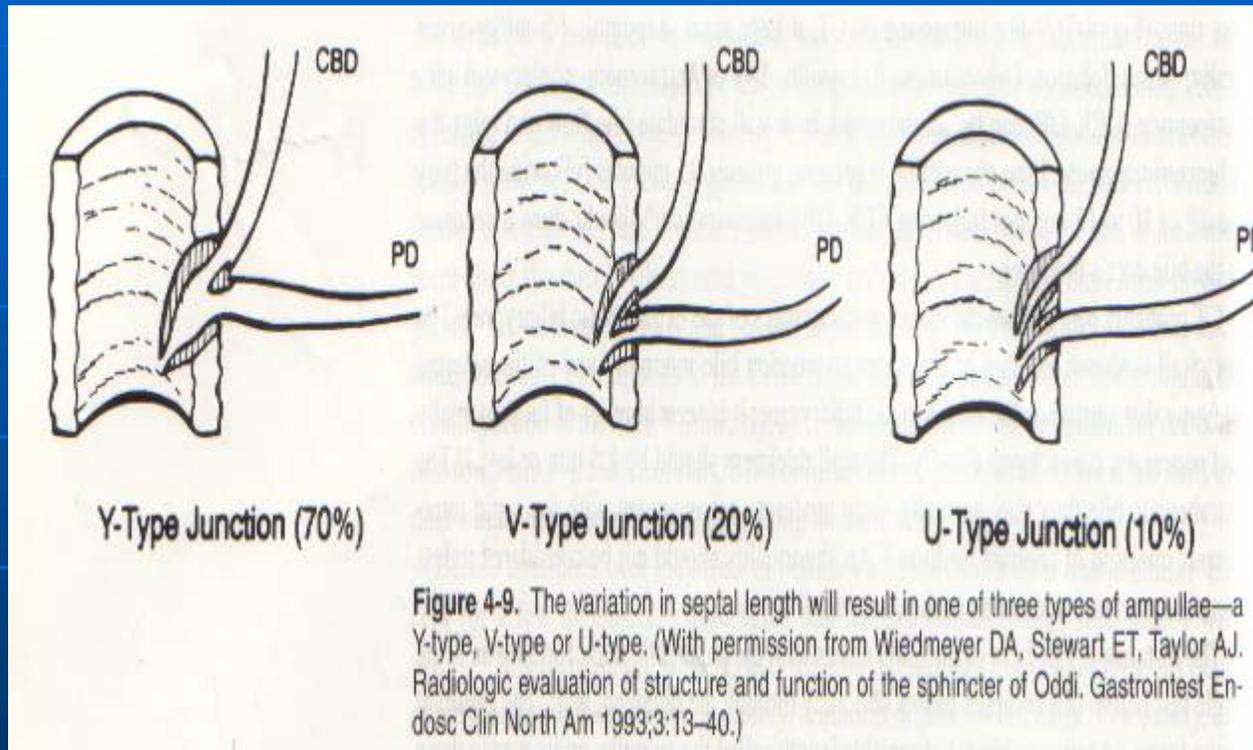
Anomalous Pancreaticobiliary Duct Union

- Distal 1-2cm of the CBD unites with the PD prior to passing through duodenal wall
- The common channel formed is the ampulla
- Common channel is usually 2-10mm in length, ULN 15mm

Ampulla Configuration

- A septum within the common channel creates different ERCP appearances based on its length
- 70% have short septum with resultant long "Y" channel
- 20% the septum length is longer with 1-2mm channel with "V" configuration
- 10% the CBD and PD penetrate into separate, adjacent openings (U)

Ampulla Configuration



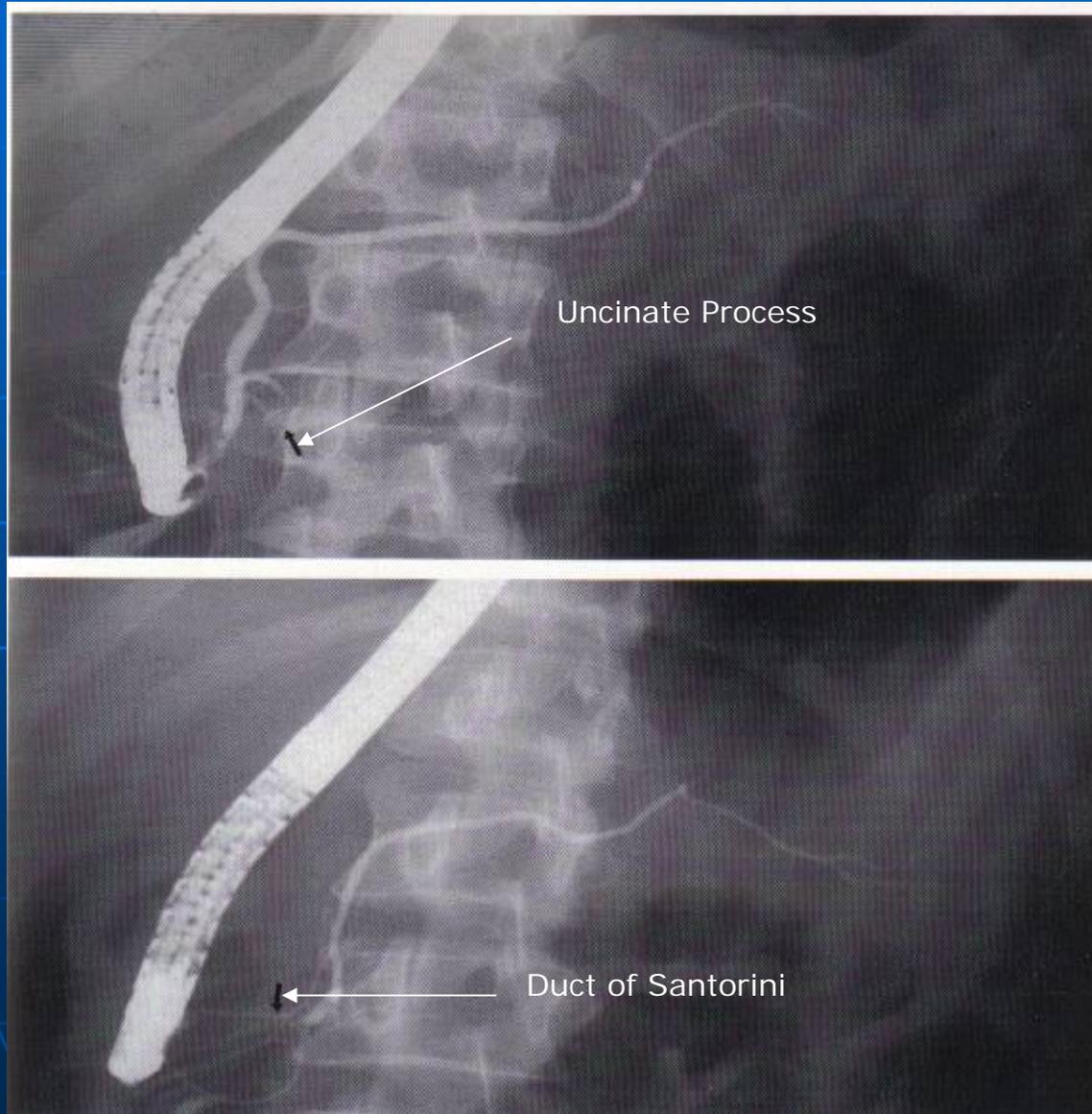
Anomalous Pancreaticobiliary Duct Union



Normal Main Pancreatic Duct

- The course of the MPD is highly variable and normal
- MPD can be divided into thirds; head, body, tail
- Underlying course is of no clinical significance
- MPD course can be altered at ERP by patient position, endoscope manipulation, cannula insertion, and displacement of organs by the endoscope

Normal PD

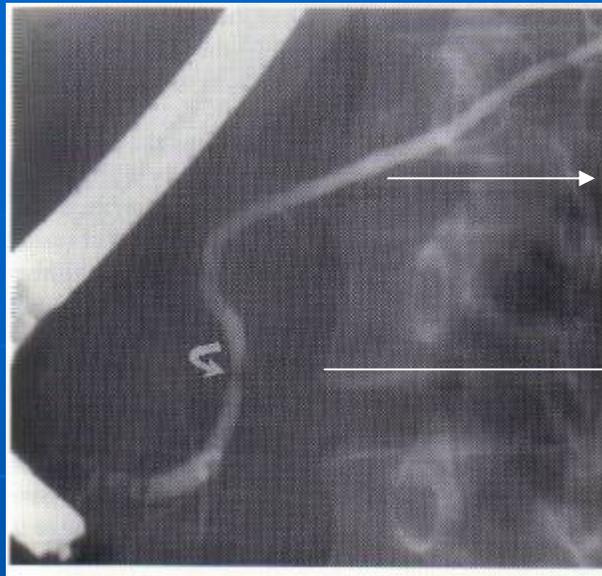


MPD length

- Normal is from 90-250mm
- Length is quite variable
- Important factor is to opacify entire length with deep cannulation or increased injection pressure (careful to avoid acinarization)

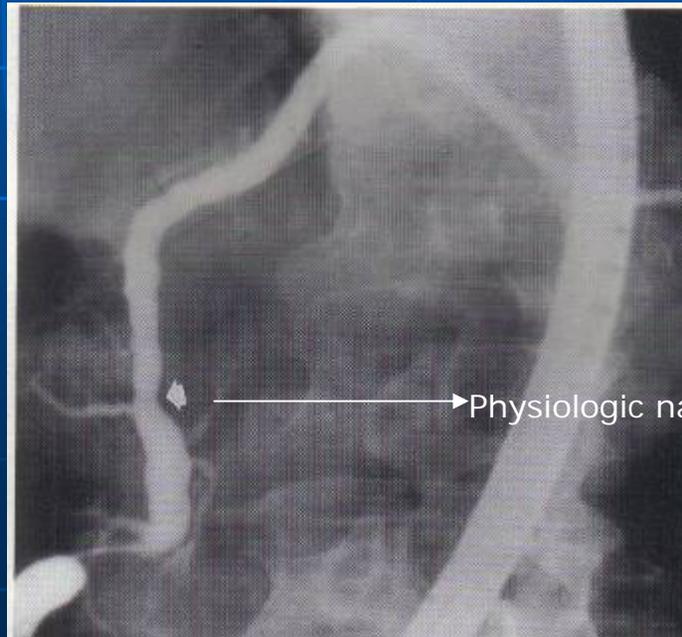
MPD Caliber

- PD caliber is greatest in head and tapers to the tail
- Two physiologic narrowings: 1) fusion of ventral and dorsal ducts 2) mid body as crosses SMA/spine
- Average dimensions of normal PD at ERP are 3-4mm in head, 2-3 mm in body, 1-2mm tail
- Highly variable and most agree a pathologic PD diameter is $>6\text{mm}$



Normal tapering of PD

Physiologic narrowing



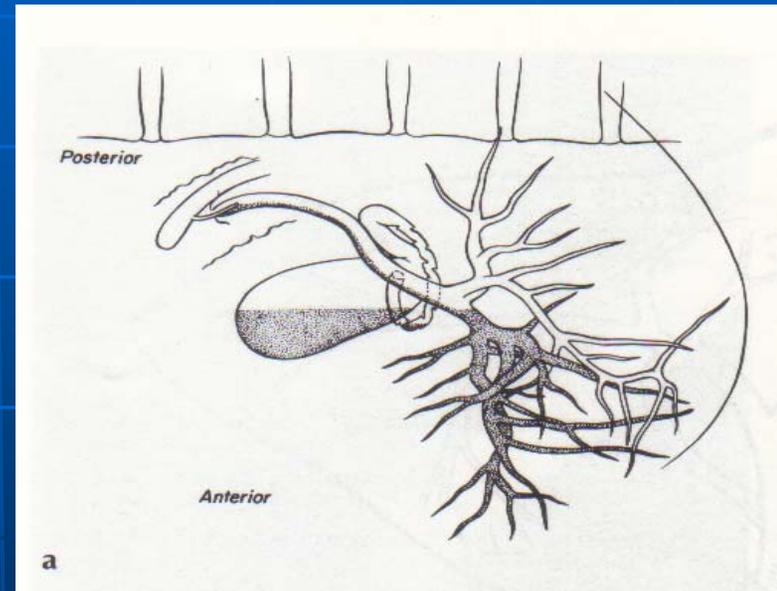
Physiologic narrowing

Radiologic Examination

- Scout films should be obtained to ensure no obscuring contrast, identify prior surgery and foreign bodies.
- Review all pertinent previous exams to guide plan for ERCP; Example: ERCP films, CT, US
- Prior surgeries need to be known for altered anatomy
- Failure to complete these tasks can lead to significant errors in interpretation of ERCP films

Anatomic Relationships and flow of Contrast

- Distal CBD posterior to CHD when penetrates the retroperitoneal duodenum
- Left IHBD lie anterior in the liver
- Right IHBD are posterior in the liver
- CD tends to course posterior to the CHD



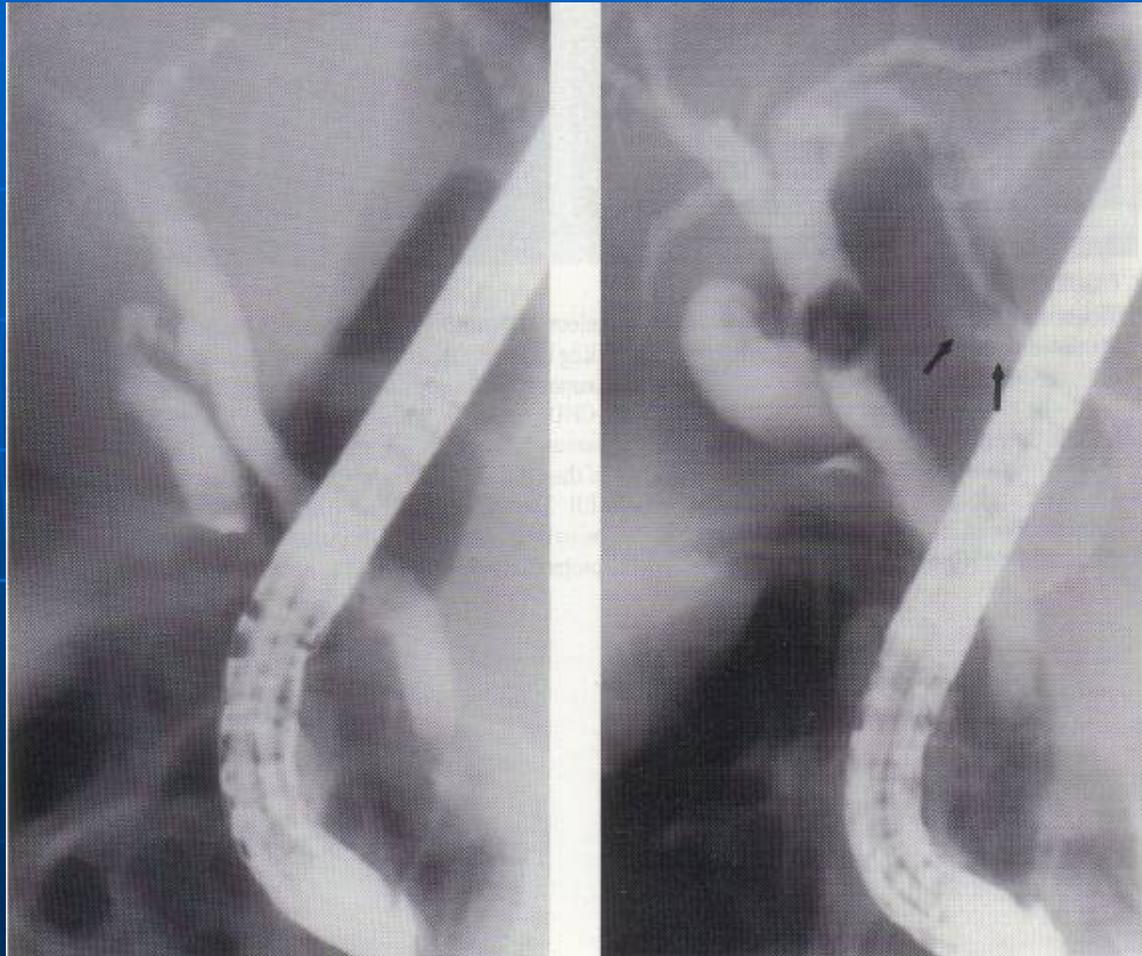
Film Sequence

- Scout film to evaluate for contrast, surgical clips, calcifications, stents, etc.
- Early injection films are essential to discern small calculi
- Stones can/will be obscured by large volume, full strength contrast
- The number of spot films needed is determined by the diagnostic question of the case and the specific area of interest
- Regardless of what system is being evaluated, one must ensure complete filling of the entire system(eg. Tail of PD, IHBD etc.)
- Post drainage films will identify functional/mechanical obstruction, eg. Papillary stenosis
- 45 for biliary tree, <5 min PD
- Document stents prior to removal, after placement.
- Film with scope removed can see missed pathology

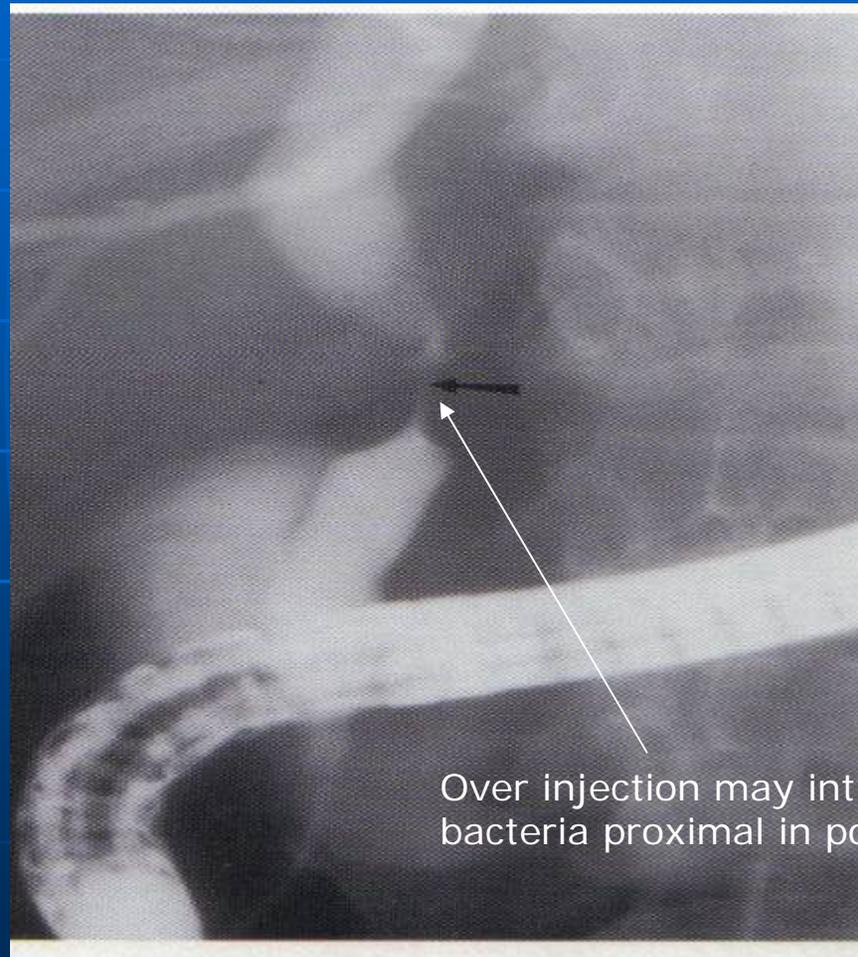
Injection Volume and Pressure

- Volume is amount which achieves opacification of ductal system in question and limited to define the anatomy
- Balloon cholangiogram is useful if there is excessive run off to GB, very dilated ducts, large ES
- PD should be injected until 2nd order branches are seen
- Injection pressure varies; high pressures may indicate a impacted cannula which can result in a submucosal injection, strictures, etc. May need selective cannulation to achieve injection.
- Smaller syringes increase injection pressure (hydraulics)
- Avoid over-injection of strictures and pseudocysts

Balloon Cholangiogram



Stricture Injection



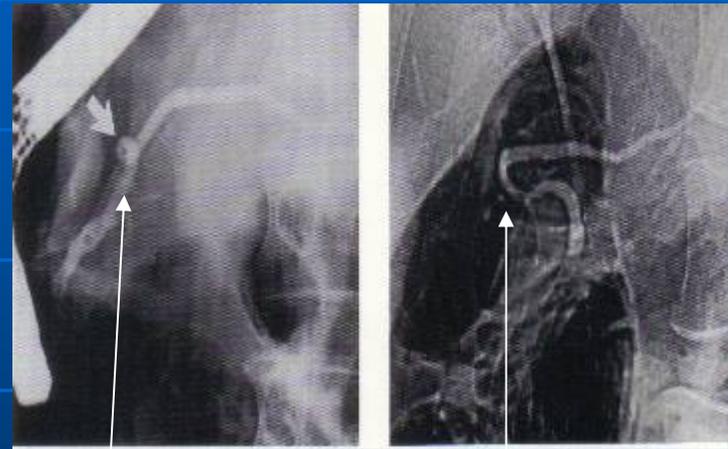
Over injection may introduce bacteria proximal in poorly drained system

Artifacts in the Interpretation of ERCP

- Must know normal variants



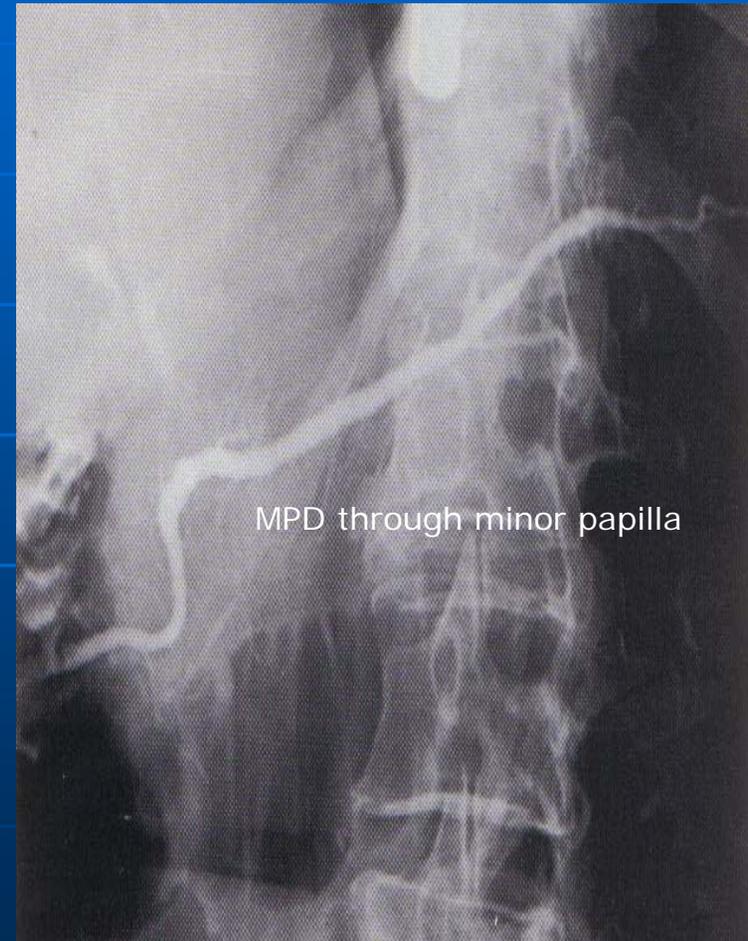
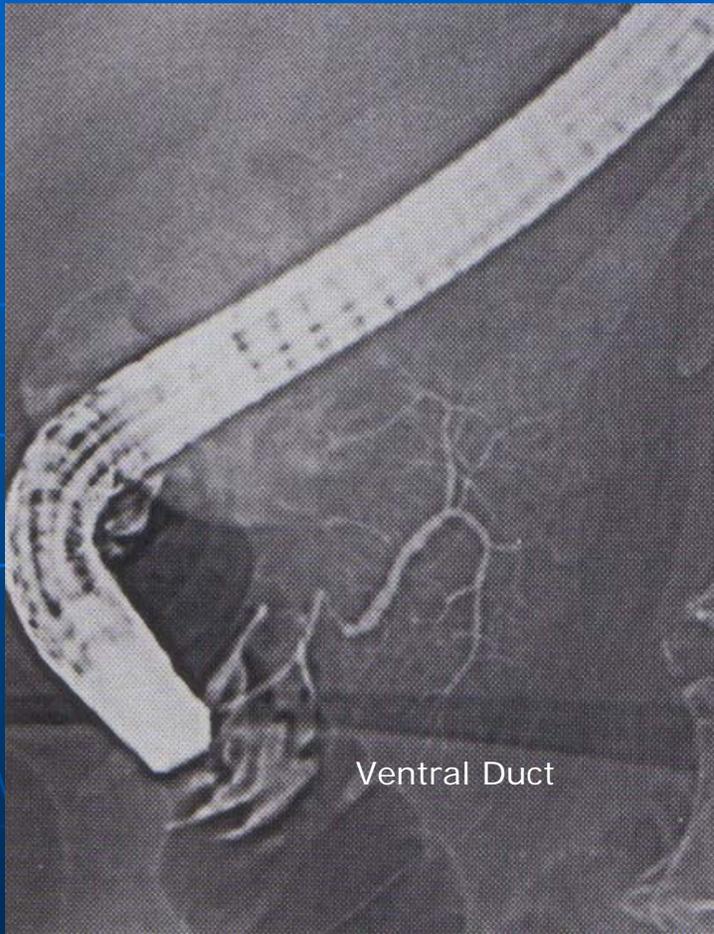
Fusion narrowing



PD loop

PD loop lateral

P. divisum



PD Course Variation



FIGURE 5-8

Normal pancreatic duct. This normal ERP shows a typical, gently ascending course. Study the superimposed ducts in the pancreatic head: duct of Santorini (arrowhead), duct of Wirsung (open arrow), and cannula (black arrow). Note that the uncinata duct (white arrow) arises mainly from the duct of Santorini.

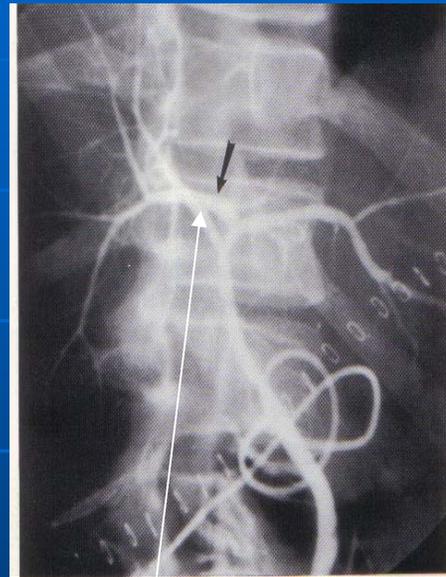
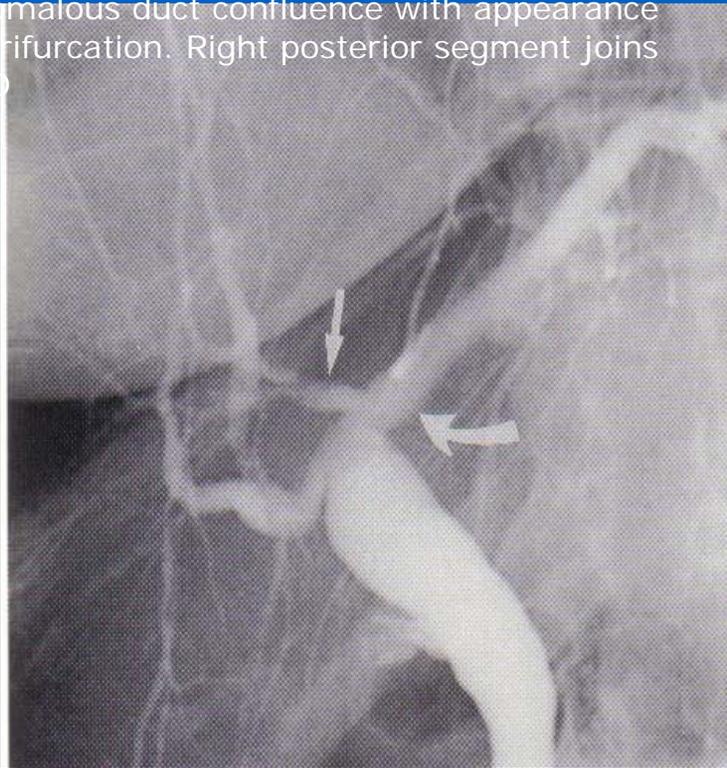
FIGURE 5-9

Normal pancreatic duct. This is a normal horizontal pancreatic duct. Note the normal variant narrowing (arrow) near the junction of the small duct of Santorini (arrowhead).

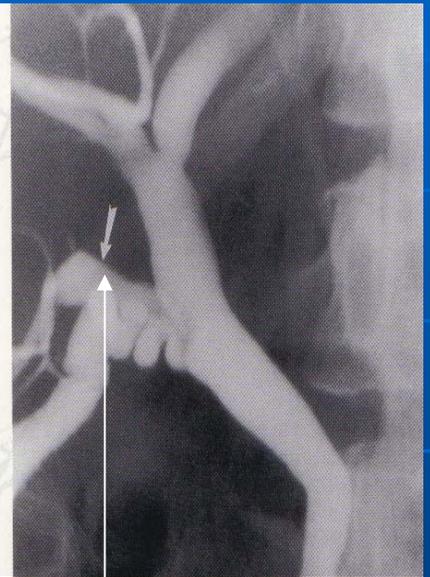


Bile Duct Variations

Anomalous duct confluence with appearance of trifurcation. Right posterior segment joins LHD



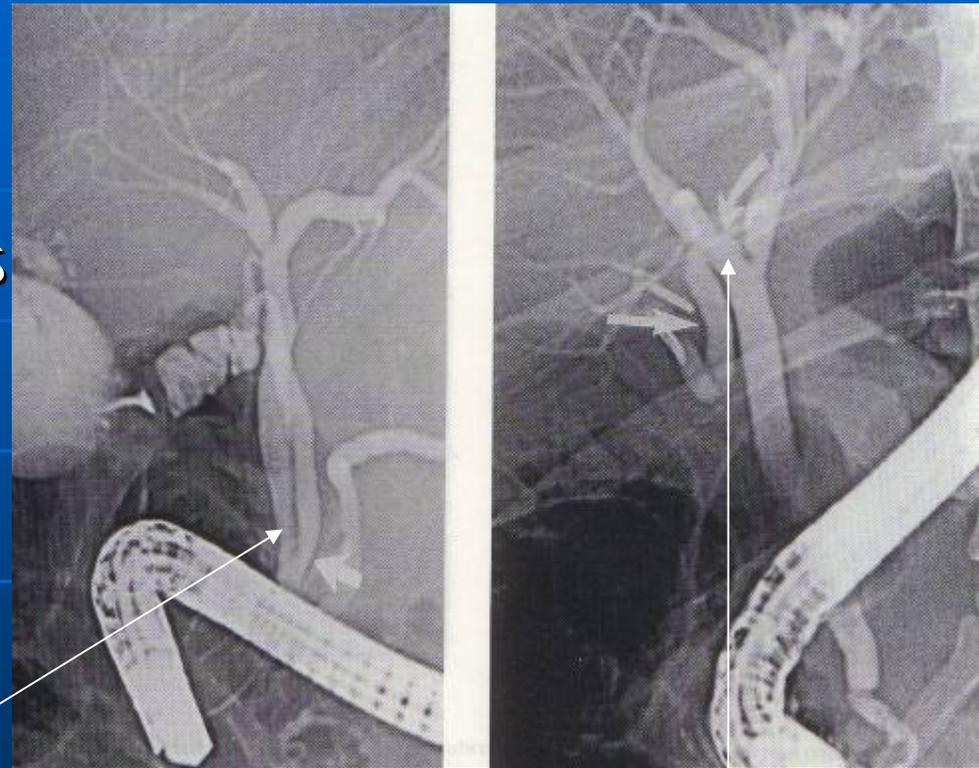
Right posterior segment
Joins LHD



Anomalous right duct
Joining CHD

Cystic Duct Variations

- Junction of CD is highly variable
- Course definition is required as useful information for surgeon



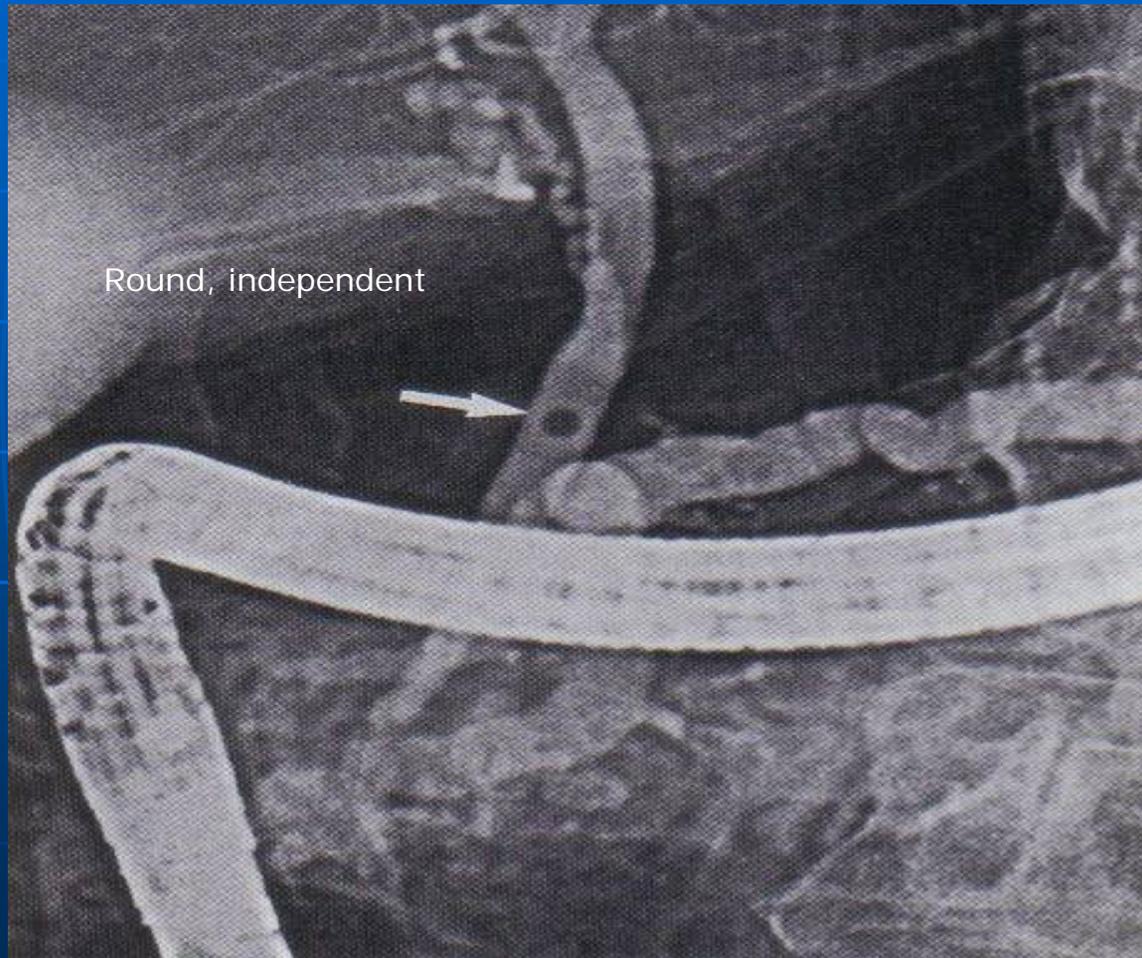
Low medial insertion
of CD

CD remnant joins the RHD

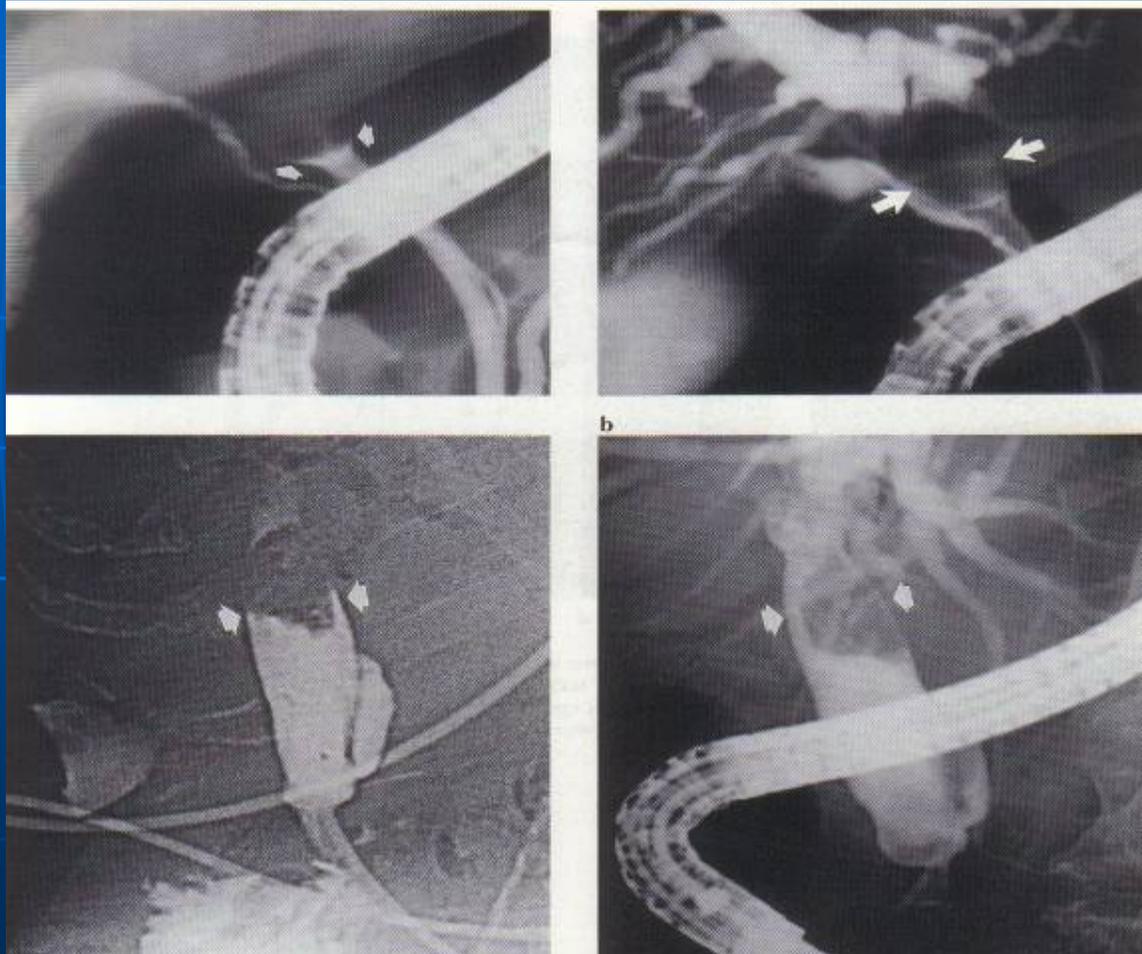
Artifact Lesions

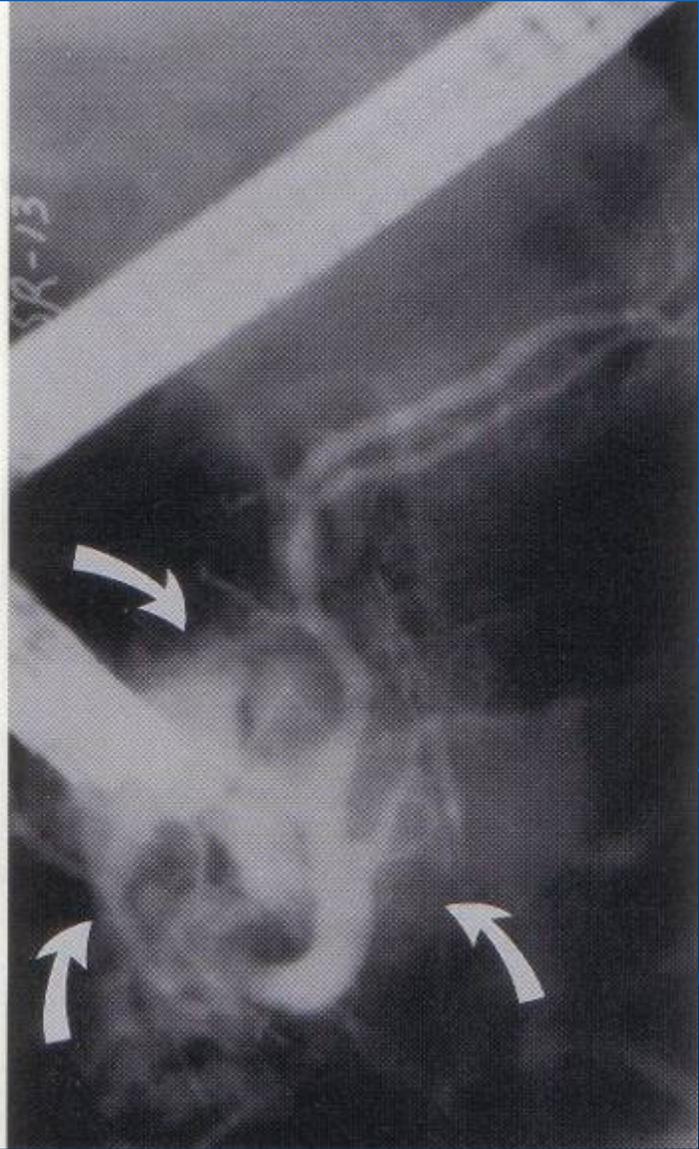
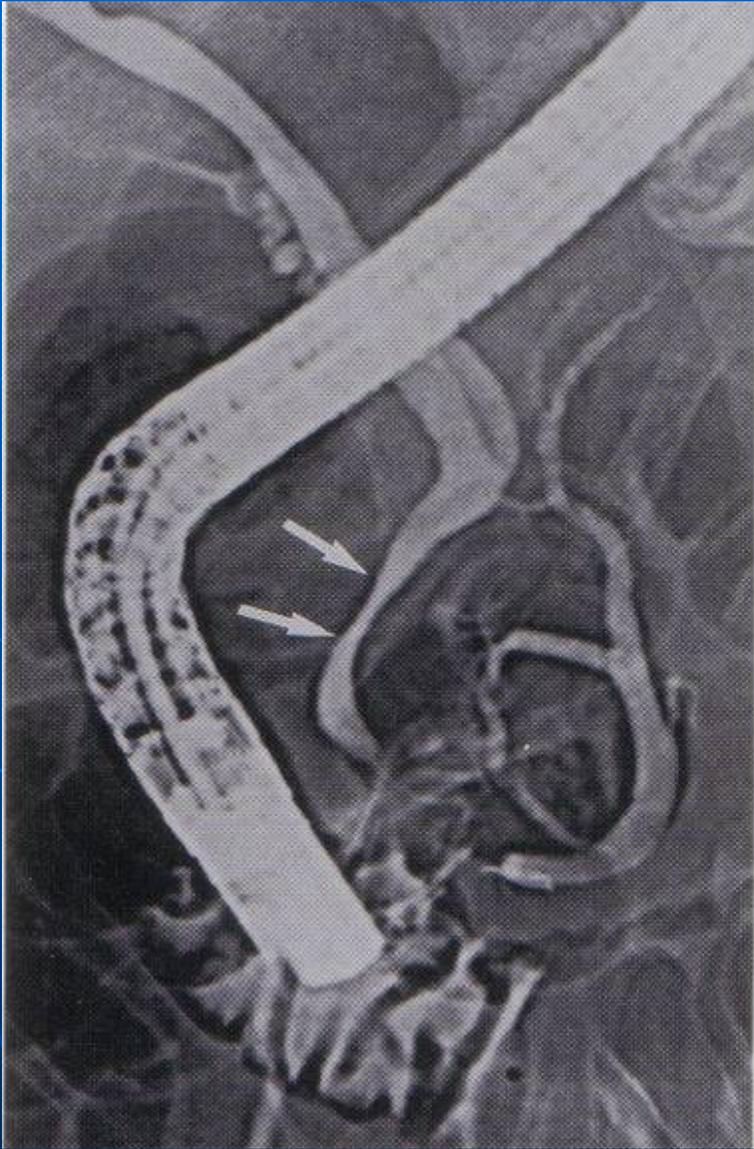
- Pseudocalculi: air, blood, mucus, pappillomas, cholangiocarcinomas, metastatic disease, lymph node compression, HCC.
- Air bubbles are usually round, oval, move in independent fashion, can be stabbed, suctioned, and are compliant to surrounding duct
- Calculi move dependently, often faceted
- Intraluminal masses are not mobile, cannot be dislodged or removed, tumors expand the duct margins focally

Air Bubble



Intraluminal mass vs. Choledocholithiasis





Pseudostrictures

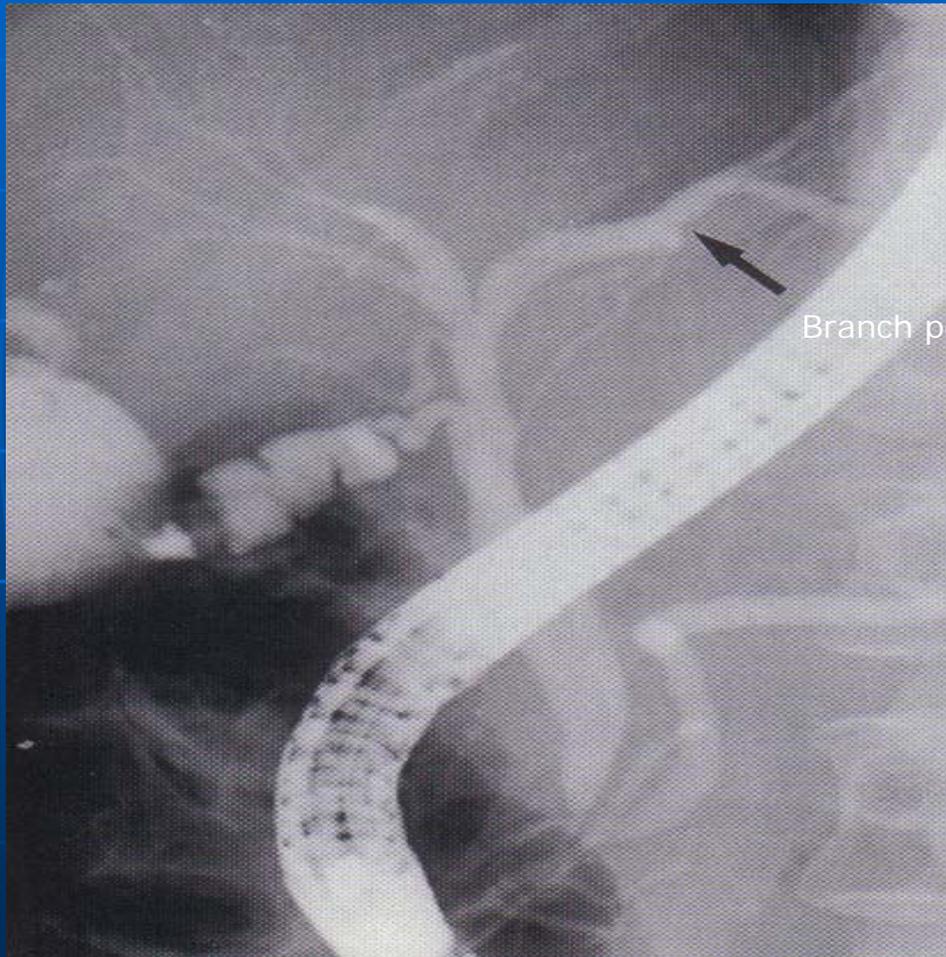
- Vascular compression
- Points of normal branching
- Transplant donor/native duct mismatch
- Under filling of intraluminal filling defects (air, blood, mucus, calculi)
- Normal ampullary segment of the CBD/PD at ampulla is narrowed as compared to remainder of ducts
- Most common over interpretation as pathologic strictures (Distinguish by upstream dilation and delayed drainage)

Vascular Impression

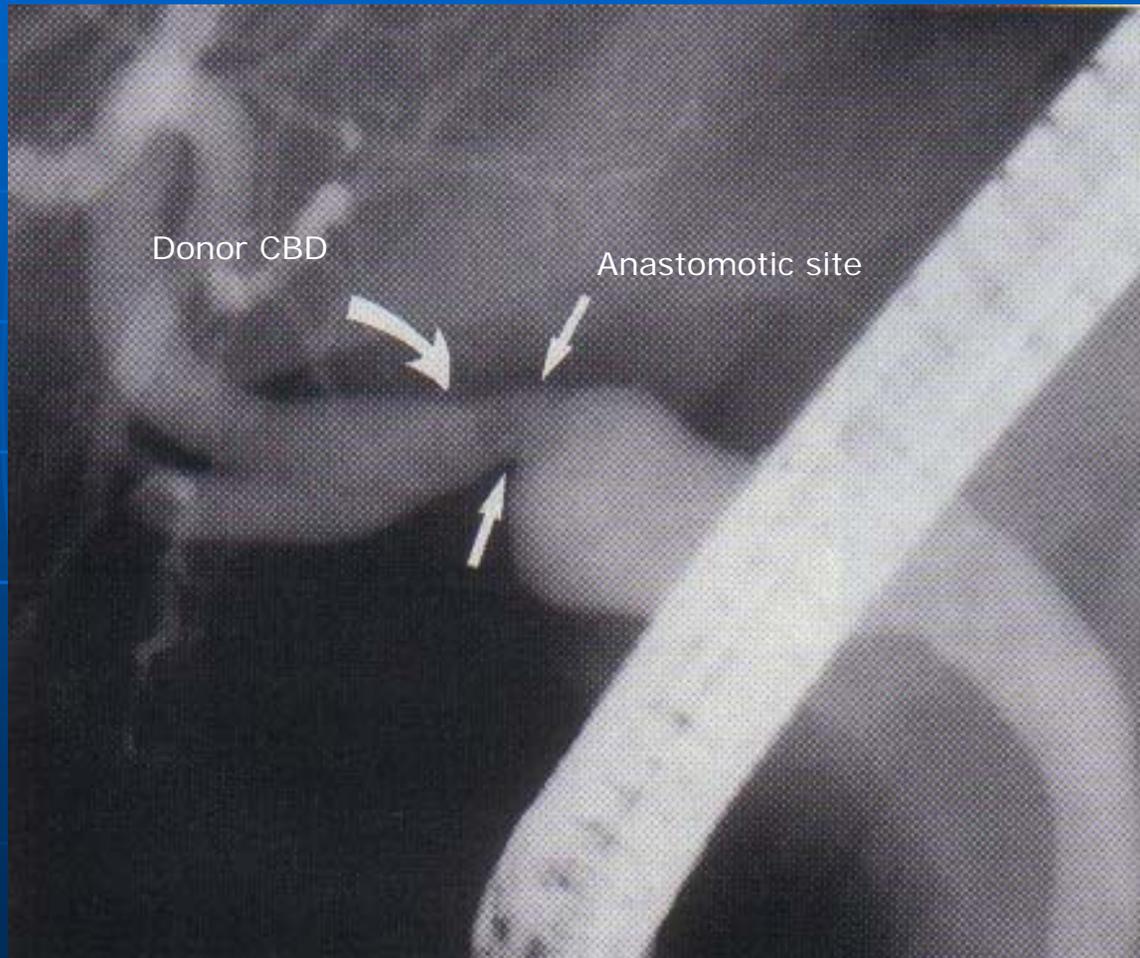


Compression from right hepatic artery

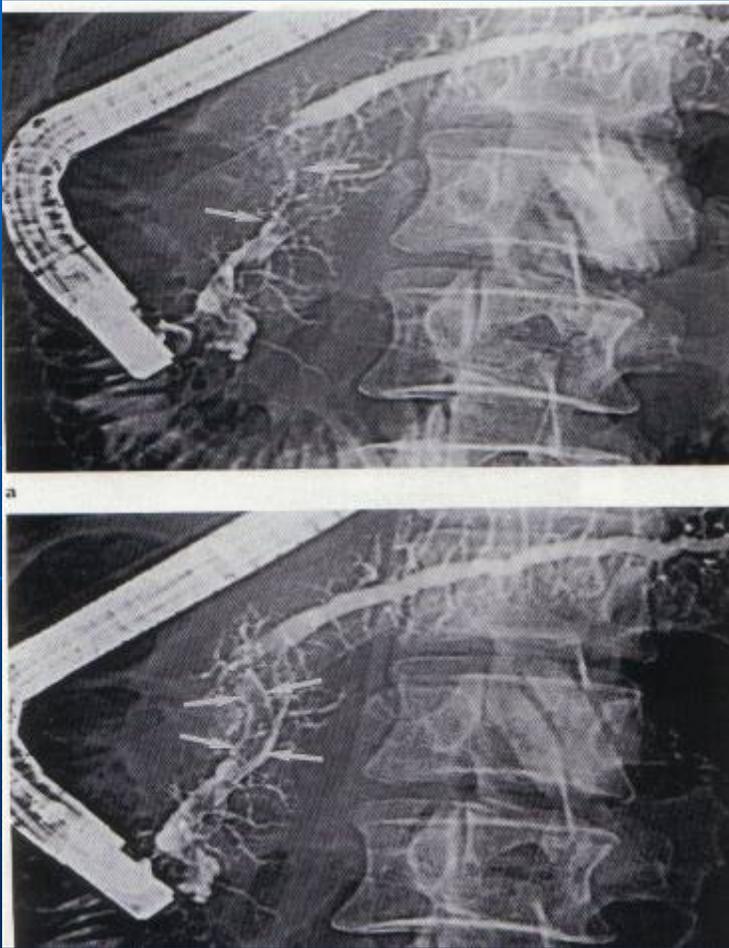
Pseudostricture of IHD



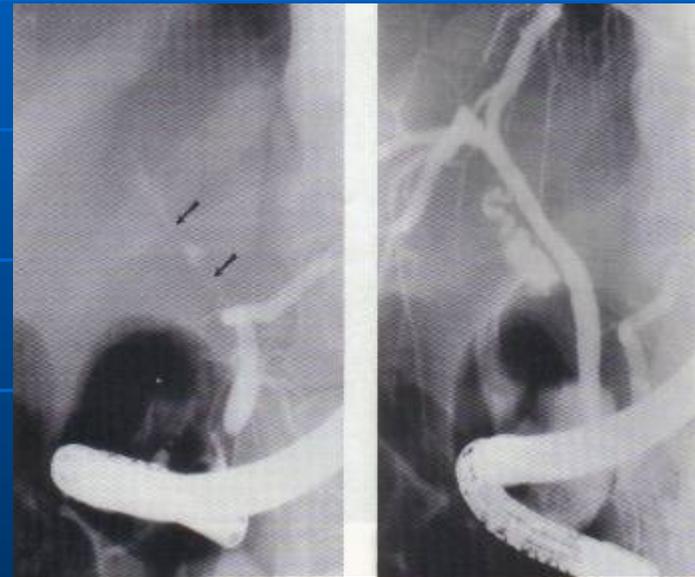
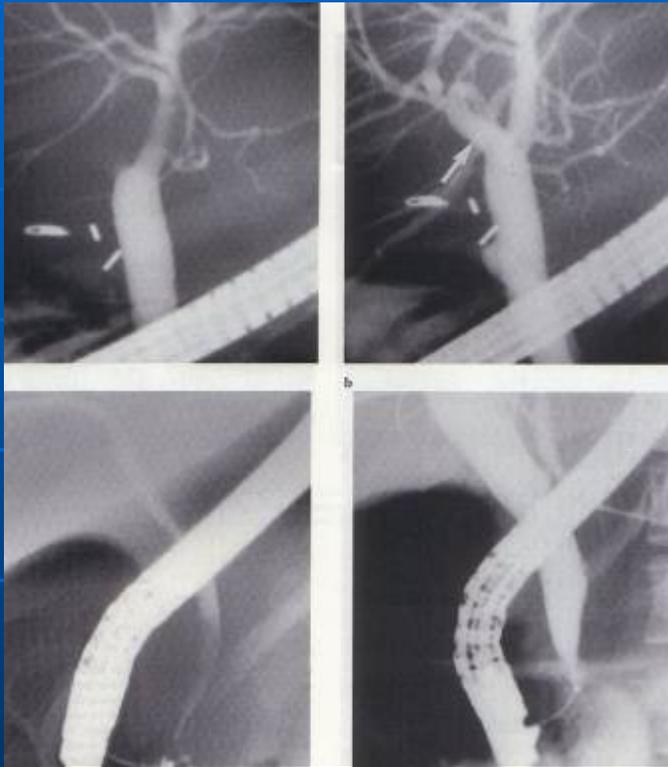
Mismatched Bile Ducts in Liver Transplant



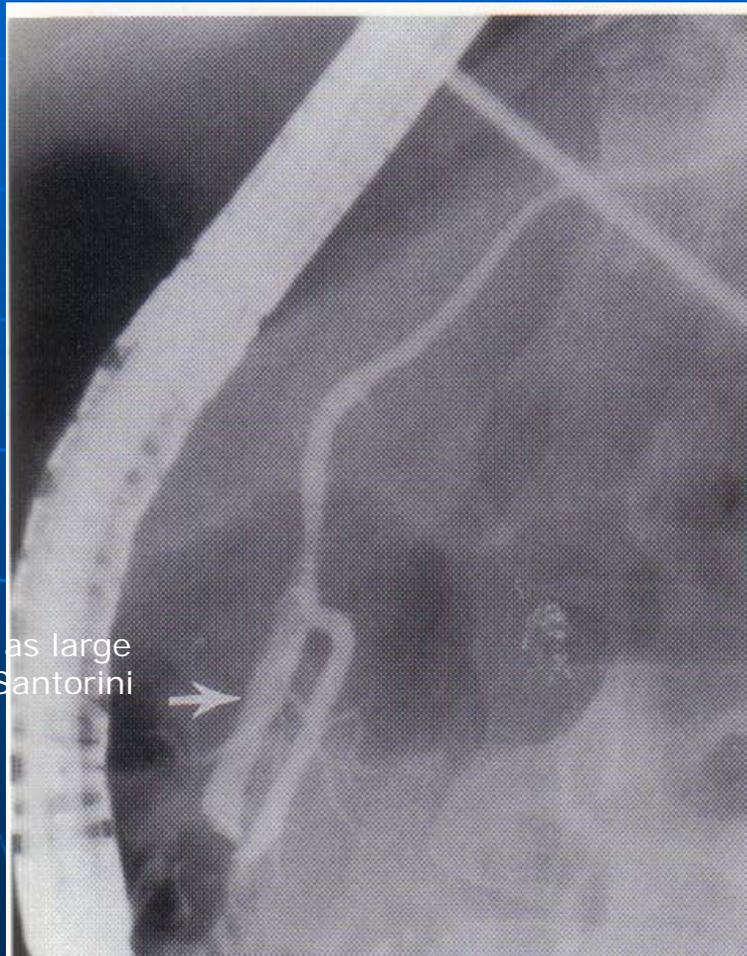
Pseudostricture



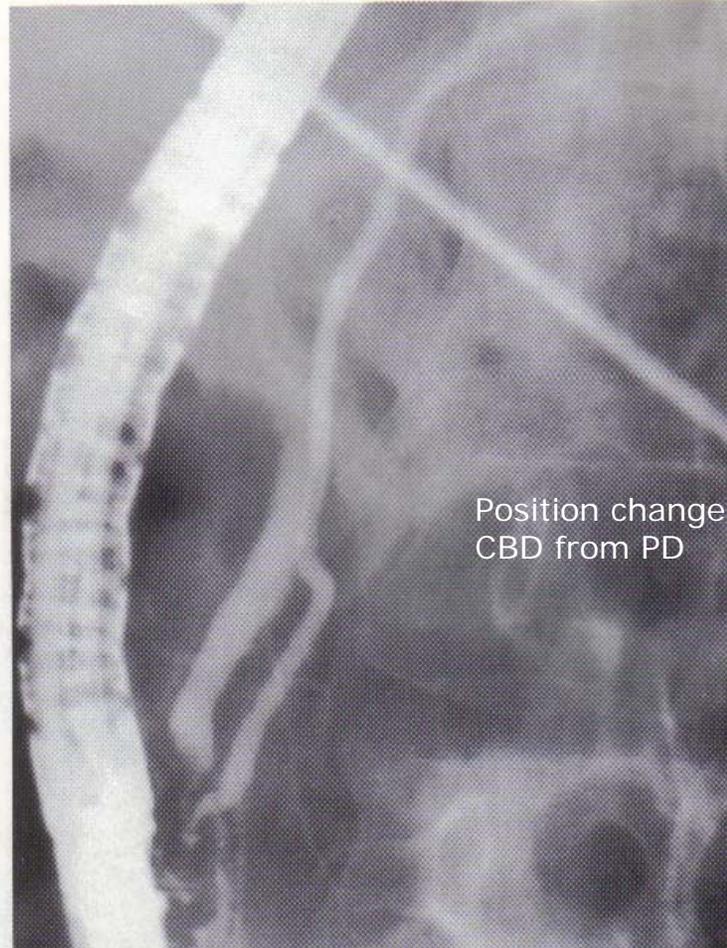
Under fill Artifacts



Under fill Artifact



Appears as large
Duct of Santorini



Position change separates
CBD from PD

Summary

- Must be familiar with normal anatomy and variants.
- Must be familiar with artifacts.
- Must be familiar with appropriate technique for injection and film
- Must be able to interpret films and fluoro to make appropriate therapeutic decisions

Endoscope is inserted through the mouth into the duodenum

