Hepatobiliary Trauma: Current Approach to Management

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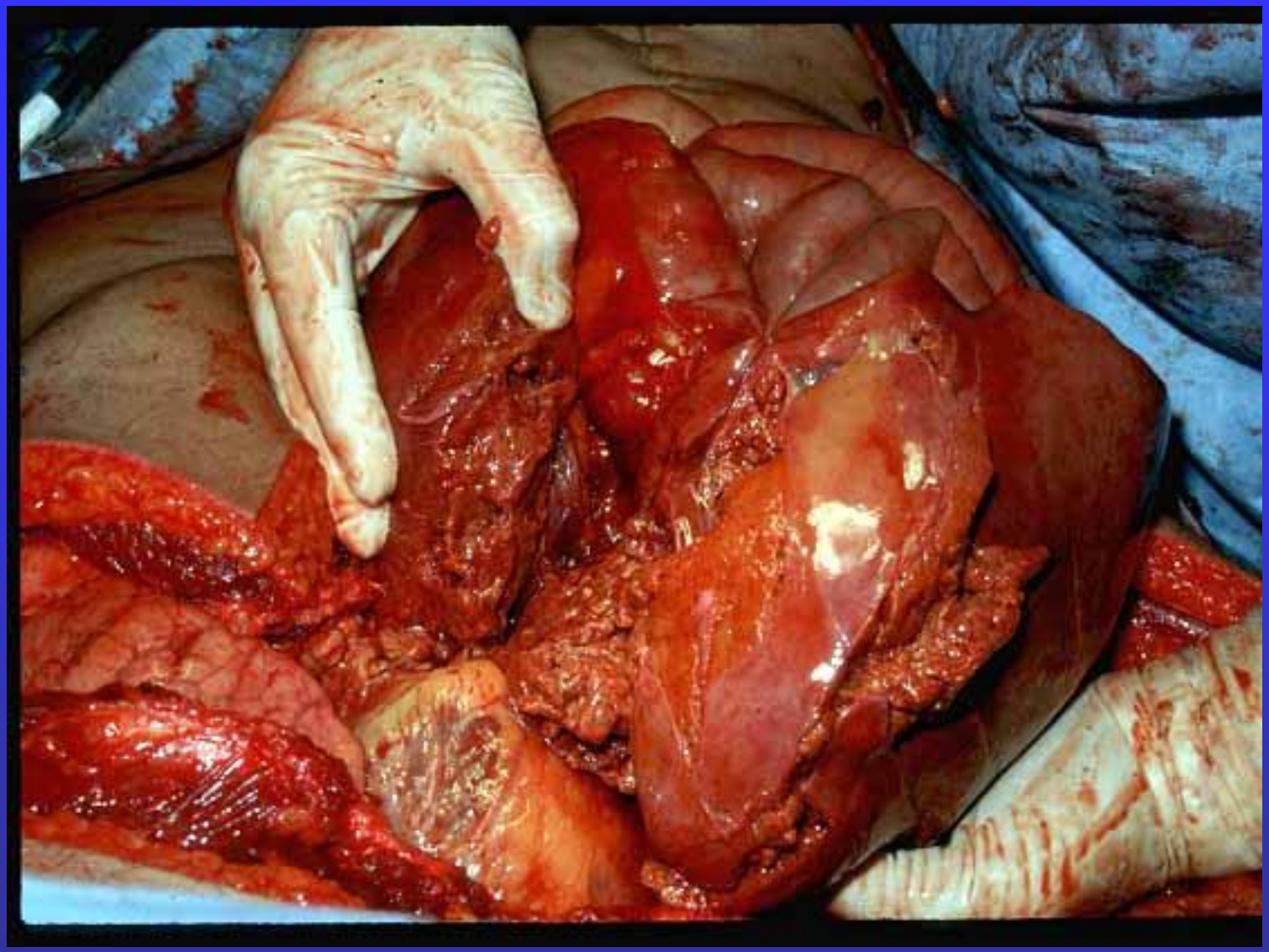


FIGURE 2.4. Ligaments of the liver viewed anteriorly. On the right is the upper layer of the right coronary ligament. On the left is the left coronary ligament, which ends as the left triangular ligament. In the midline lies the falciform ligament, the free margin of which contains the ligamentum teres. Most of convex superior surface is illustrated ending in a sharp inferior margin.

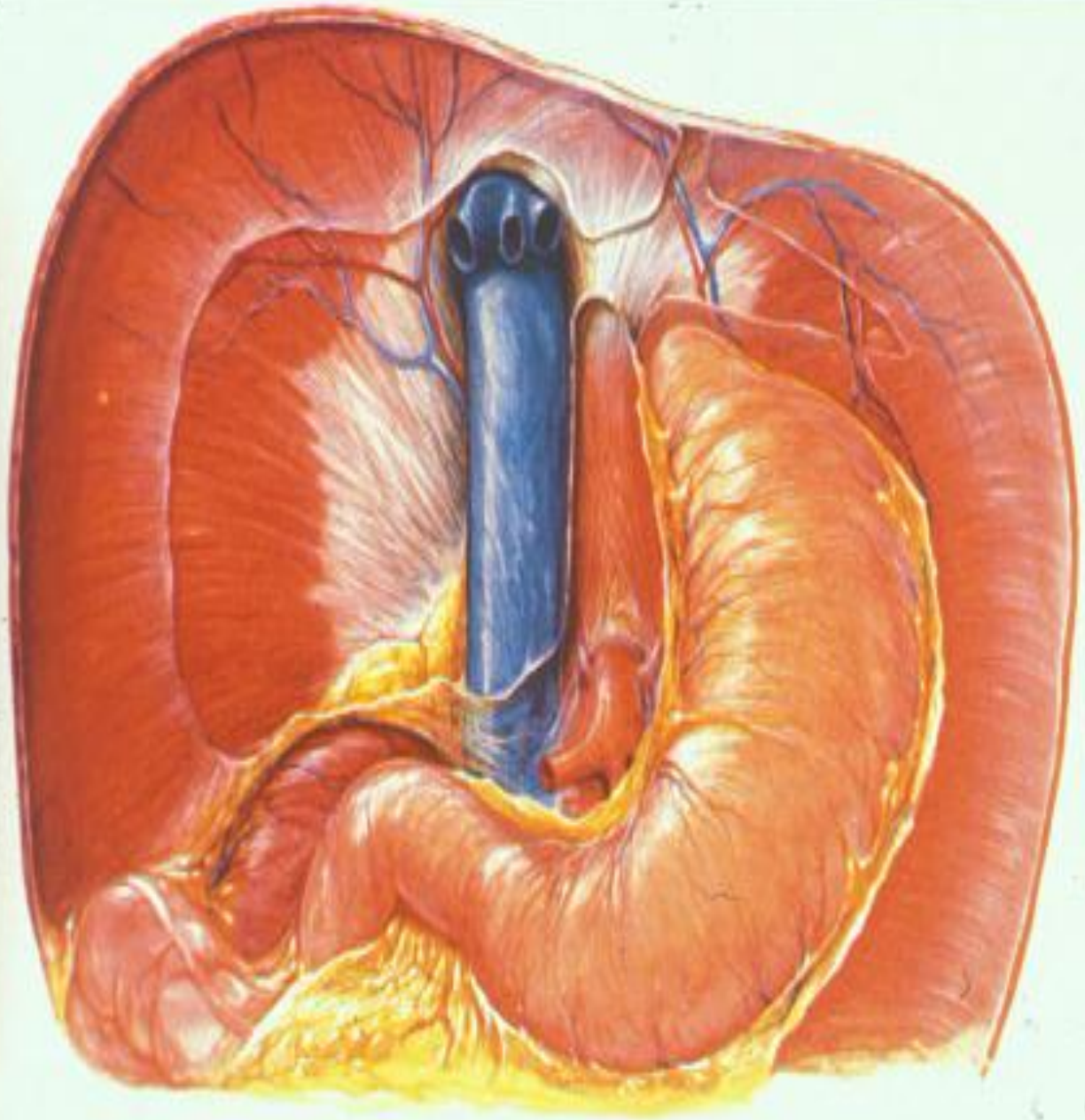


FIGURE 2.5. Diaphragmatic surface after removal of the liver. The ligamentous attachment, bare area, and adjacent structures (inferior vena cava, aorta, stomach, duodenum, hepatic flexure of colon, and right adrenal and kidney) can be seen.

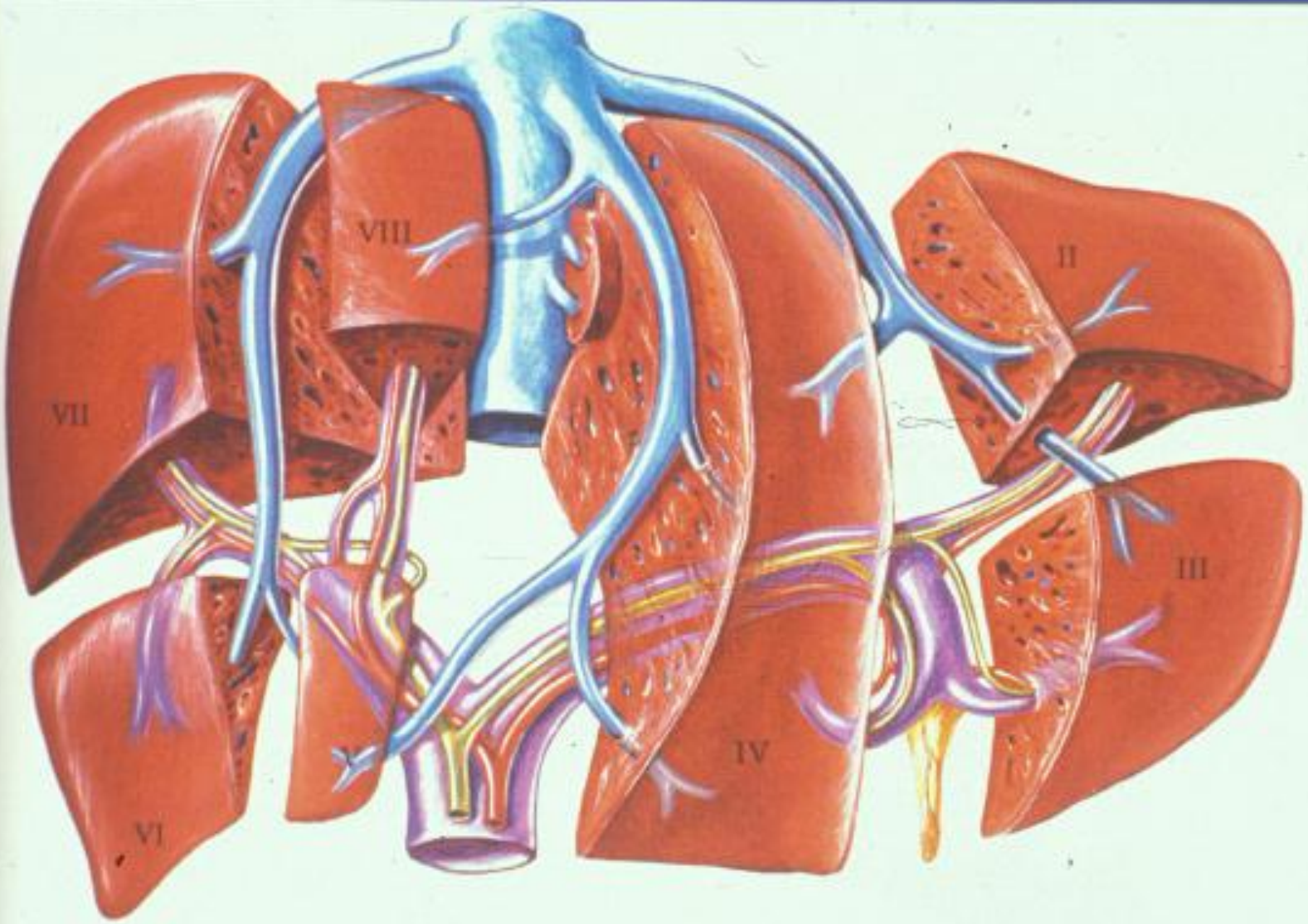


FIGURE 2.12. "Blow out" of Couinaud's segmental divisions.

OIS Liver Injury Grades

I	Haematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1cm parenchymal depth	2
II	Haematoma	Subcapsular, 10-50% surface area	2
		Intraparenchymal, <10cm diameter	2
	Laceration	1-3cm parenchymal depth, <10cm length	2
III	Haematoma	Subcapsular, >50% surface area or expanding. Ruptured subcapsular or parenchymal haematoma	3
		Intraparencymal haematoma >10cm or expanding	3
	Laceration	>3cm parenchymal depth	3
IV	Laceration	Parenchymal disruption involving 25-75% of hepatic lobe or 1-3 Coinaud's segments in a single lobe	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Coinaud's segments within a single lobe	5
	Vascular	Juxtahepatic venous injuries ie. retrohepatic vena cava/central major hepatic veins	5
VI	Vascular	Hepatic Avulsion	6

Advance one grade for multiple injuries to same organ up to Grade III.

BACKGROUND

- 1990: **nonoperative** "therapy" for liver tx
- 2000: nonoperative approach = **standard**
- **85% blunt liver trauma**: no surgery
- Most have **Grade I-III injuries**
- Hemodynamics **uncompromised**

Knudson/Lim: 1990 Pachter/Knudson:1996

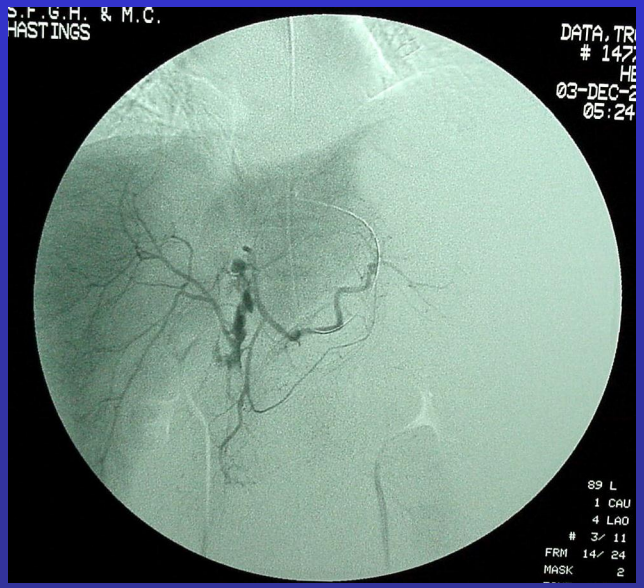
Malholtra/Fabian: 2000

GRADE IV-V LIVER INJURIES

- Operative mortality: **>50%**
- Hemodynamically **compromised**

ADJUNCTIVE MEASURES FOR LIVER INJURIES

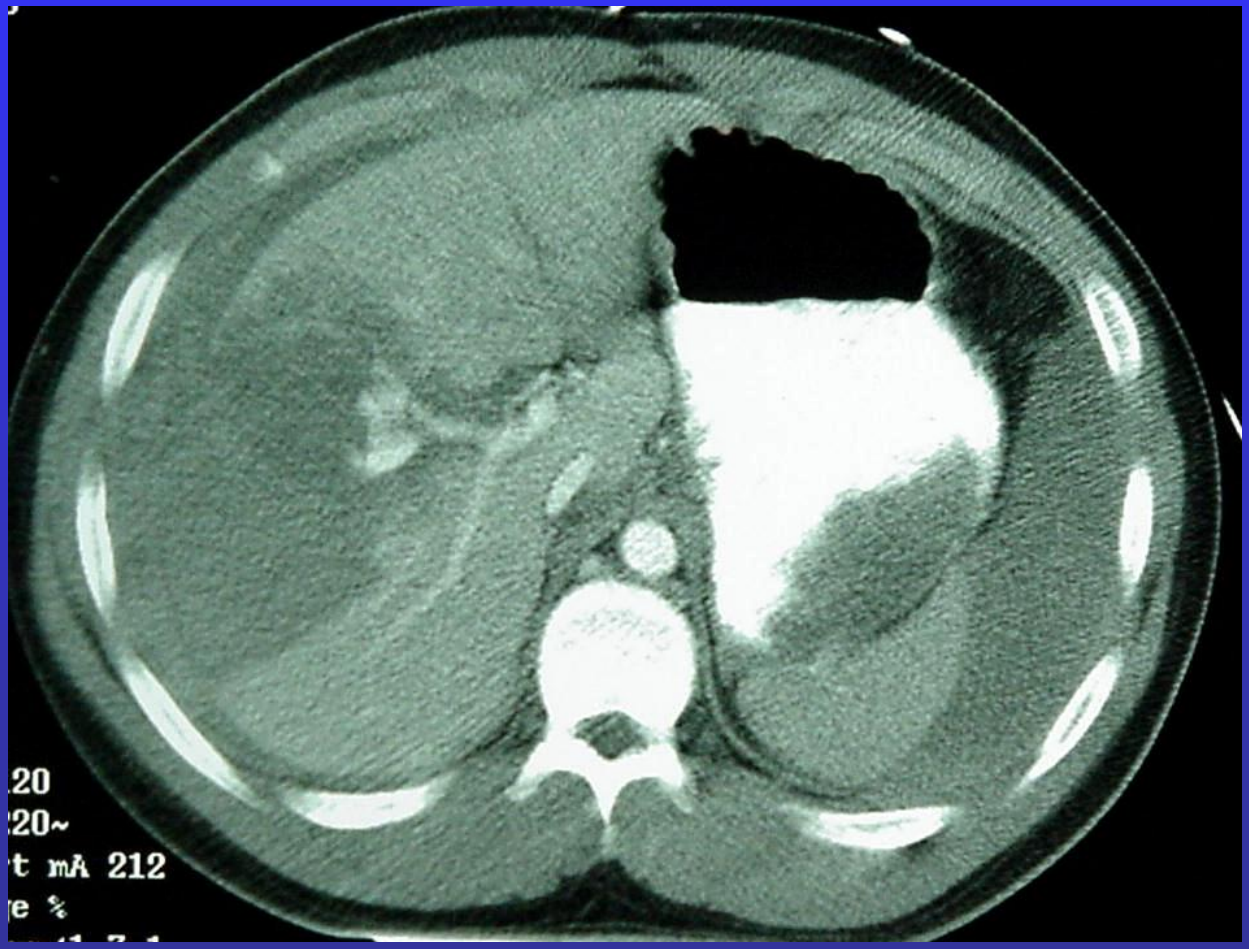
- Angiography
- ERCP with stenting/sphincteroromy
- Percutaneous drainage: IAH



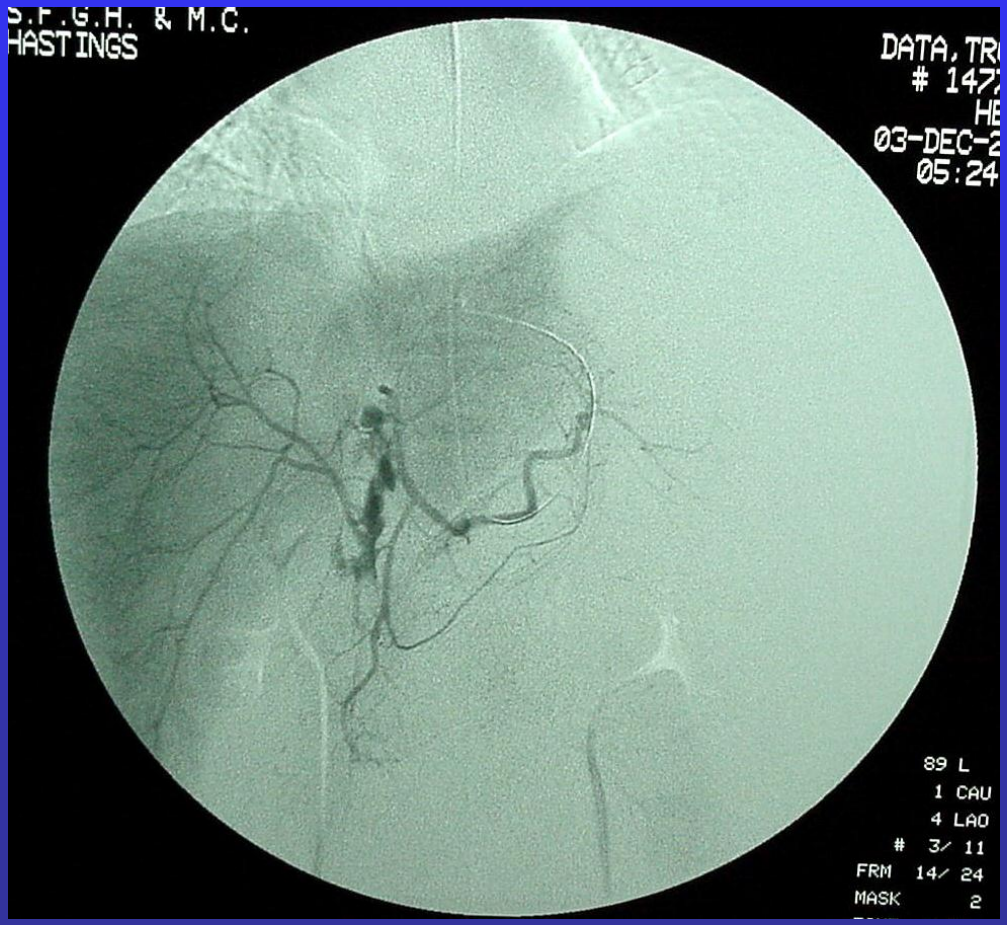
CASE PRESENTATION

- 20 year old man: **restrained** driver in MVA
- seat-belt mark; **tense, tender** abdomen
- BP-80 systolic: **responsive** to fluids
- **FAST exam positive** - transfusion initiated
- Abdominal **CT scan** performed

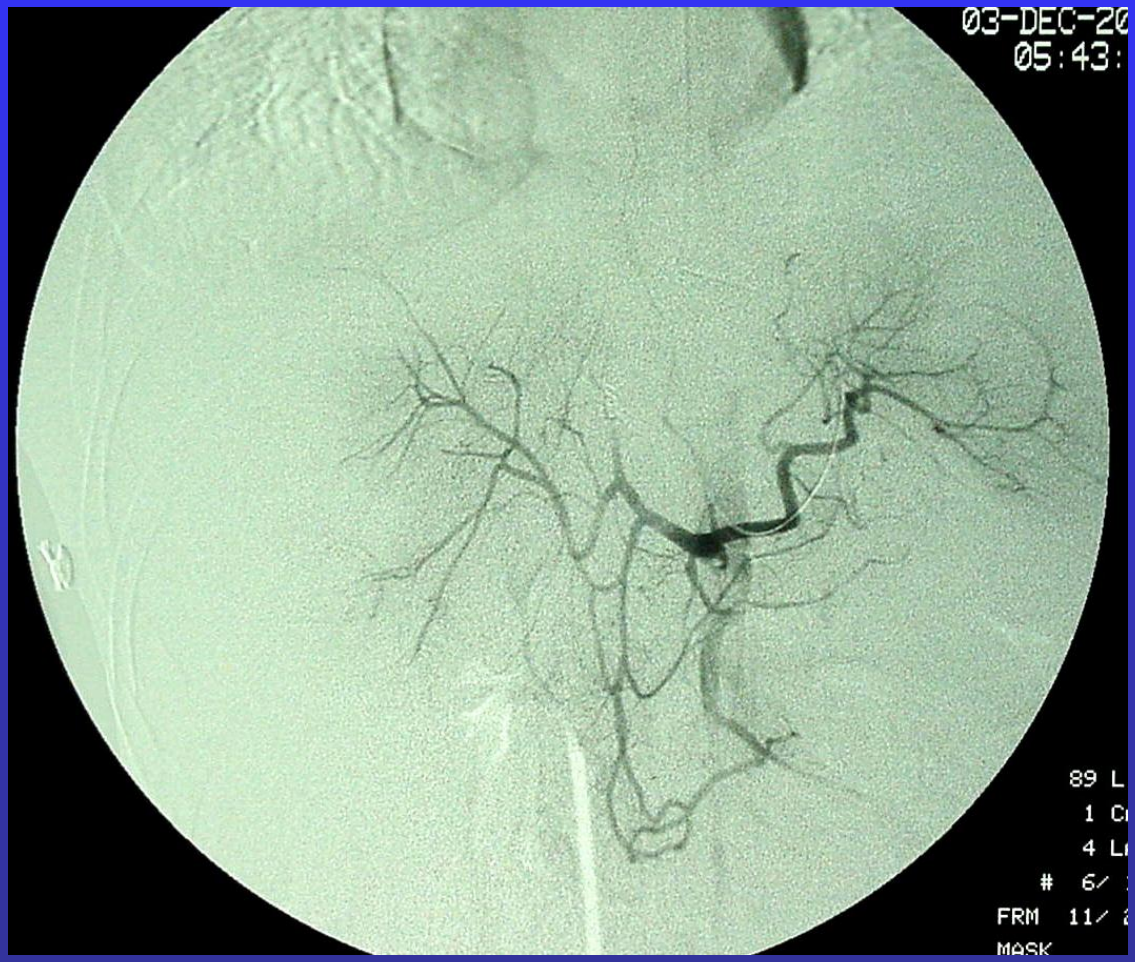
INITIAL CT SCAN: ACTIVE EXTRAVASATION



ANGIOGRAM –ACTIVE EXTRAVASATION



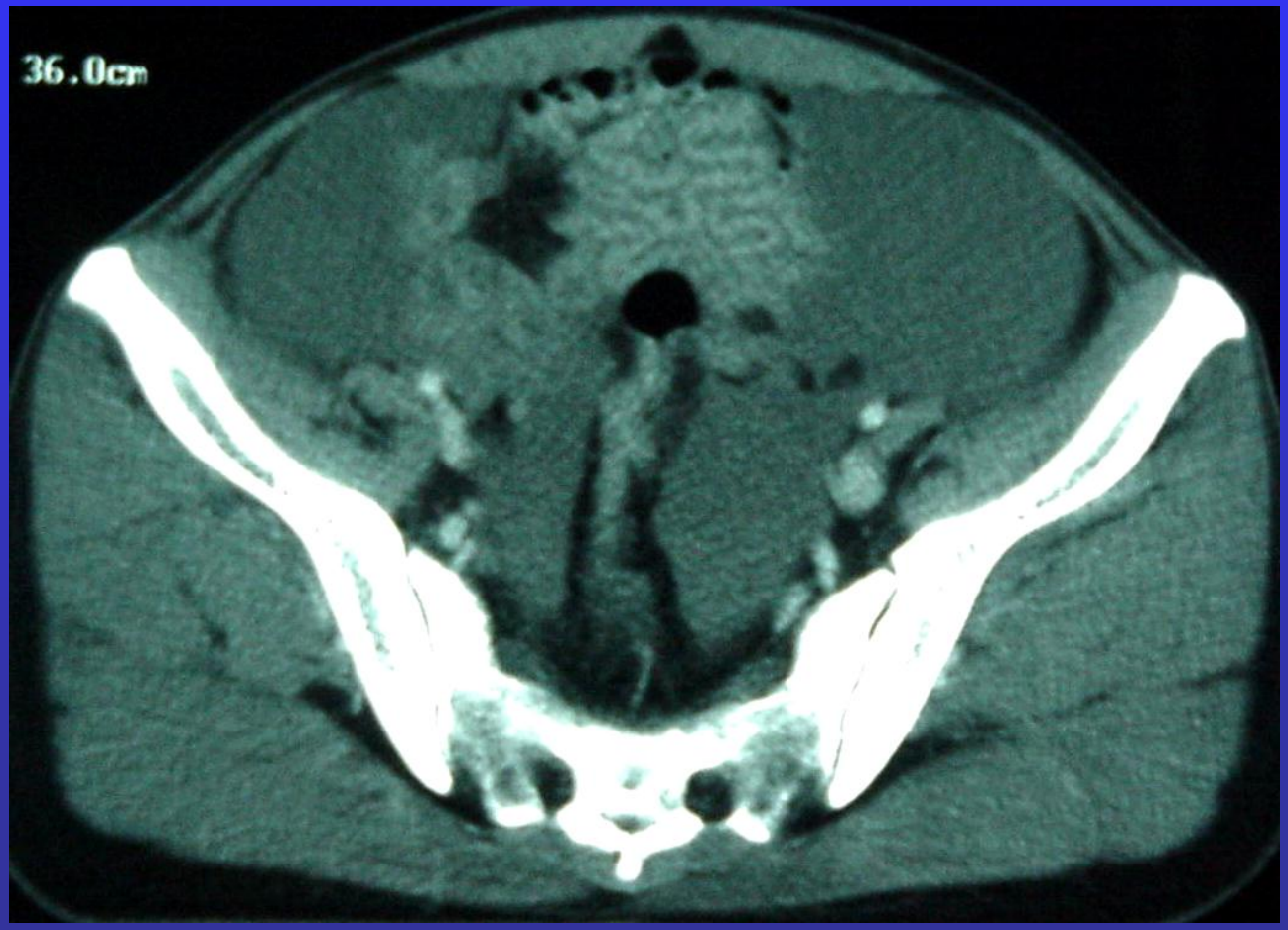
POST-EMBOLIZATION ANGIOGRAM



ICU COURSE

- Bleeding controlled with embolization
- **9 unit transfusions**: first 24 hours
- Progressive respiratory failure
- PT Day #4: **FiO2-100%, PEEP of 14 cm**
- PIP: **42**
- IAP: **50**
- **OR for Decompression???**

PELVIC COLLECTION -PRE DECOMPRESSION

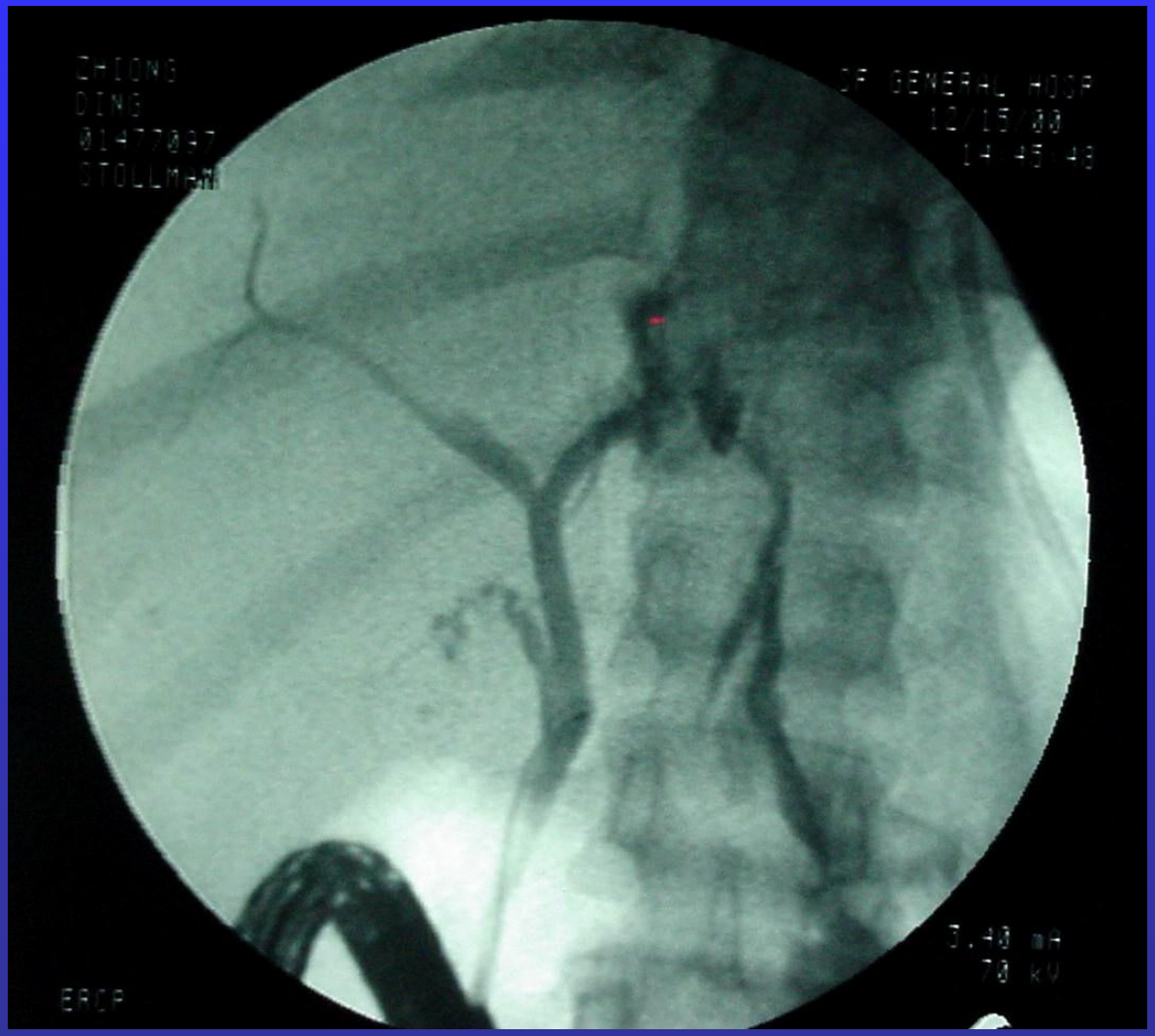


PELVIC DRAINS: POST US - GUIDED DECOMPRESSION

HOSPITAL COURSE: CONTINUING THE SAGA

- Abdominal decompression: **4Liters!**
- IAP: **12**
- Dramatic improvement in **PIP/FiO2**
- Continuous high-output **bilious drainage**

ERCP PRIOR TO STENT



SUMMARY: 3 PATIENTS GRADE V LIVER INJURIES

	PRE	POST
• **BLOOD**	6-9 UNITS/first 24 hours	
• **IAP**	35-50	12
• **FIO2**	50-100%	40-50%
• **CREAT**	0.9-1.5	0.6-0.8
• **FLUID**	drained	3-5L

2/3 patients with bile leaks

REDUCTION IN LIVER MORTALITY

- Grade IV-V injuries
- Mortality reduced from **40-80% to 8-22%**
- **Multi-modality** therapy:
  - -early packing
  - -angioembolization
  - -ERCP/stents/drainage abscesses

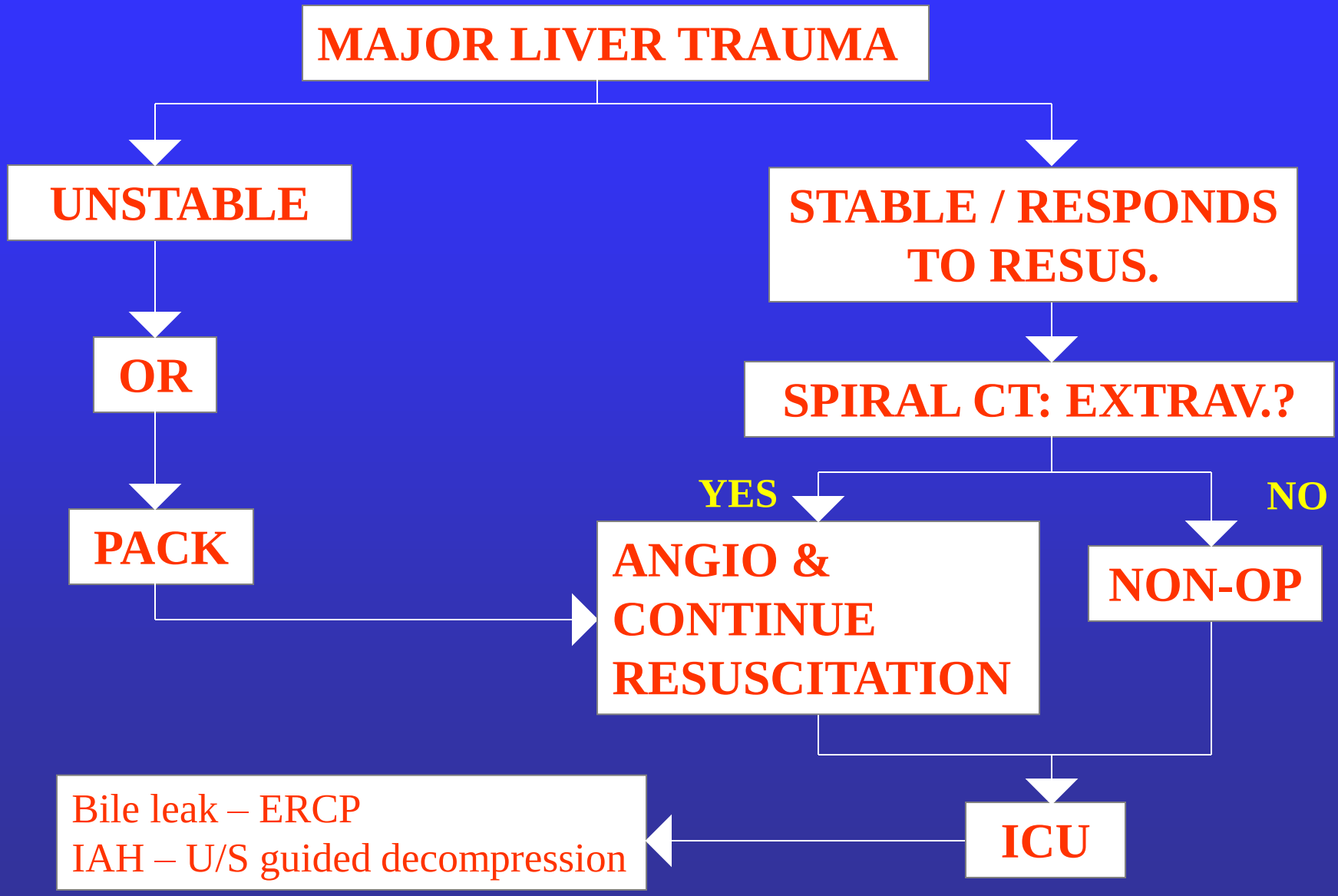
Asensio et al J Trauma,2000

APPLICATION TO PENETRATING TRAUMA

- Adjunctive techniques - complications of penetrating liver trauma*
- Nonoperative management - selected cases

Knudson/Lim:1994

PROPOSED ALGORITHM:



SPIRAL CT CLASSIFICATION

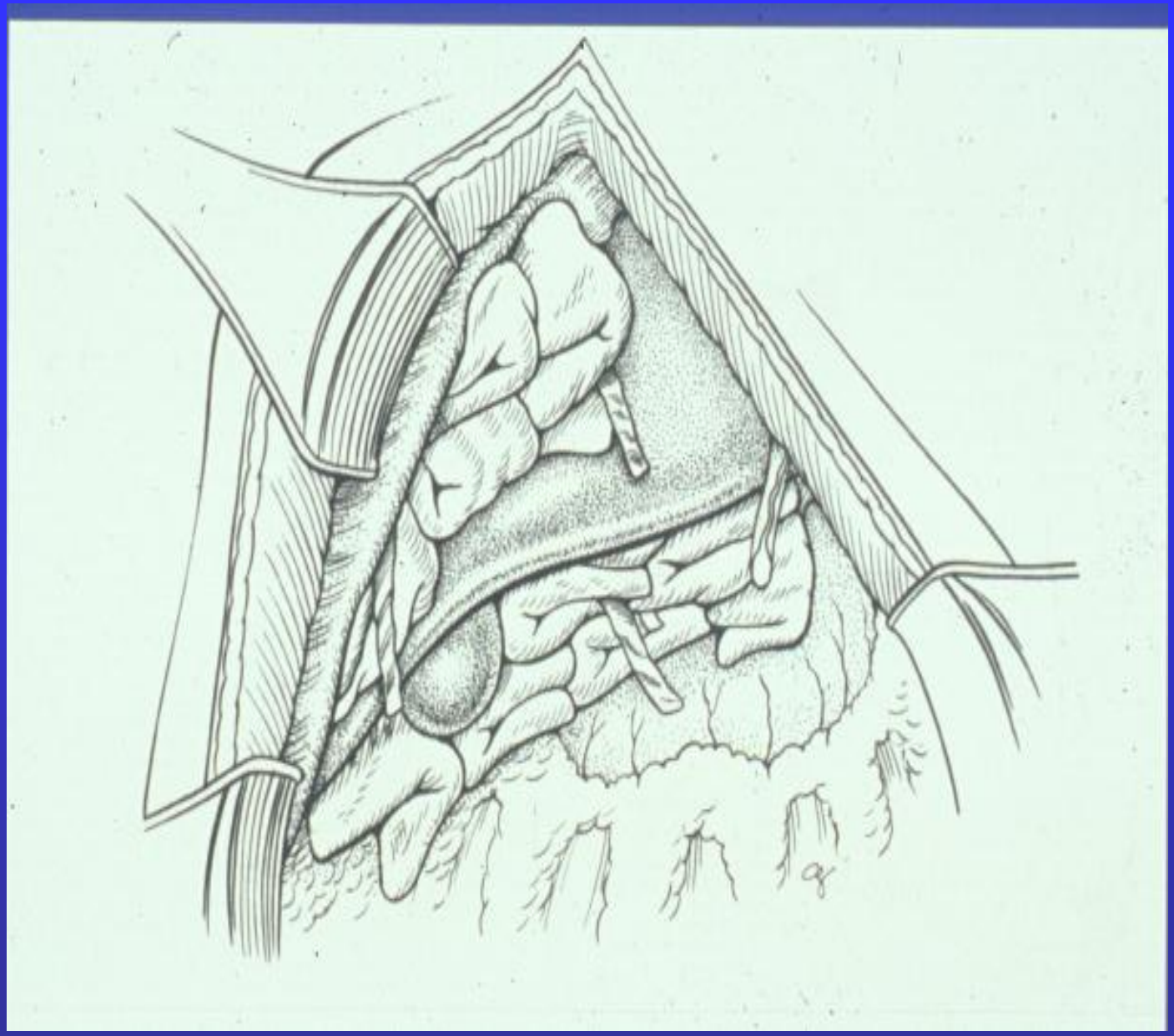
- **Type I:** active extravasation-peritoneum
  - unstable/required laparotomy
- **Type II:** intraparenchymal contrast + hemoperioneum: 4/6 to OR
- **Type III:** only intraparenchymal contrast
  - none required laparotomy

Feng et al, J Trauma, 2000

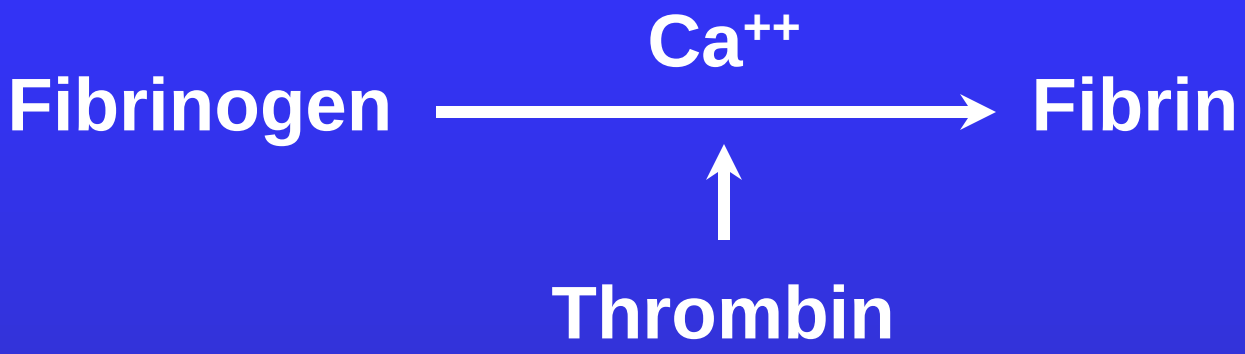
Autotransfusion

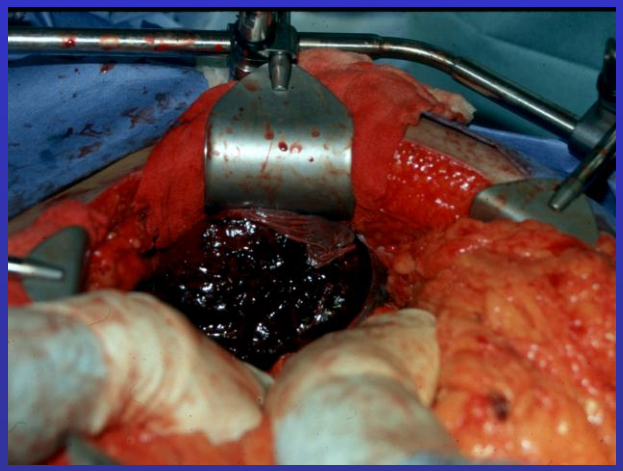
Perihepatic Packing

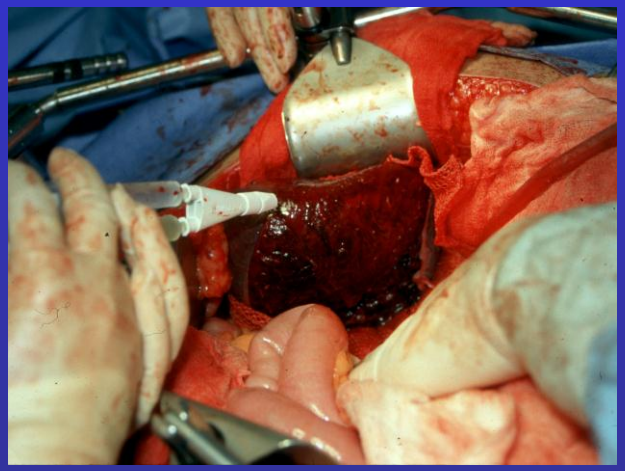
- Damage control procedure
- Laparatomy pads compress areas of injury
- Avoid mobilization of the liver
  - falciform and triangular ligaments
  - diaphragmatic and retroperitoneal attachments
- Temporary abdominal wall closure
  - Skin or “Bogota” bag silo
- Return to OR for removal of lap pads in 24-48 hr

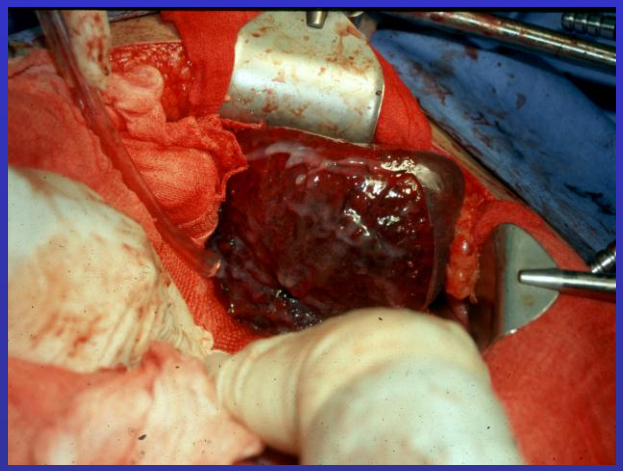


Fibrin Glue

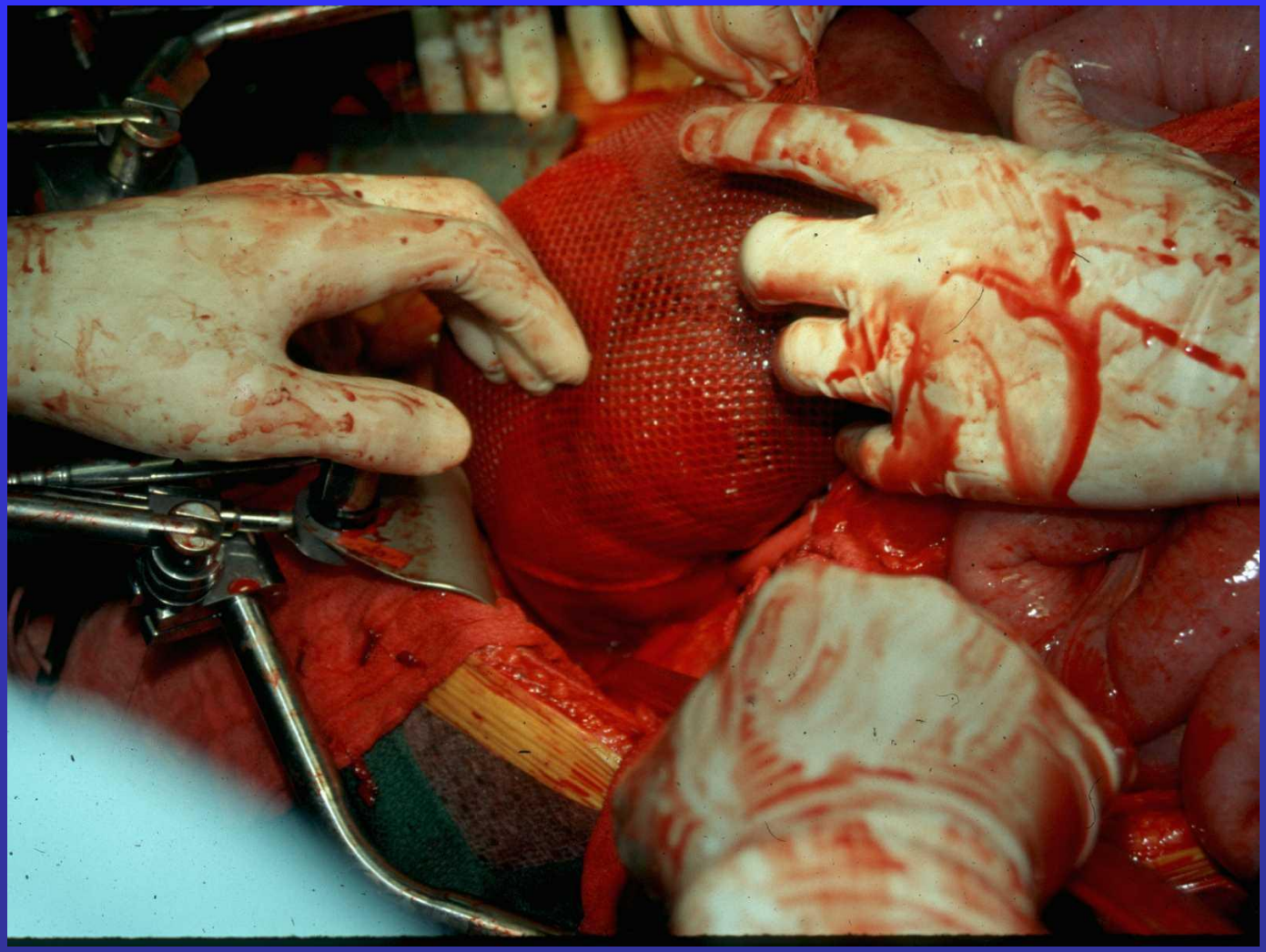








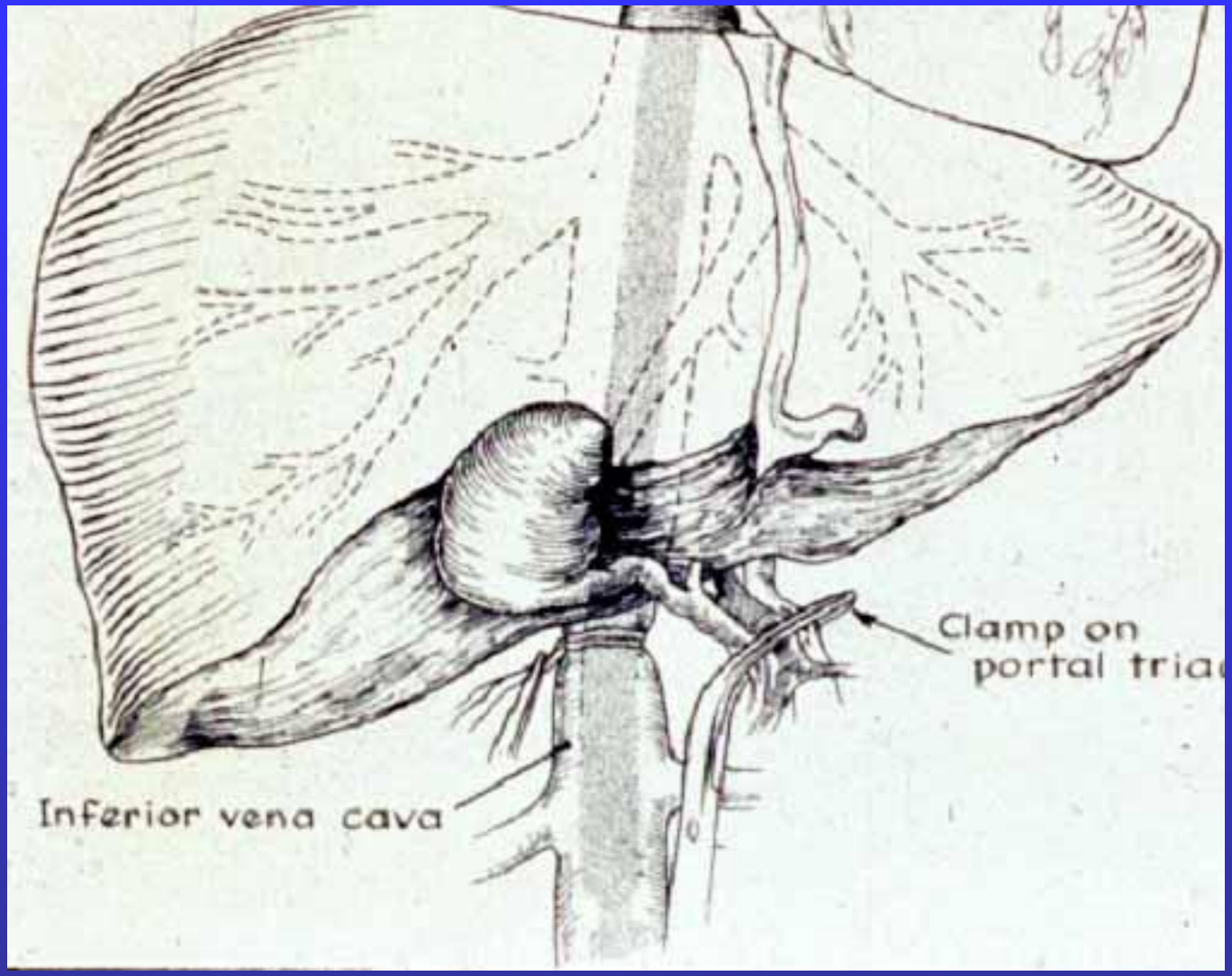
Absorbable Mesh Packing



Pringle Maneuver

- First described in 1908*
- Can be tolerated for up to 60 minutes
  - Causes ischemia reperfusion injury to liver
  - Associated with massive bowel edema
- Controls hepatic parenchymal hemorrhage in 60-80% of cases
  - Helps diagnose hepatic vein/caval injuries

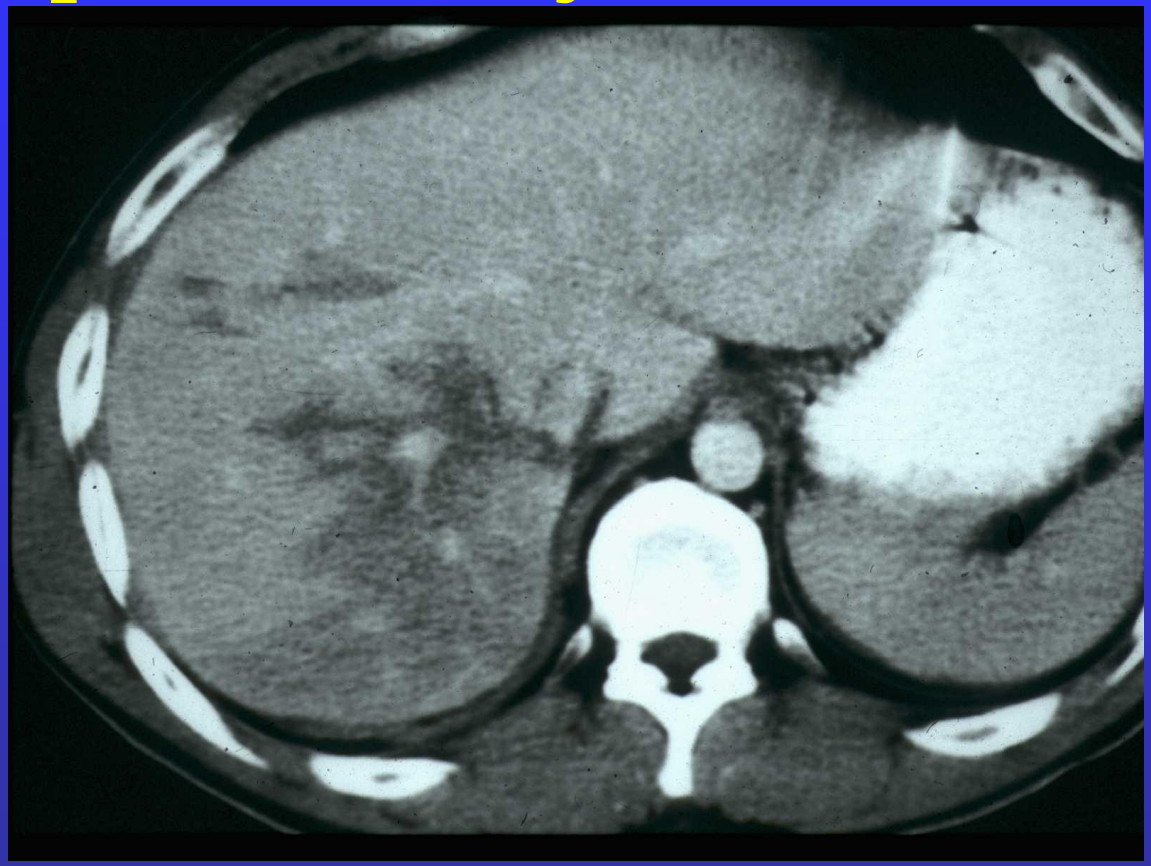
*J Pringle, *Ann Surg* 48:541, ‘08


Clamp on
portal tria
Inferior vena cava

Hepatic Artery Ligation

- Collateral flow through translobar and subcapsular vessels
- Well tolerated if portal flow is preserved
  - Portal vein supplies 80% of hepatic oxygen requirement
  - Hepatic artery clamping increases portal vein oxygen extraction

Hepatic Artery Extravasation



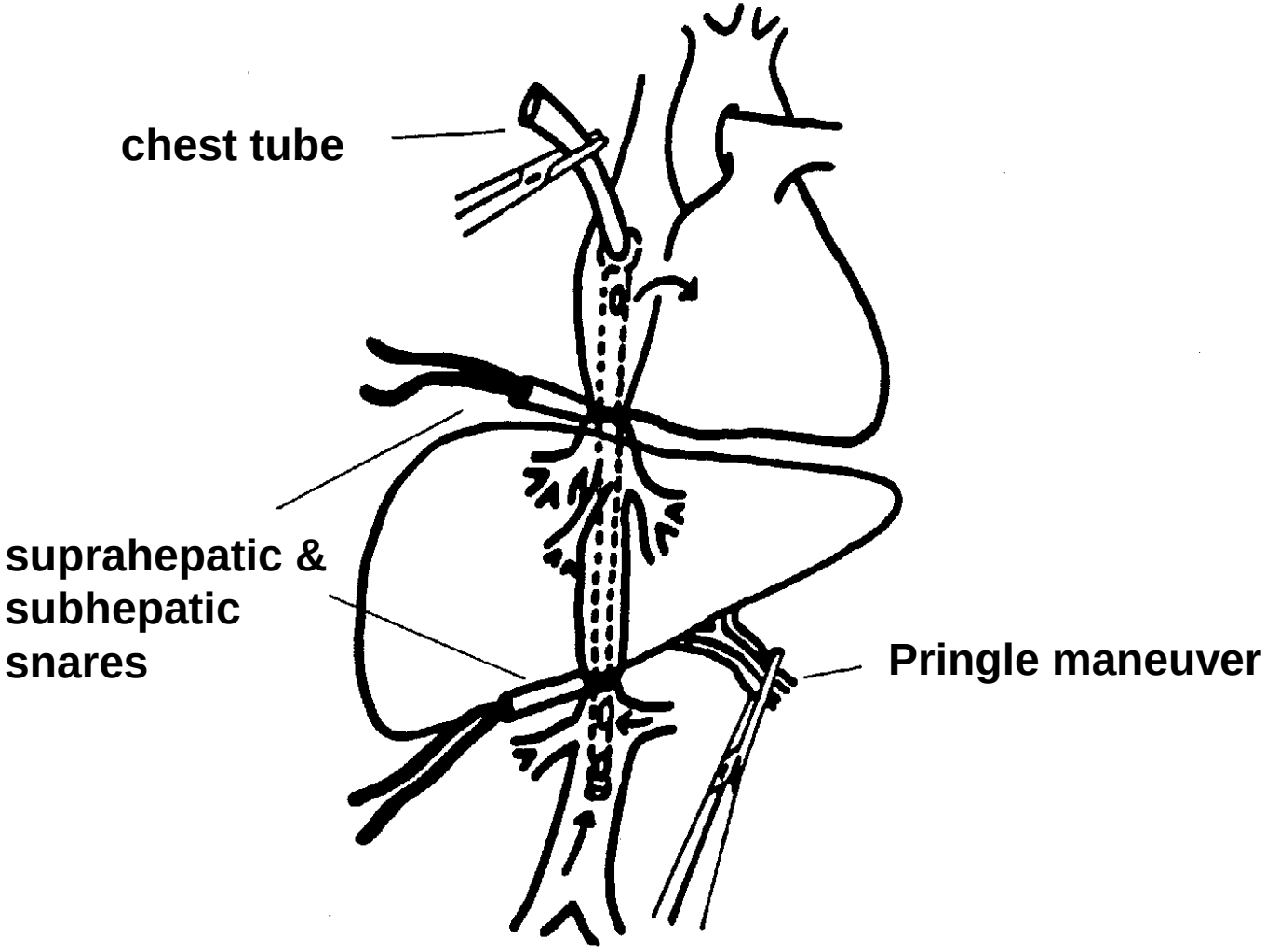
Successfully controlled by embolization

Vena Caval Blood Flow

	Percent
Superior Vena Cava	25
Inferior Vena Cava	75
Renal Veins	25
Portal Vein	40
Infrarenal IVC	10

J Malo, et.al., *J Appl Physiol* 56:1403, ‘84

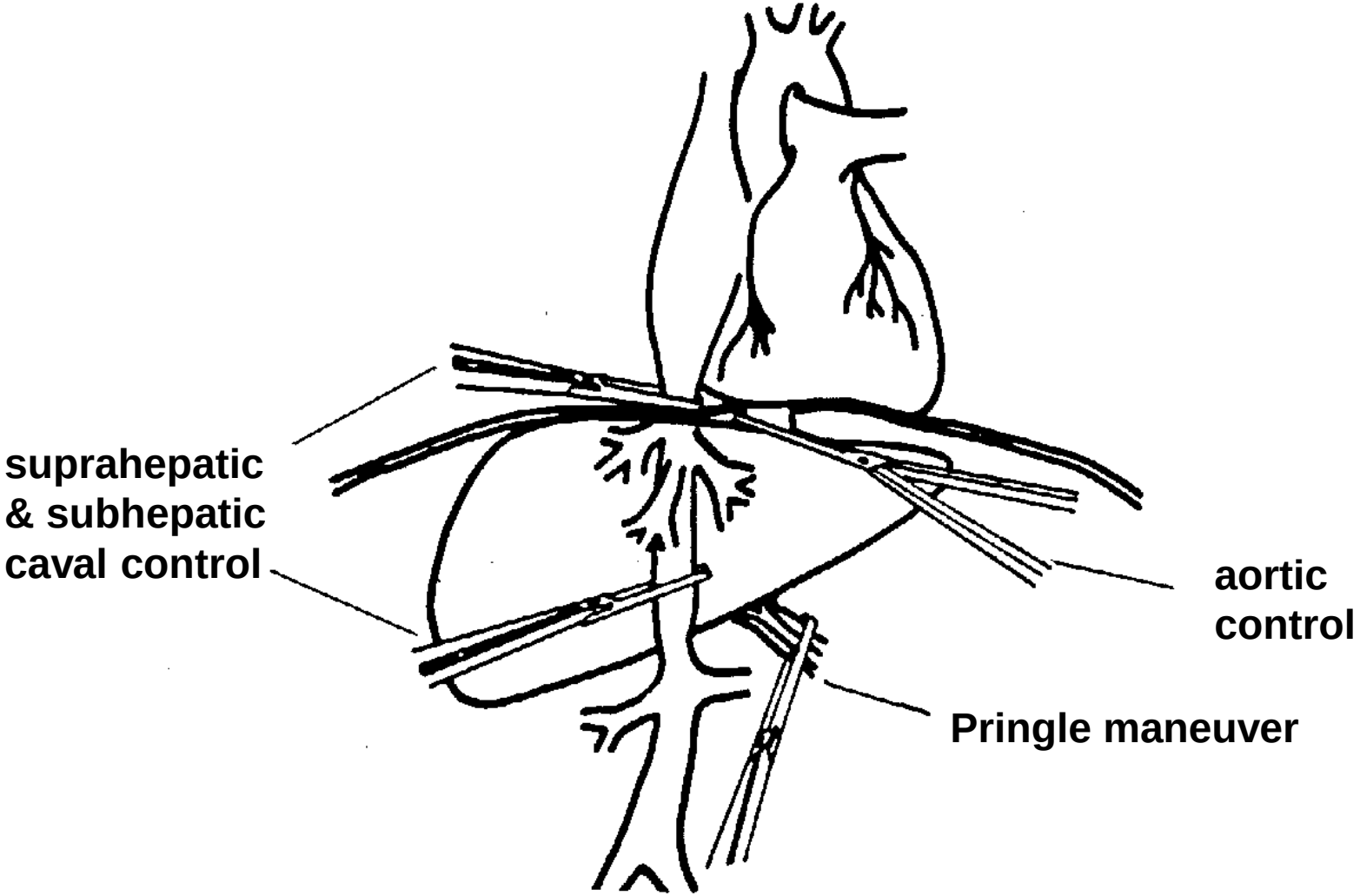
Atrial-Caval Shunt

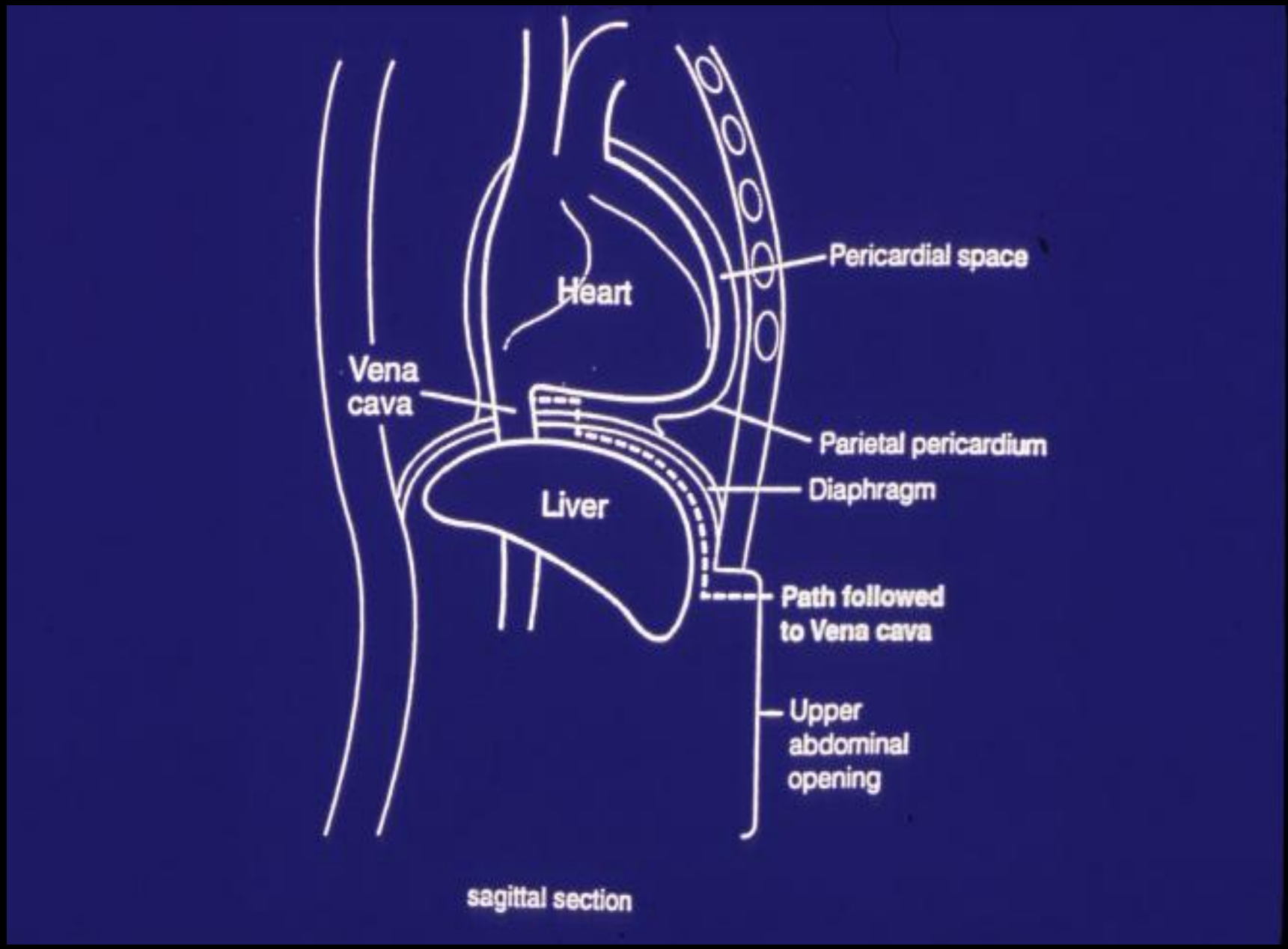


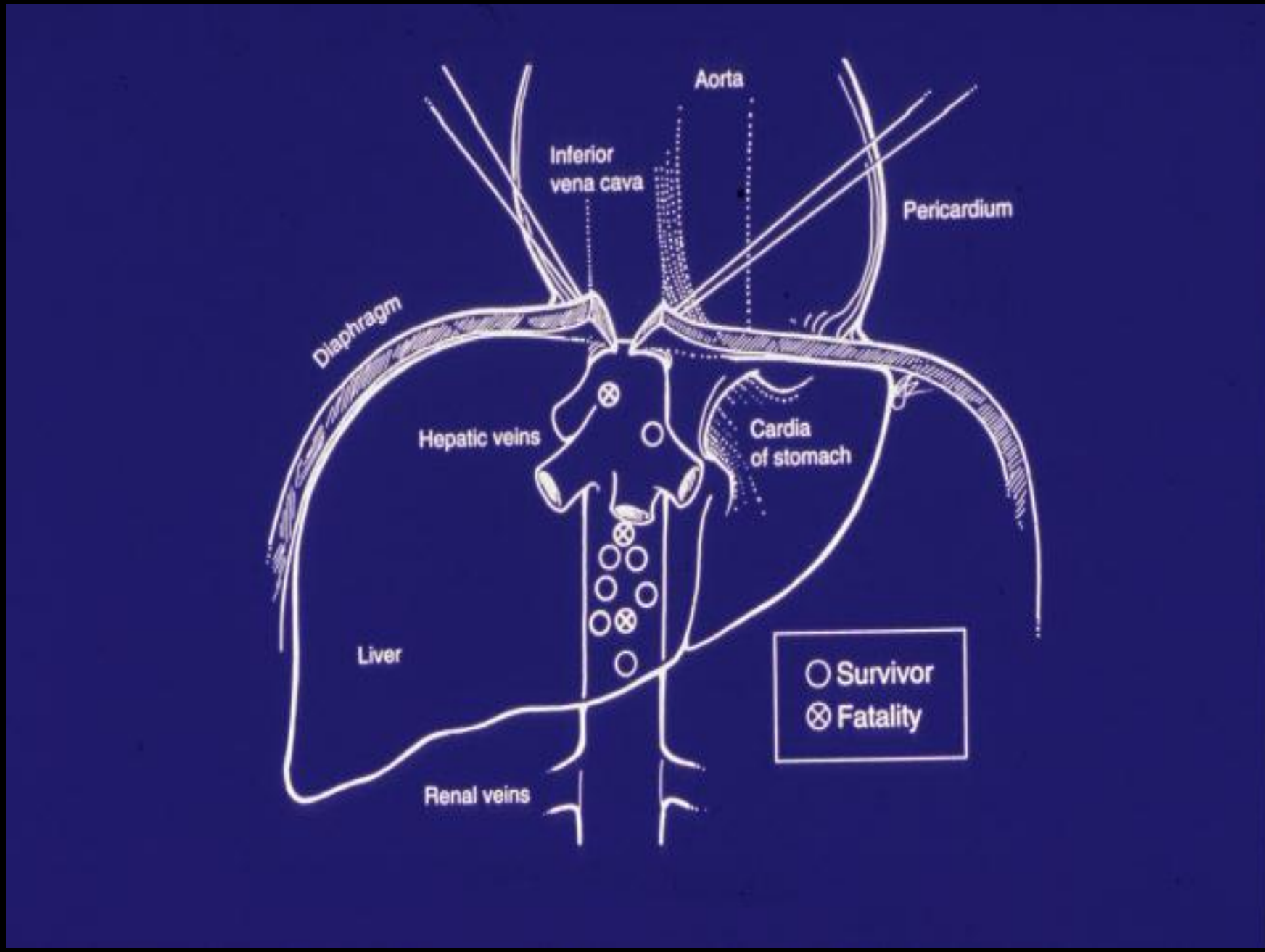
Problems with Atrial Caval Shunts

- Generally requires additional thoracotomy or sternotomy
- Snaring the vena cava is technically challenging
- Insertion is associated with additional blood loss
- Potential for air embolism in a hypotensive patient

Total Vascular Occlusion




Pericardial space
Heart
Vena cava
Parietal pericardium
Diaphragm
Liver
Path followed to Vena cava
Upper abdominal opening
sagittal section


Aorta
Inferior
vena cava
Pericardium
Diaphragm
Hepatic veins
Cardia
of stomach
Liver
Survivor
Fatality
Renal veins

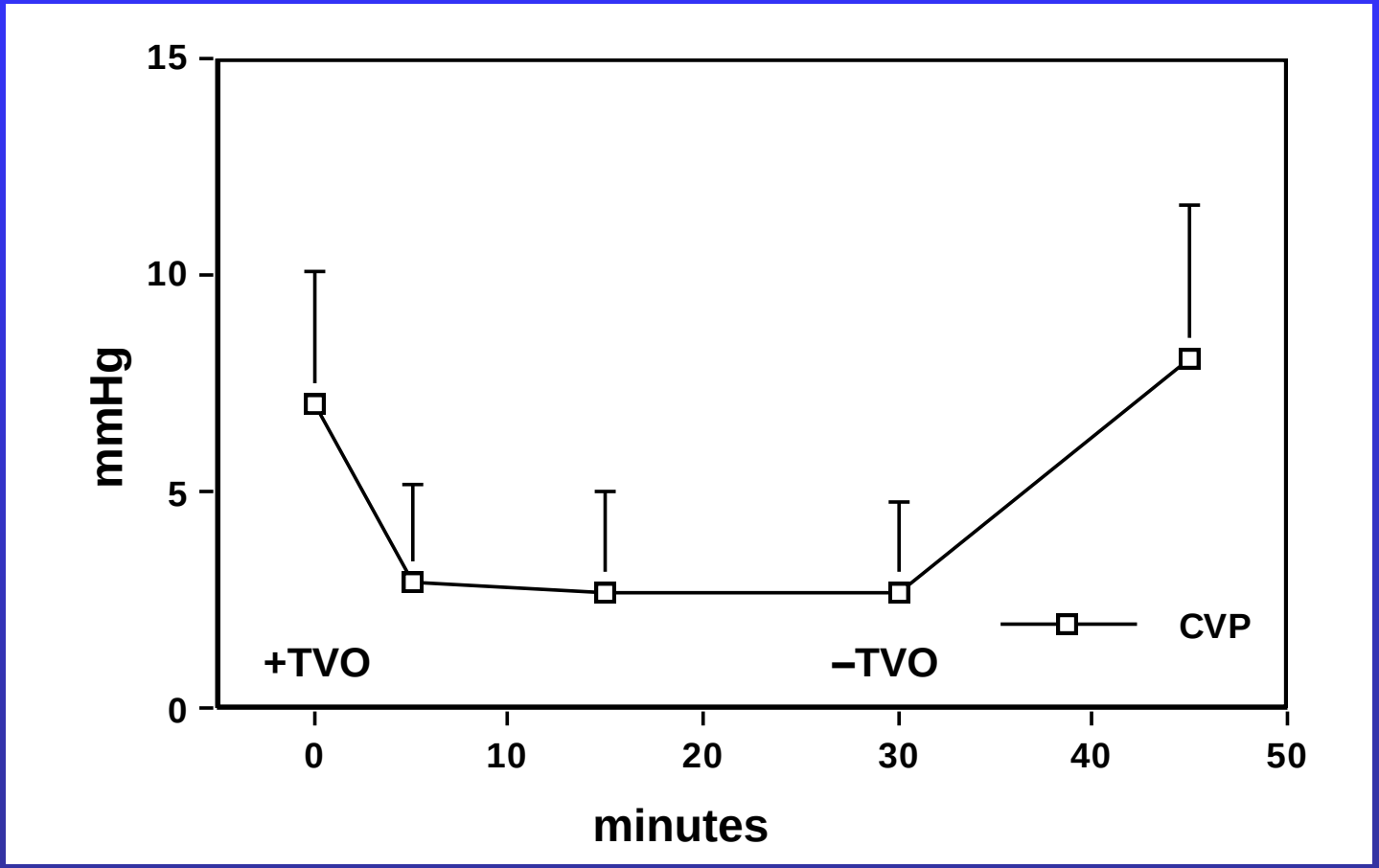
Indications for Total Vascular Occlusion (TVO)

- Penetrating injuries
  - Major GSW with blast injury to parenchyma requiring hepatotomy for control of hemorrhage
  - Penetrating retrohepatic caval and hepatic vein injuries
- Blunt injuries
  - Second-stage hepatic resections
  - Liver avulsion

- Consider TVO when the Pringle maneuver and packing together are insufficient

CVP After Total Vascular Occlusion

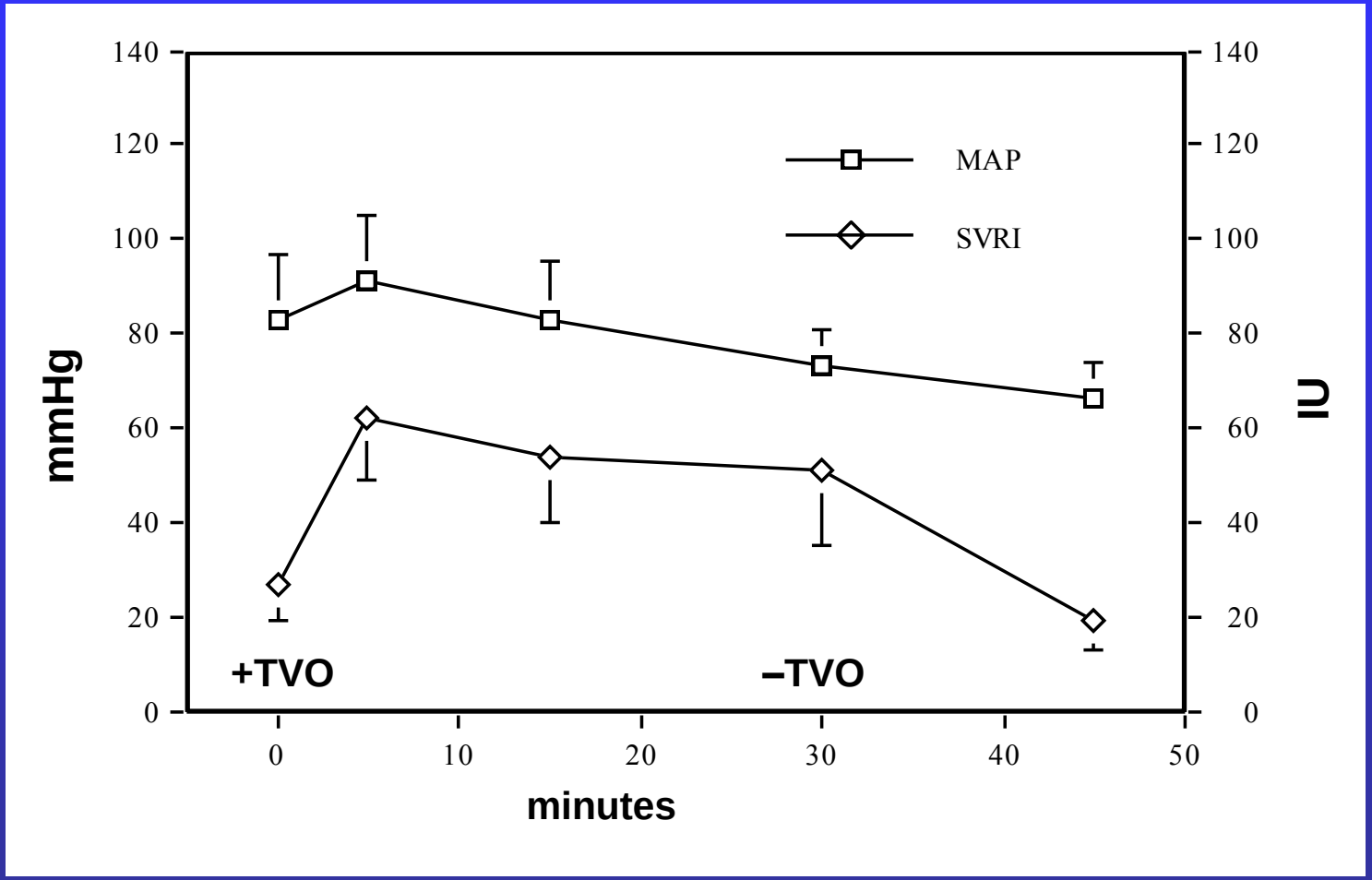
22 noncirrhotic patients



D Eyraud et.al. *Anesth Analg* 95:1173, ‘02

Hemodynamics of TVO

22 non-cirrhotic patients



D Eyraud et.al. *Anesth Analg* 95:1173, ‘02

Humoral Agents in TVO

22 non-cirrhotic patients

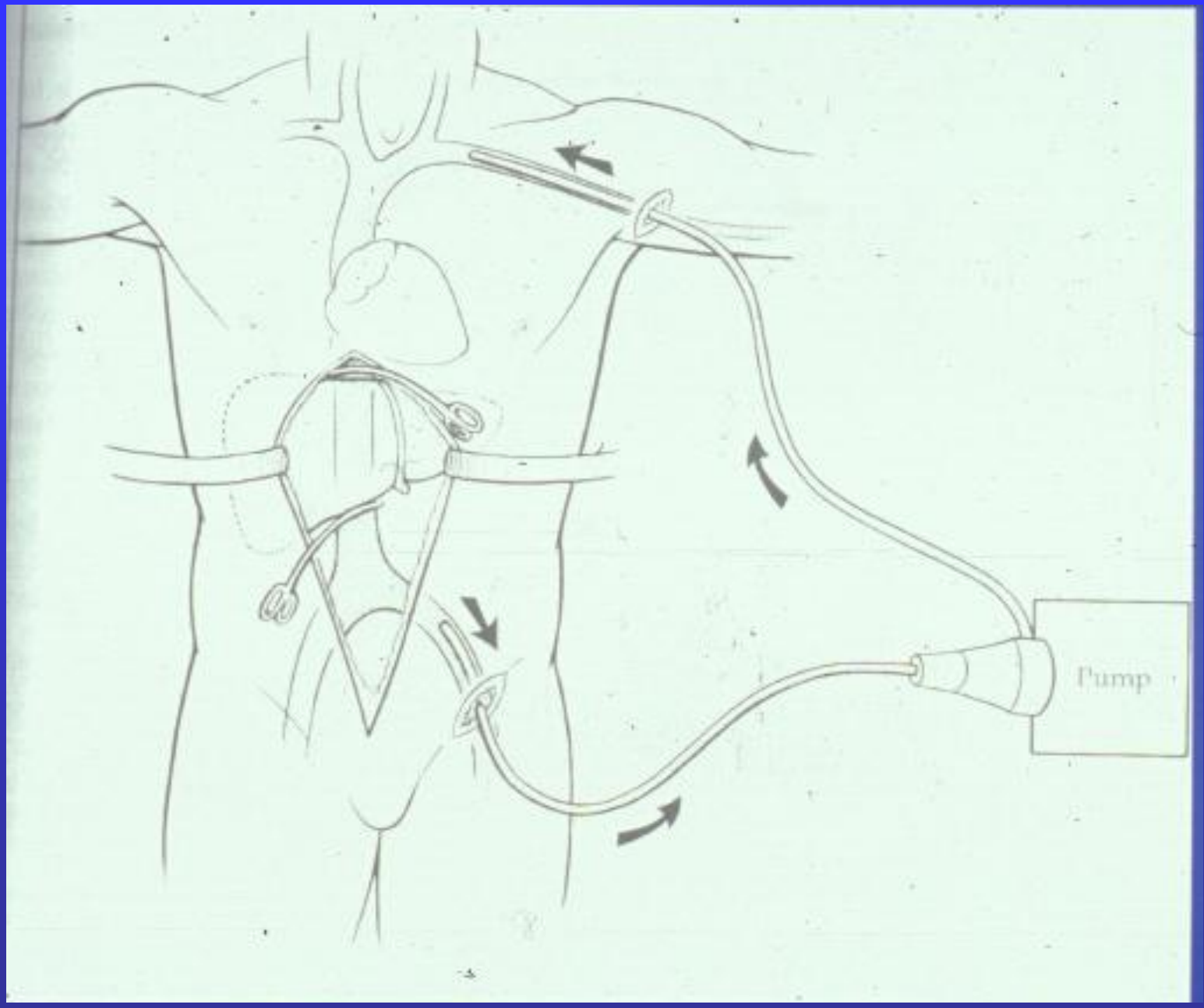
Hormone	Baseline	5 minutes after clamping
Arg vasopressin (pg/ml)	8 ± 10	31 ± 26
Epinephrine (pg/ml)	175 ± 128	347 ± 292
Norepinephrine (pg/ml)	595 ± 366	1226 ± 1045

D Eyraud et.al. *Anesth Analg* 95:1173, ‘02

Extracorporeal Inferior Vena Caval Bypass: study in 5 mongrel dogs

- Bypass all blood to suprahepatic vena cava
  - Percutaneous femoral vein to internal jugular vein
  - Inferior mesenteric vein to internal jugular vein
  - Heparin bonded shunts with extracorporeal pump
- Less drop in MAP and CO
  - Compared to Pringle maneuver + complete caval interruption (TVO) or atrial-caval shunt

Howdieshell, et.al., *Crit Care Med* 24:631, '96


Pump

Vascular Occlusion

- 10 patients with penetrating juxtahepatic IVC injuries
- Pringle maneuver & clamping of the vena cava above and below the liver
- Aortic clamping used only if systolic BP < 60 mmHg
- 9 left OR and 7 discharged alive

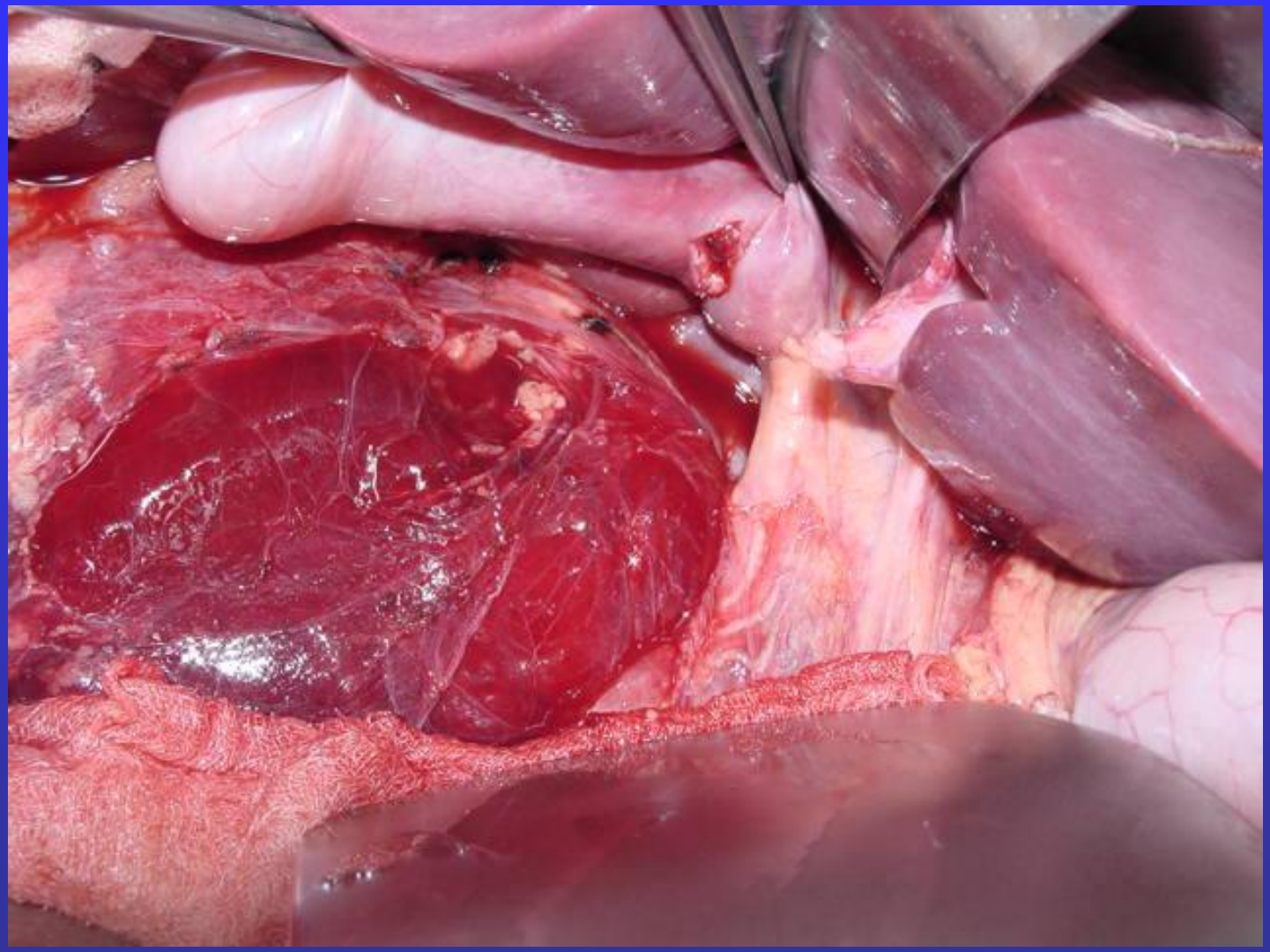
Khaneja, et.al., *J Am Coll Surg* 184:469, '97

Selective Vascular Occlusion

- Pringle maneuver
- Dissection of the R side of the vena cava with isolation of the R hepatic vein trunk and middle/left hepatic vein confluence
  - Be careful of an inferior R hepatic vein
- Application of bulldog clamps to the hepatic veins parallel to the vena cava

- Maintains flow in the IVC

Extrahepatic Biliary Injuries

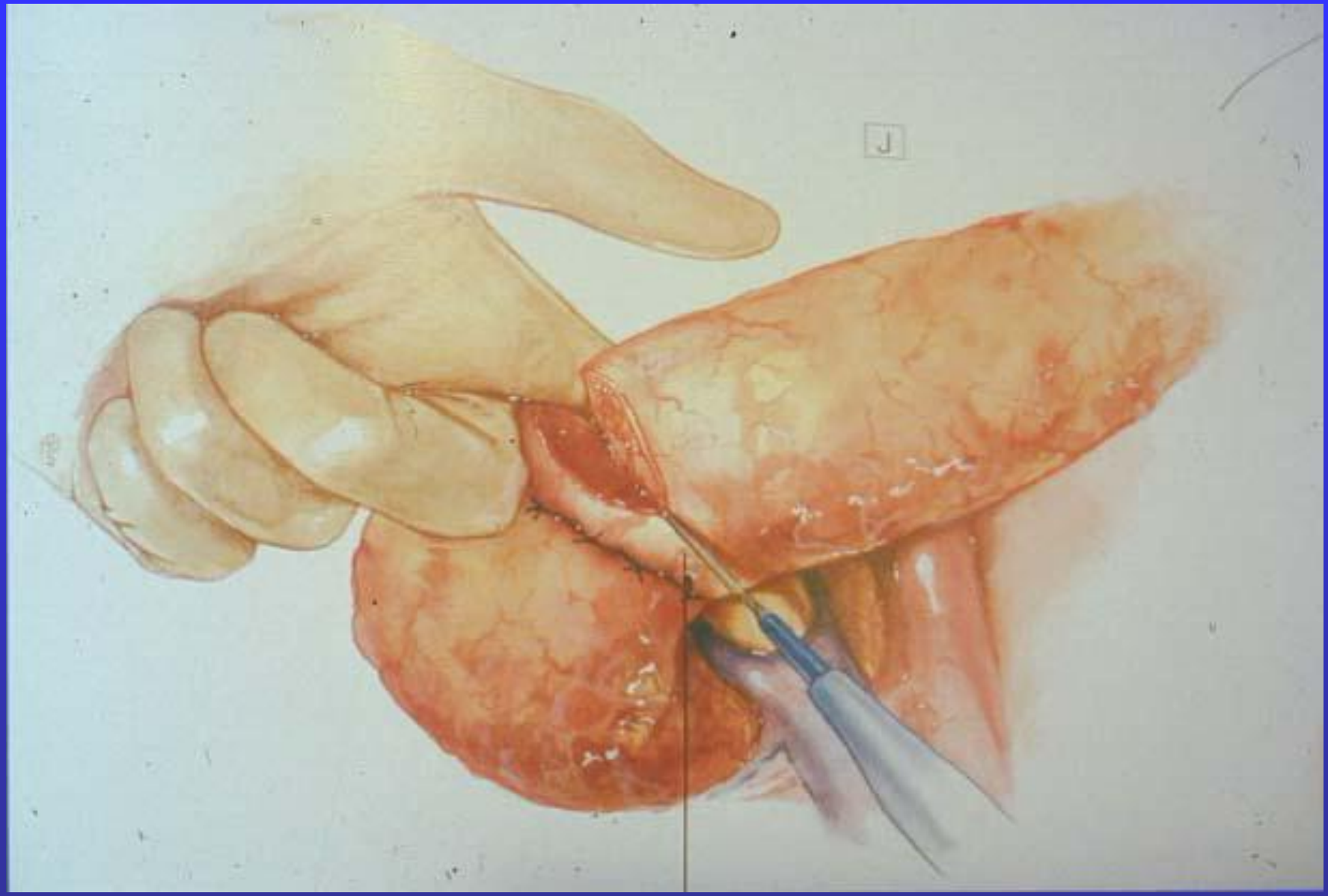


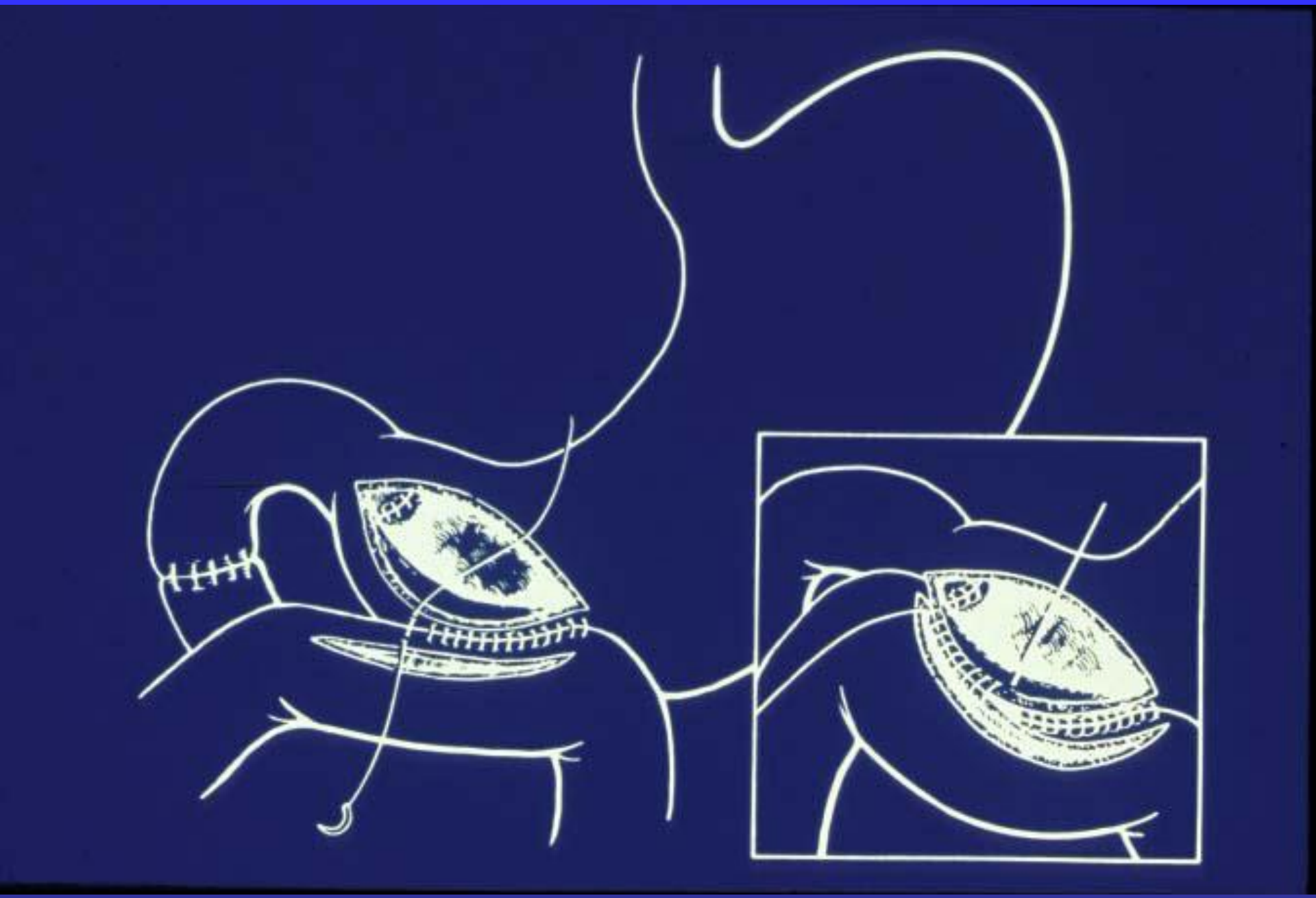
33-year-old Man with Multiple Gun Shot Wounds

- Portal vein
- Hepatic artery
- Blast injury to CBD
- Diaphragm
- Spleen
- Blast injury to the pancreas
- Duodenum
- Stomach

Initial Therapy

- Splenectomy
- Closure of stomach wounds
- Repair of hepatic artery


J



Treatment of Blast Injury and Hole in the Common Duct

- Cholecystectomy
- Repair of small hole in the distal duct
- T-tube drainage of the duct

Post Operative Course

- Liver Failure
  - Coma
  - Hypoprothrombinemia
  - Hyperbilirubinemia

11-23-94 - Opening eyes to command

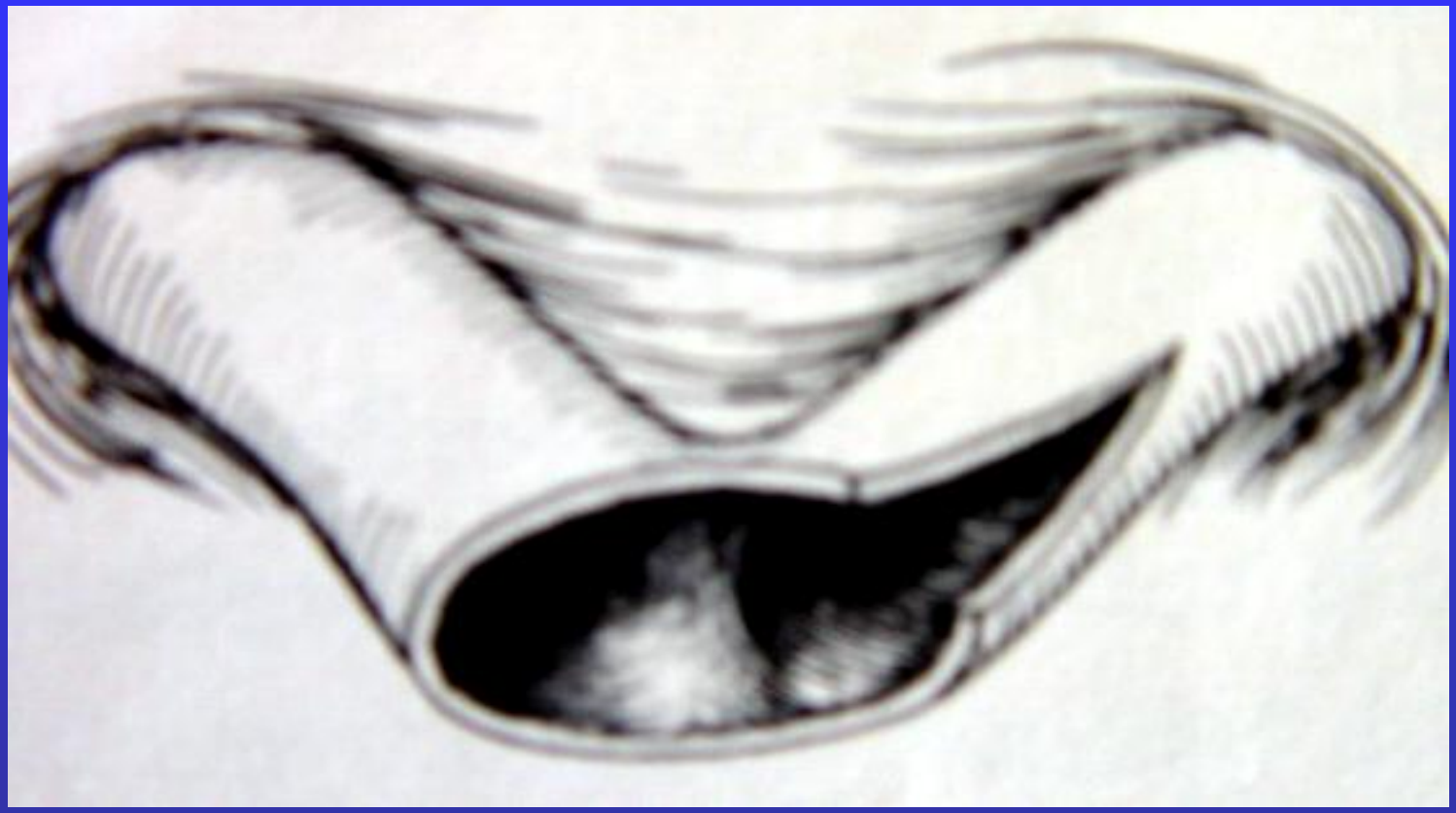
11-26-94 - Extubated

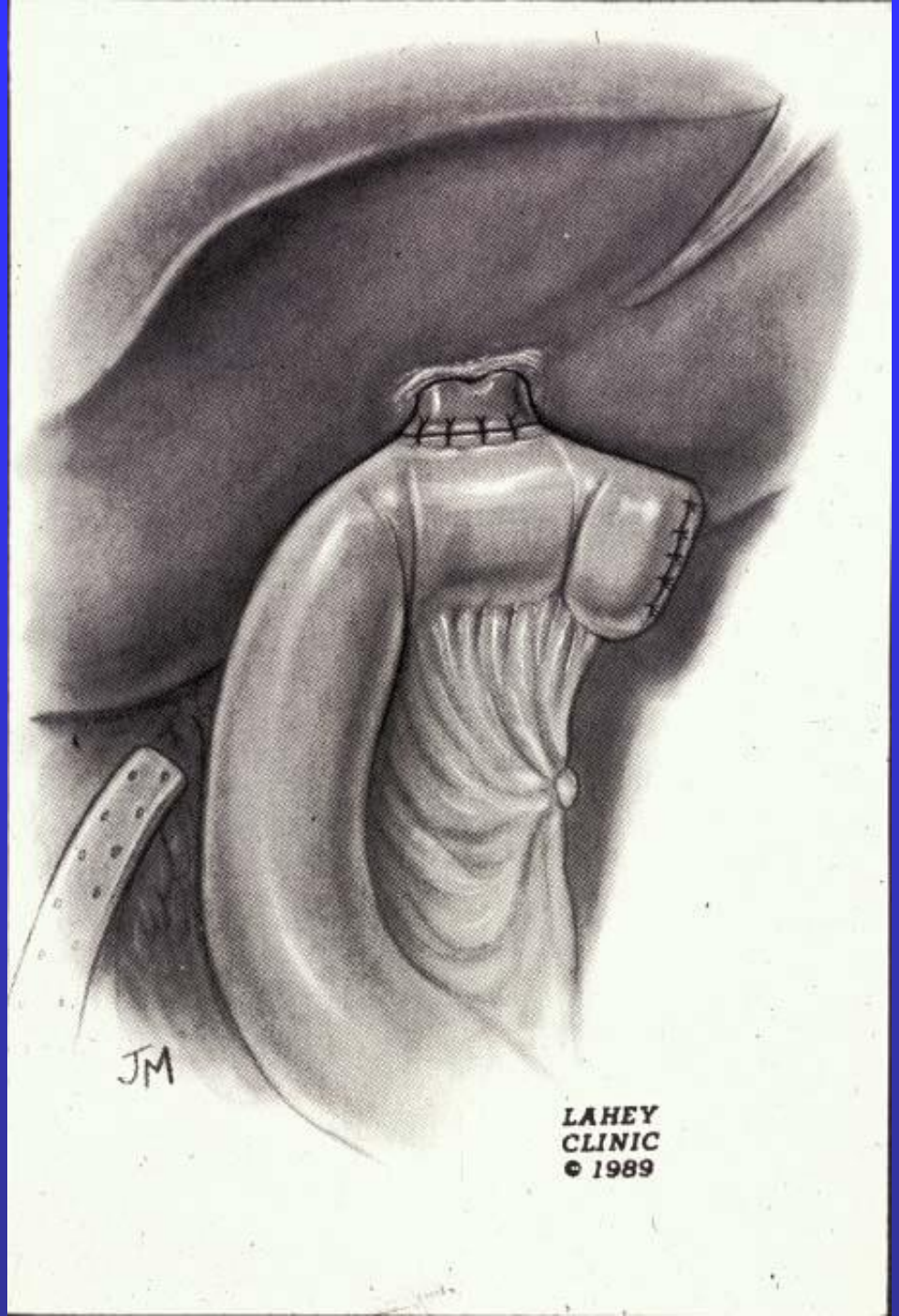
12-1-94 - 510 cc of bile drainage from RUQ drains

T-tube cholangiogram 12-1-94

* distal CBD intact with flow of contrast into duodenum
* extravasation of contrast in region of proximal CBD

February 1995 - Transhepatic stent

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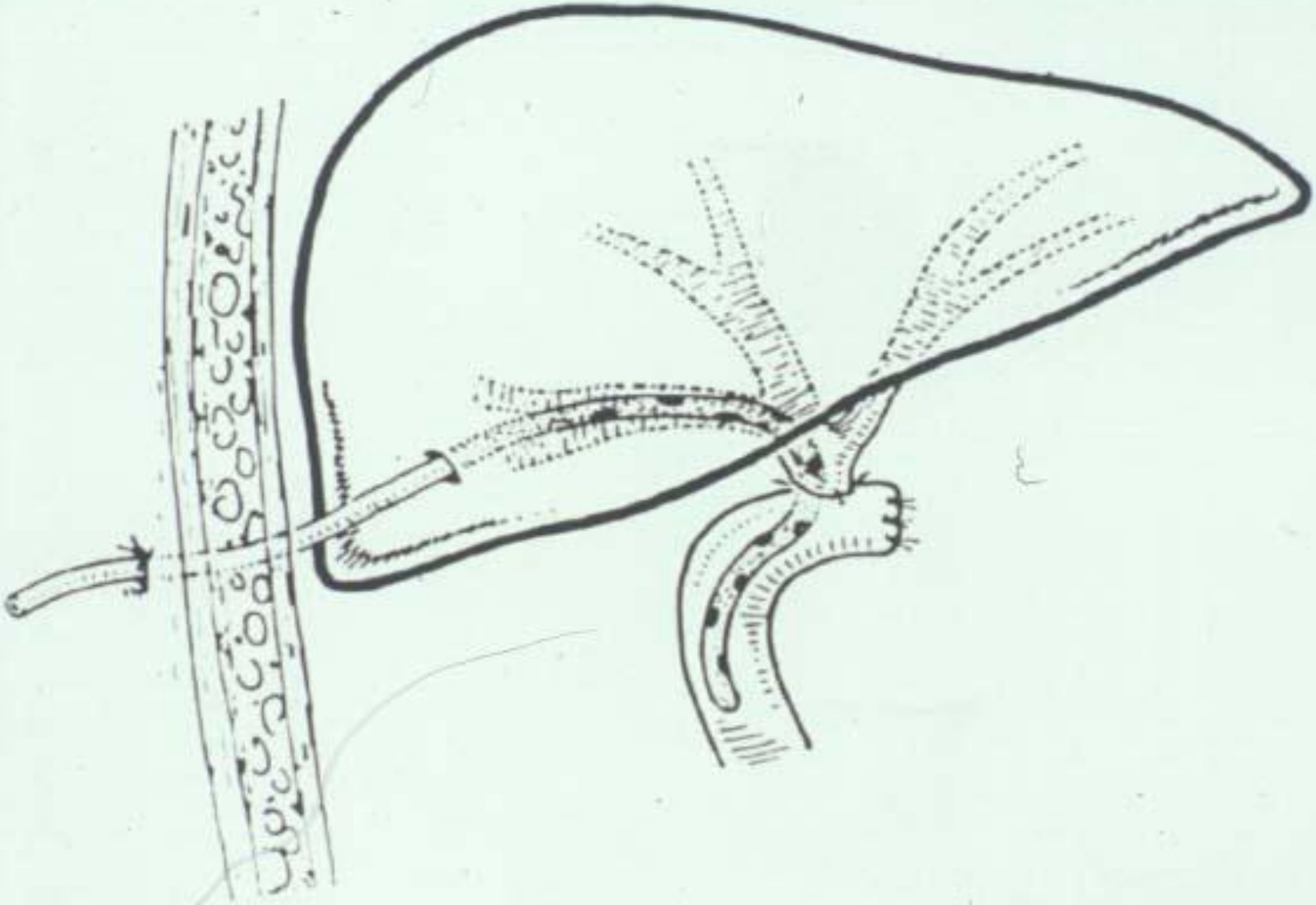
© 1989



Extrahepatic Biliary Injury

- Gallbladder most common site—treatment cholecystectomy
- Injury to the Extrahepatic bile ducts is uncommon. Treatment depends upon the location and nature of the injury and the physiologic status of the patient

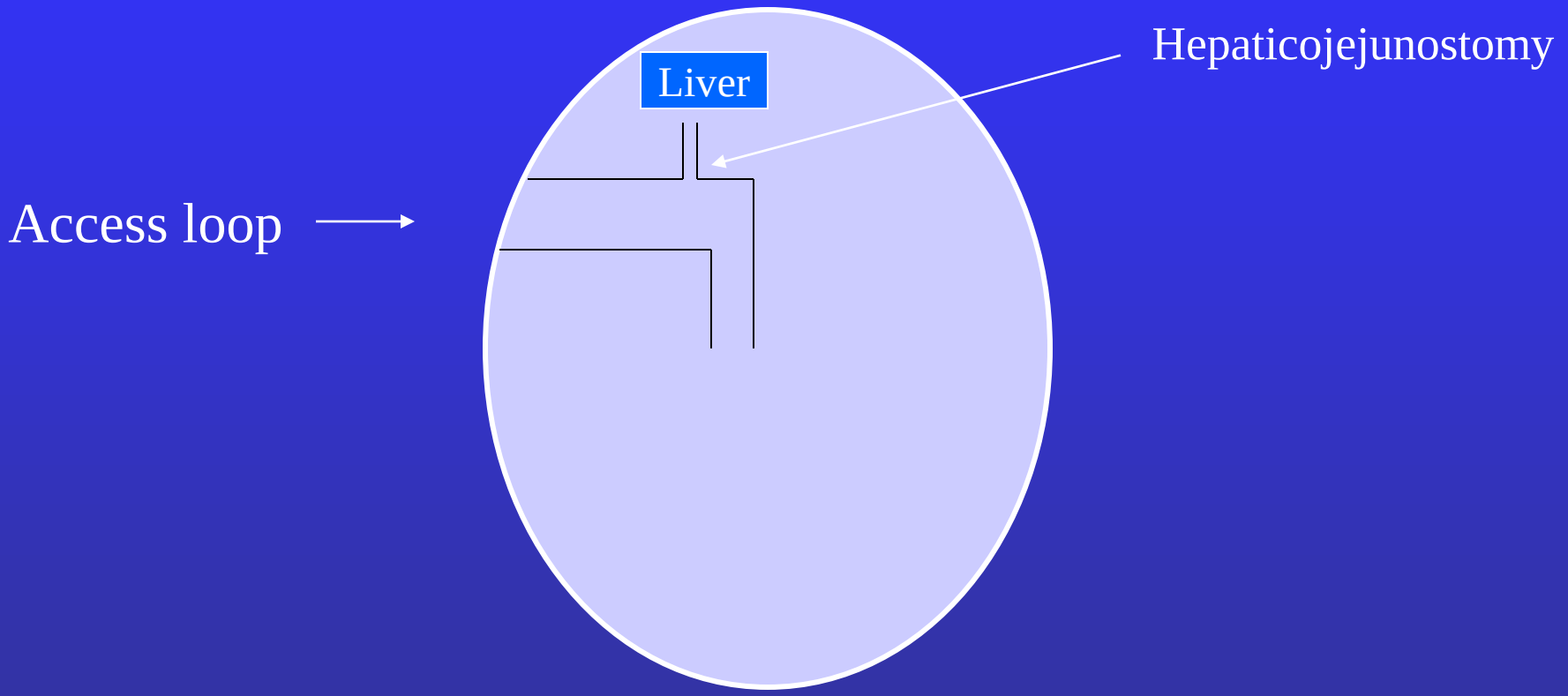
Treatment Options for Extrahepatic Bile Duct Injuries

- Small injuries due to stab wounds--lateral choledochorrhaphy
- Duct transections--Roux-en-y choledochojejunostomy
- Complex injuries in unstable patients--cholecystectomy and t tube drainage of the duct

Bade Pg, Thomson SR, Hirshberg A, Robbs JV. Surgical Options in Traumatic Injury to the extrahepatic biliary tree. Br J Surg 1989;76:256-8.
Burgess P, Fulton RL. Gallbladder and extrhepatic biliary duct injury following Abdominal trauma. Injury 1992;23:413-4

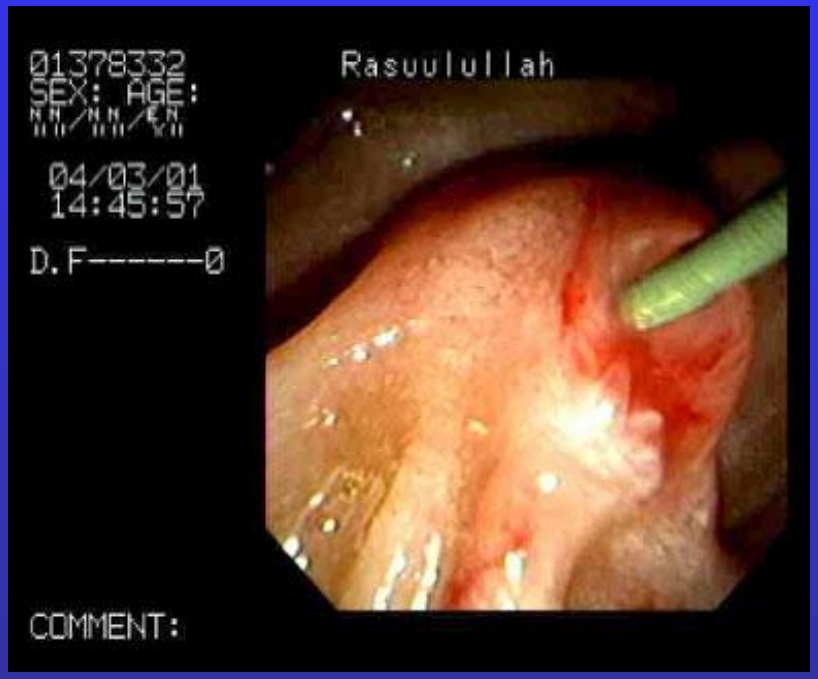
Technical Tips for Hepaticojejunostomy

- Single layer absorbable suture
- Spatulate the duct
- Extend choledochotomy to left hepatic duct
- Place interrupted sutures in the anterior wall of the duct prior to beginning the posterior row of the anastomosis

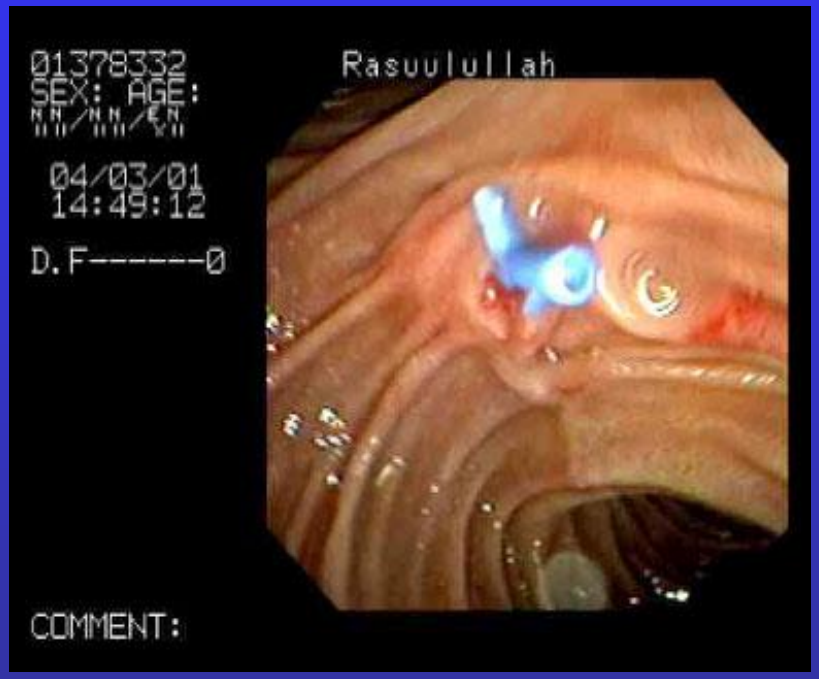

Liver
Hepaticojejunostomy
Access loop

ERCP in Patients with Pancreatic Trauma

- 20 patients (ages 17-54)
- 6 patients (30%) normal ERCP
- 13 patients with partial or complete PDD
- 1 patient with biliary injury (Rx biliary stent)
- 15 patients Rxed expectantly after ERCP
- 2 patients-distal pancreatectomy
- 7 patients sphincterotomy and/or pancreatic stent—none required surgery

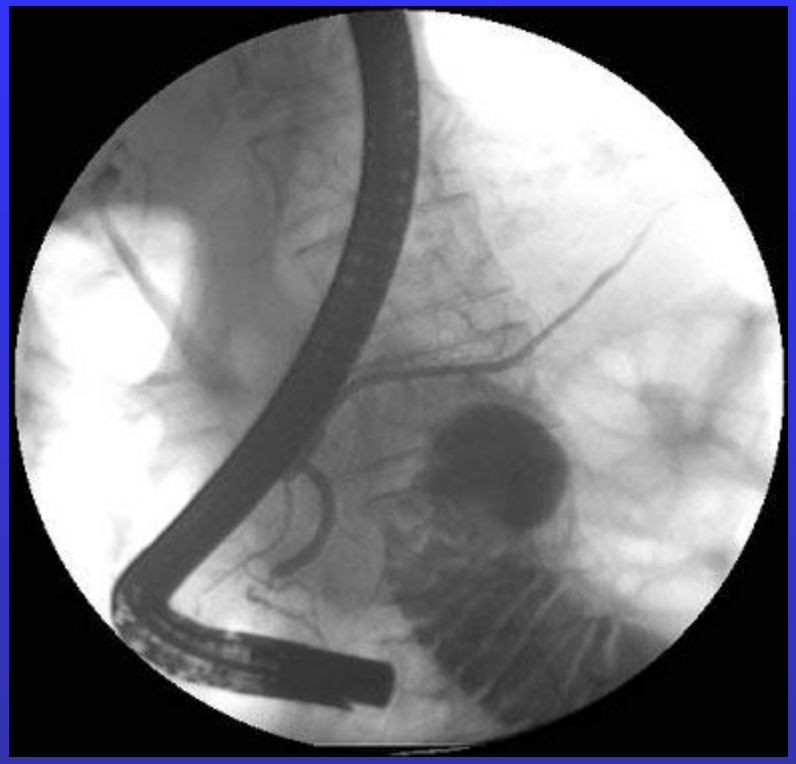


Sphincterotomy

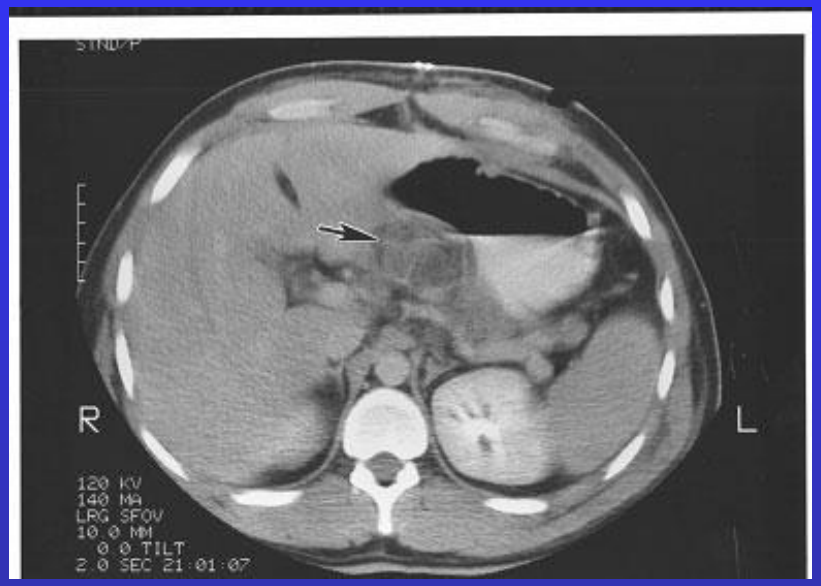


Pancreatic stent

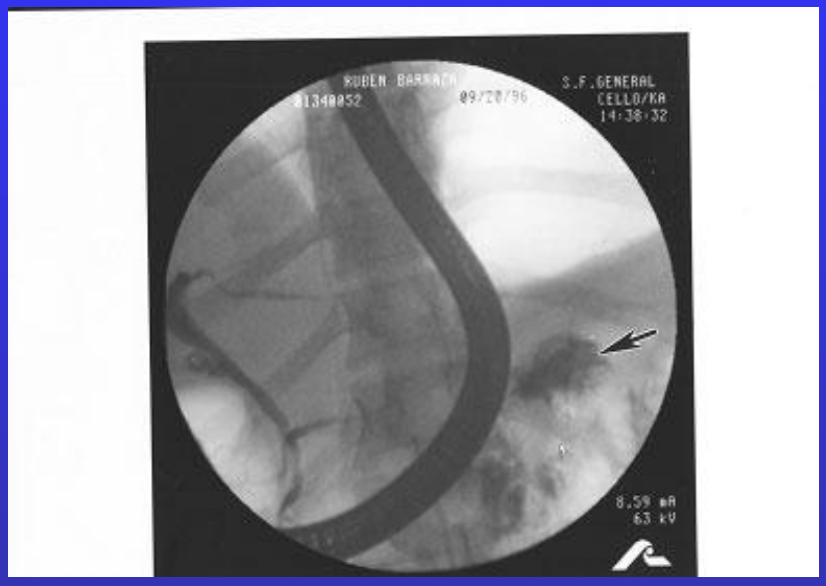
Normal ERCP



Blunt trauma

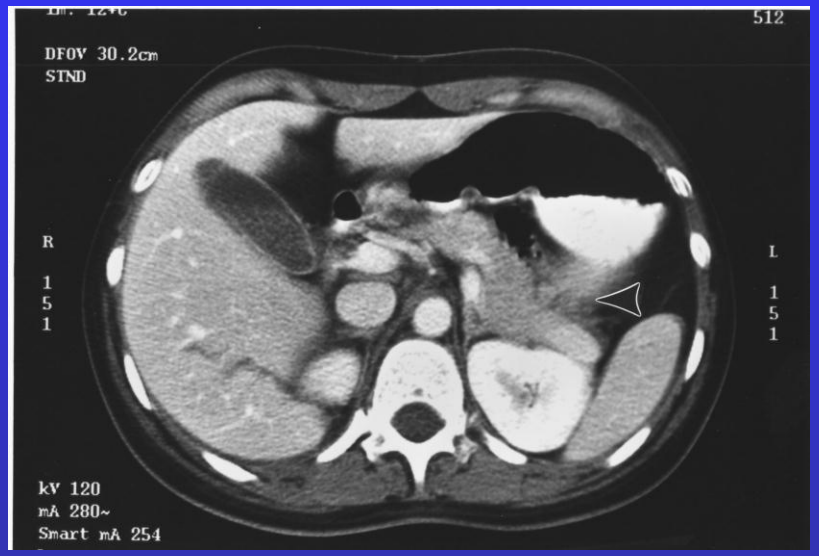


Pancreatic and peripancreatic edema



Extravasation of contrast
From pancreatic duct
Rx- pancreatic sphincterotomy

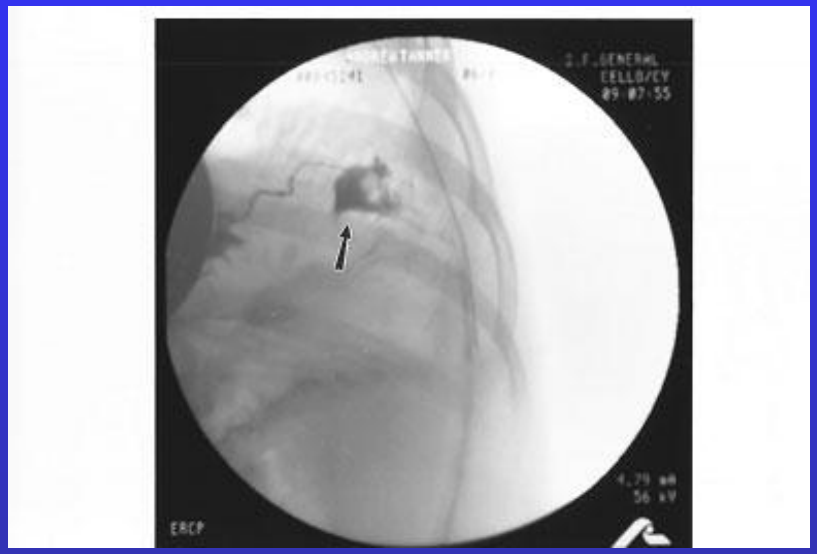
Blunt Trauma



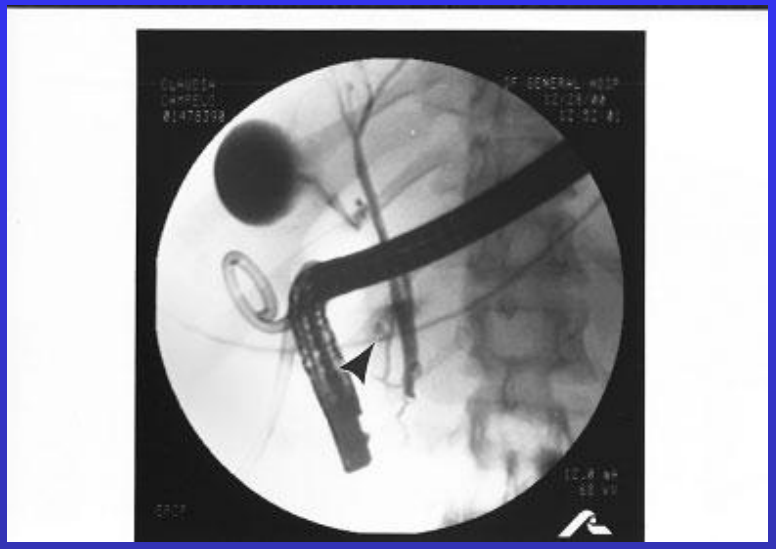
Mildly edematous pancreatic tail
Fluid in lesser sac

Extravasation of contrast at
Tail of pancreas
Rx- Observation

2 cases of Blunt Trauma

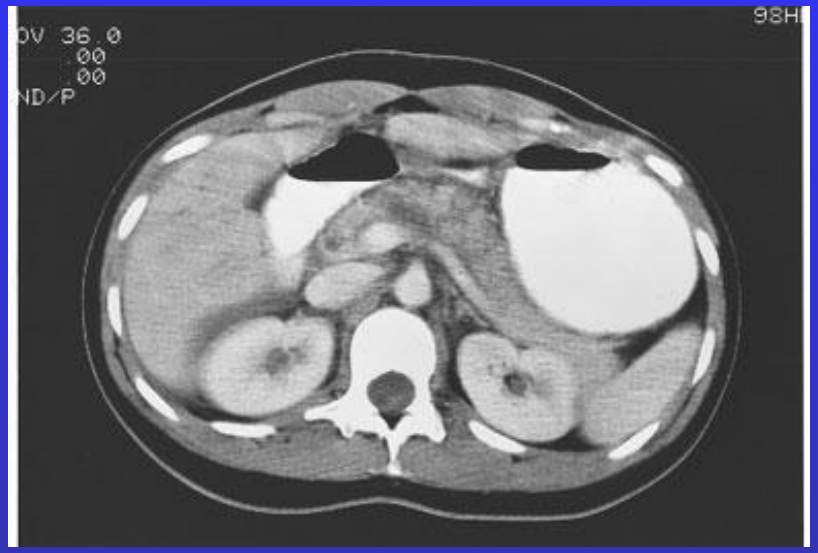


Extravasation from
Pancreatic tail
Rx-Sphincterotomy

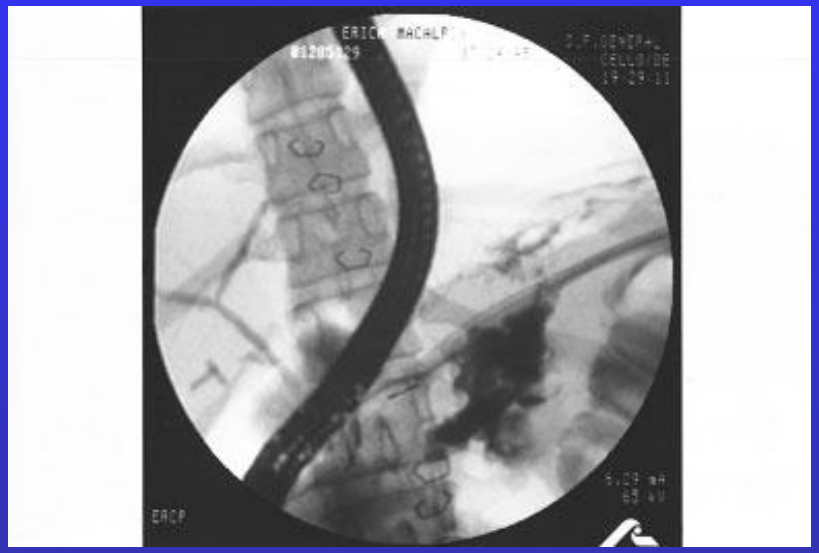


Extravasation from head of
Pancreas
Rx-IR perpancreatic drains

Blunt Trauma



Mild edema of body of pancreas



Extensive extravasation
Rx- distal pancreatectomy

Distal Pancreatectomy

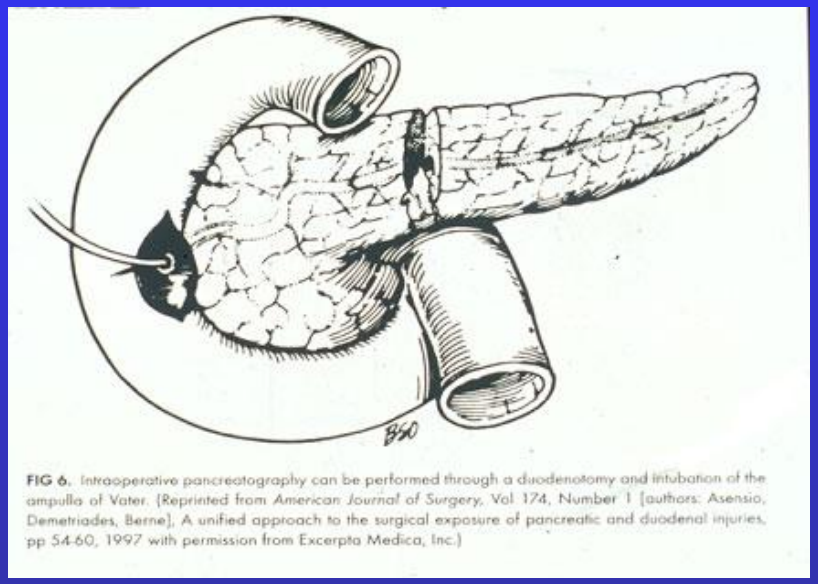
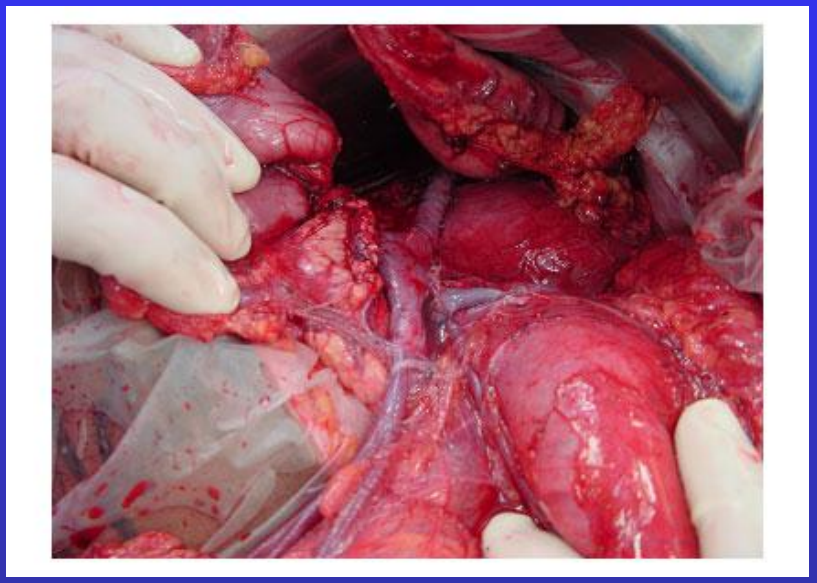


FIG 6. Intraoperative pancreatography can be performed through a duodenotomy and intubation of the ampulla of Vater. (Reprinted from *American Journal of Surgery*, Vol 174, Number 1 [authors: Asensio, Demetriades, Berne], A unified approach to the surgical exposure of pancreatic and duodenal injuries, pp 54-60, 1997 with permission from Excerpta Medica, Inc.)



Distal Pancreatectomy with Preservation of the Spleen

Lessons Learned

- Use ERCP to diagnose PDD after both blunt and penetrating trauma
- Treat PDD in selected cases by pancreatic sphincterotomy and/or pancreatic duct stent
- Early diagnosis of PDD can lead to prompt minimally invasive or resection therapy and minimize morbidity and mortality

Summary

- Non operative treatment of all hepatic injuries if possible
- Pack liver and close if bleeding is controlled
- Pringle maneuver for proximal control
- Supra and infrahepatic caval occlusion for distal control
- Temporary aortic crossclamp to prevent cardiac arrest in selected patients

Summary

- Cholecystectomy for gunshot wounds of the gallbladder in stable patients
- Cholecystorrhaphy vs cholecystectomy for small stab wounds of the gallbladder
- Tube cholecystostomy in unstable patients
- Choledochorrhapy for small stab wounds of the common bile duct
- Hepatojejunostomy for Common Duct Transections
- Drain the bile duct in the unstable patient