Pancreatic and Duodenal injuries

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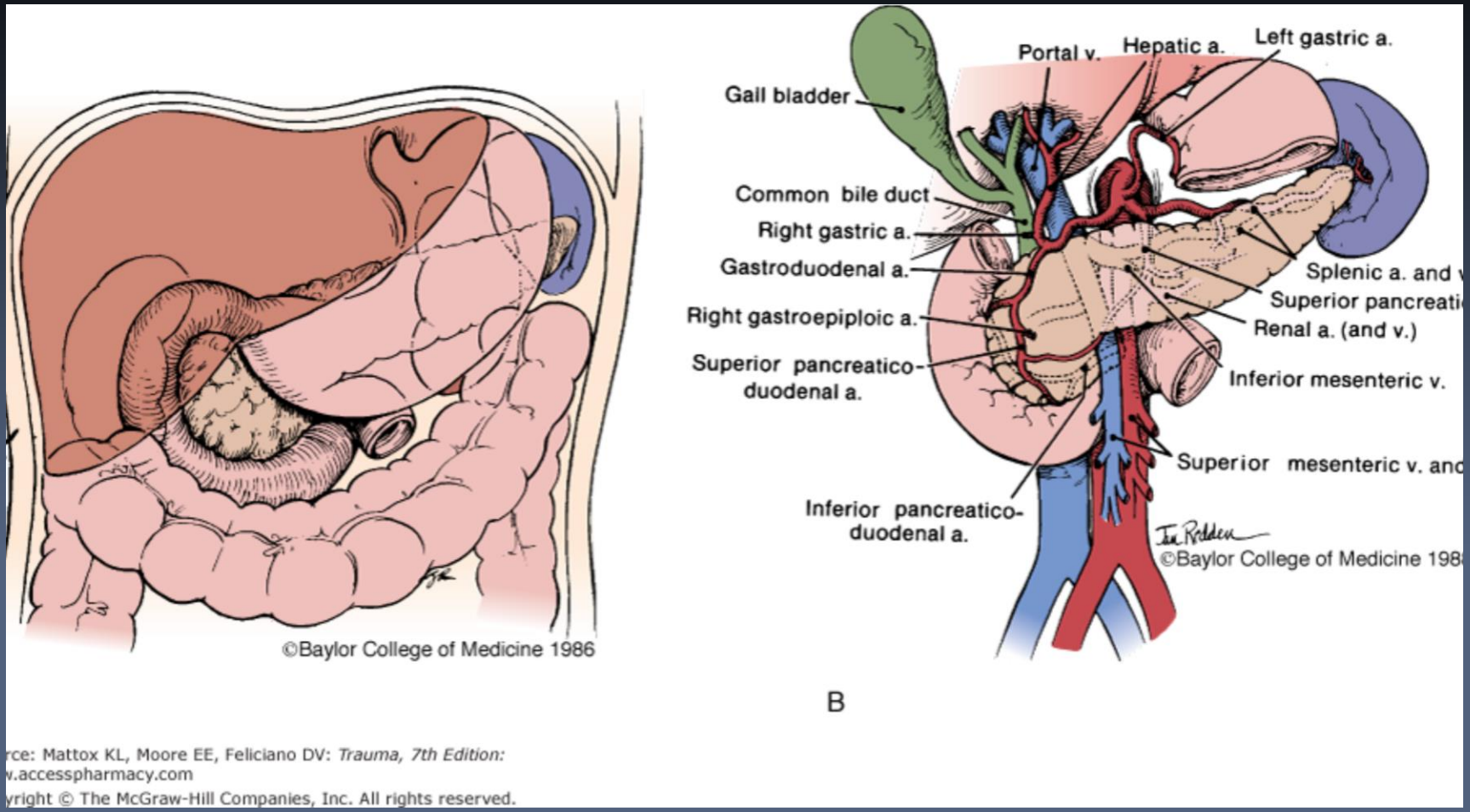
Pancreatic Injury

- Confounding factors
- Location
  - Central
  - Retroperitoneal
- Incidence 0.6%
  - Practice pattern
  - 3-6 % of all Laparotomies
- Complications
  - Mortality
  - Morbidity
- Mechanism
  - Blunt
  - Penetrating



rce: Mattox KL, Moore EE, Feliciano DV: *Trauma, 7th Edition:*
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  - Blunt
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Pancreatic Trauma Mortality

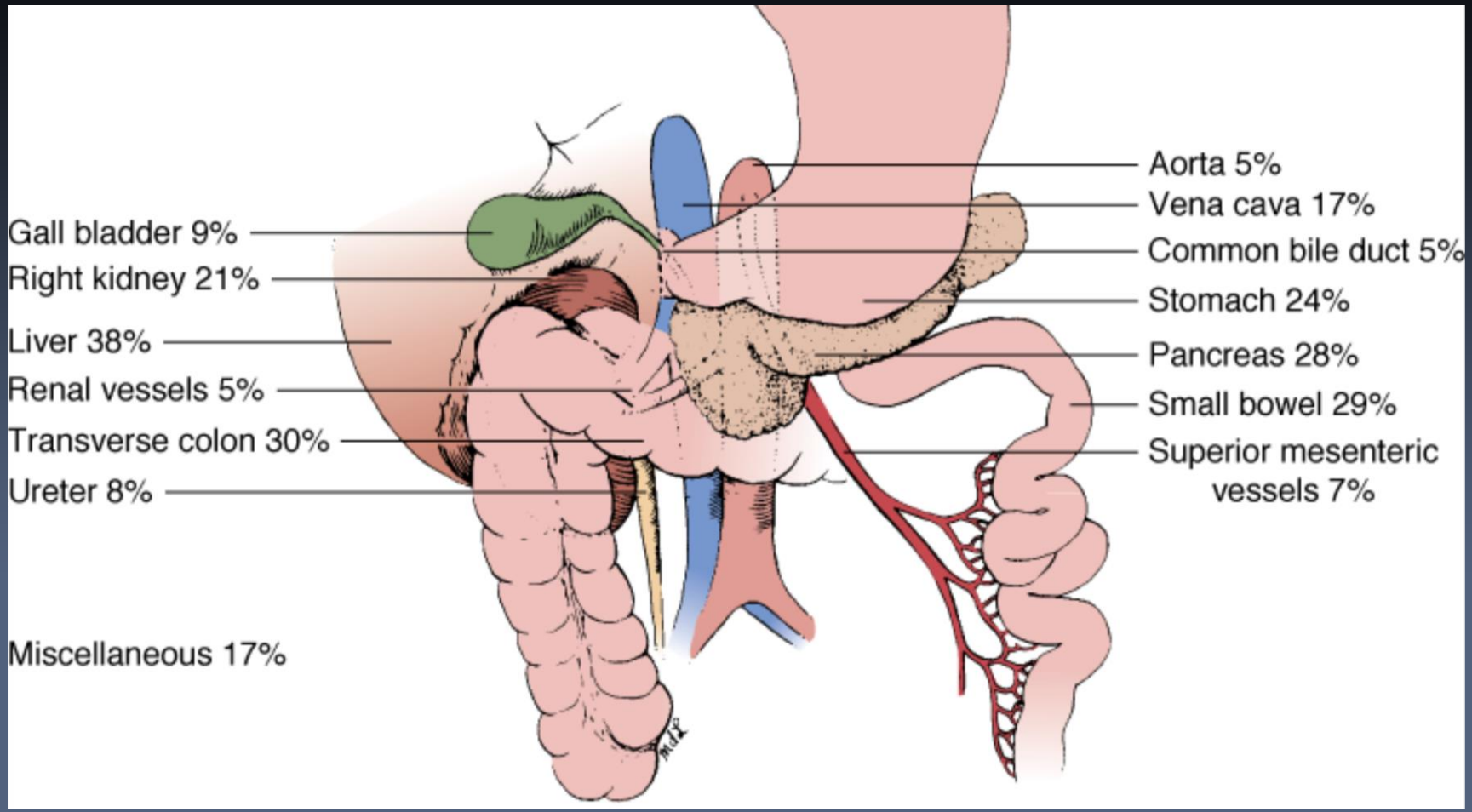
Table 32-2 Pancreatic Trauma: Mortality by Mechanism of Injury in Large Series (>100 Patients)

Series	Total Patients (% Penetrating)	Stab Wound Died/Total (%)	Gunshot Died/Total (%)	Penetrating Died/Total (%)	Blunt Died/Total (%)	Overall Died/Total (%)
Houston 1978[8]	448 (78)	5/75 (7)	53/273 (19)	58/348 (17)	15/100 (15)	73/448 (16)
Atlanta 1981[9]	283 (79)	2/32 (6)	27/192 (14)	29/224 (13)	10/59 (17)	39/283 (14)
Dallas 1985[10]	500 (72)	4/76 (5)	74/286 (26)	78/362 (22)	26/138 (19)	104/500 (21)
New York 1990[11]	103 (100)	7/32 (22)[ch32fn3]	20/71 (28)[ch32fn3]	33/103 (32)[ch32fn3]	—	33/103 (32)[ch32fn3]
Memphis 1991[12]	131 (76)	31[ch32fn4]	68[ch32fn4]	16/99 (16)	5/32 (16)	21/131 (16)
Durban 1995[13]	152 (85)	5/66 (8)	15/63 (24)	20/129 (16)	5/23 (22)	25/152 (16)
Memphis 1997[14]	134 (81)	?[ch32fn5]	?[ch32fn5]	108[ch32fn5]	26[ch32fn5]	17/134 (13)
Seattle 2003[15]	193 (39)	29[ch32fn5]	47[ch32fn5]	76[ch32fn5]	117[ch32fn5]	24/193 (12)
Boston 2009[16]	230 (9)	?c	?[ch32fn5]	?c	?[ch32fn5]	27/230 (12)
Overall	**2174 (75)**	**23/281 (8)**	**189/885 (21)**	**234/1265 (18)**	**61/352 (17)**	**363/2174 (17)**

Pancreatic Injury Pattern

- Injury – usually not in isolation
  - Liver 46%
  - Stomach 41%
  - Vascular 28%
  - Spleen 26%
    - Duodenum 16%
- # of concomitant injuries: 2-4
  - Higher ISS
- Mortality rate 2x with associated duodenal injury
  - 29%
- Mortality
  - 75% within 48 hours
  - Hemorrhage
- Morbidity 25-50% of patients

Associated structures at risk of injury



Mortality timing

Series	Total Patients	Deaths (%)	Early Deaths Due to Hemorrhage/CNS (%)	Late Deaths Due to Sepsis/MOF/Other (%)
WTA 1990[6]	164	30 (18)	22 (73)	8 (27)
Memphis 1991[12]	131	21 (16)	14 (67)	7 (33)
Memphis 1997[14]	134	17 (13)	11 (65)	6 (35)
Cleveland 1997[27]	72	12 (17)	8 (67)	4 (33)
Seattle 2003[15]	193	24 (12)	18 (75)	6 (25)
Detroit 2004[7]	222	50 (23)	40 (80)	10 (20)
Overall	**916**	**154 (17)**	**113 (73)**	**41 (27)**

Pancreatic anatomy

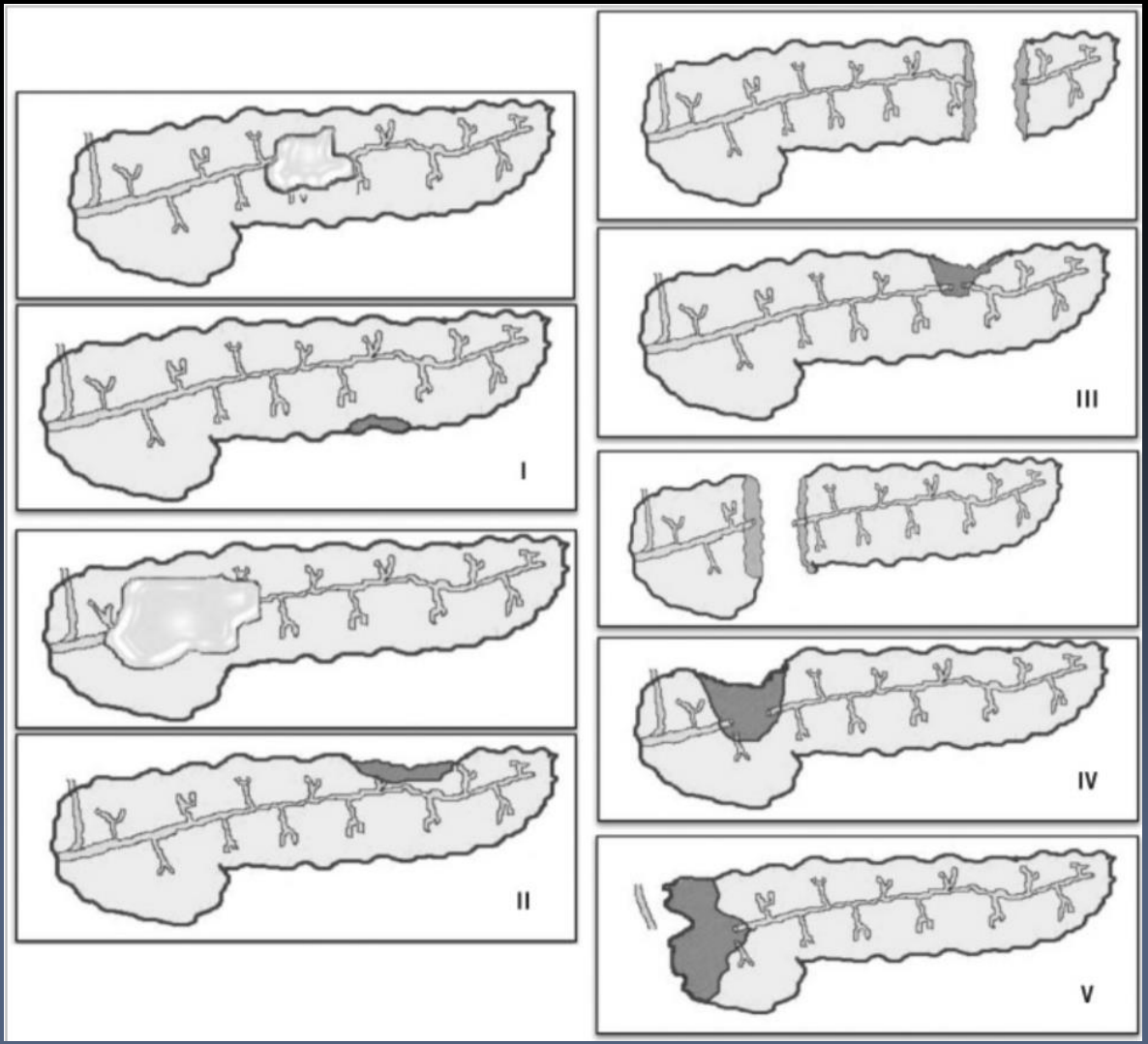
- Replaced Right Hepatic Artery
  - 15%
- Aberrant proper Hepatic Artery
  - 5%
- CBD anatomy
- Duct of Santorini
  - Proximal location to the papilla
- SMV
  - Associated injury
- IMV
  - Mobilization of duodenum

- Gallbladder
  - A friend

AAST Pancreas Organ Injury Scale

Grade[ch32tbl01_8]		Injury Description
I	Hematoma	Major contusion without duct injury or tissue loss
	Laceration	Major laceration without duct injury or tissue loss
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference
III	Laceration	Distal transection or parenchymal injury with duct injury
IV	Laceration	Proximal (to right of superior mesenteric vein) transection or parenchymal injury
V	Laceration	Massive disruption of pancreatic head

[a]Advance one grade for multiple injuries to the same organ.



Grading the severity of pancreatic injury: grade I – minor contusion or laceration with no duct injury, grade II – major contusion or laceration with no duct injury, grade III – transection or major laceration with duct disruption in distal pancreas, grade IV – transection of proximal pancreas or major laceration with associated injury to the ampulla, grade V – Massive disruption of the pancreatic head

Diagnosis

- Penetrating injury
  - Exploration
  - Imaging
- Blunt Trauma
  - Imaging
  - Exploration for other injuries
- Pitfalls with delay in diagnosis
  - 6-24 hrs – 23%
  - >24 hrs - 20%
- Isolated pancreatic injury
  - Time to exploration --- 9 days

- Adjuncts
  - Amylase serum -- > 3 hrs from TOI
  - Physical exam unreliable

Imaging

- CT
  - Not ideal but the best modality currently utilized
- Correlation with ductal injury
  - 43-70% when followed by confirmatory procedure
- Single institution study
  - Sensitivity 68%
  - PPV 100%
  - AAST grade underestimated – 31%
- Multi-institutional AAST study
  - 16-64 MDCT
  - Ductal injury 54 and 52% sensitivity
  - Inter-operator variability
  - Protocols for image acquisition
- MRCP
- ERCP

Diagnostic criteria on CT

Imaging findings in pancreatic injuries

Direct findings:

- Laceration (linear region of nonenhancement)
- Diffuse or focal pancreatic enlargement
- Heterogenous enhancement

Indirect findings:

- Peripancreatic fat stranding or fluid
- Fluid between the splenic vein and the pancreas
- Peripancreatic hemorrhage
- Injuries to adjacent organs or vessels
- Trajectory of penetrating injury through the region of the pancreas

WBCT

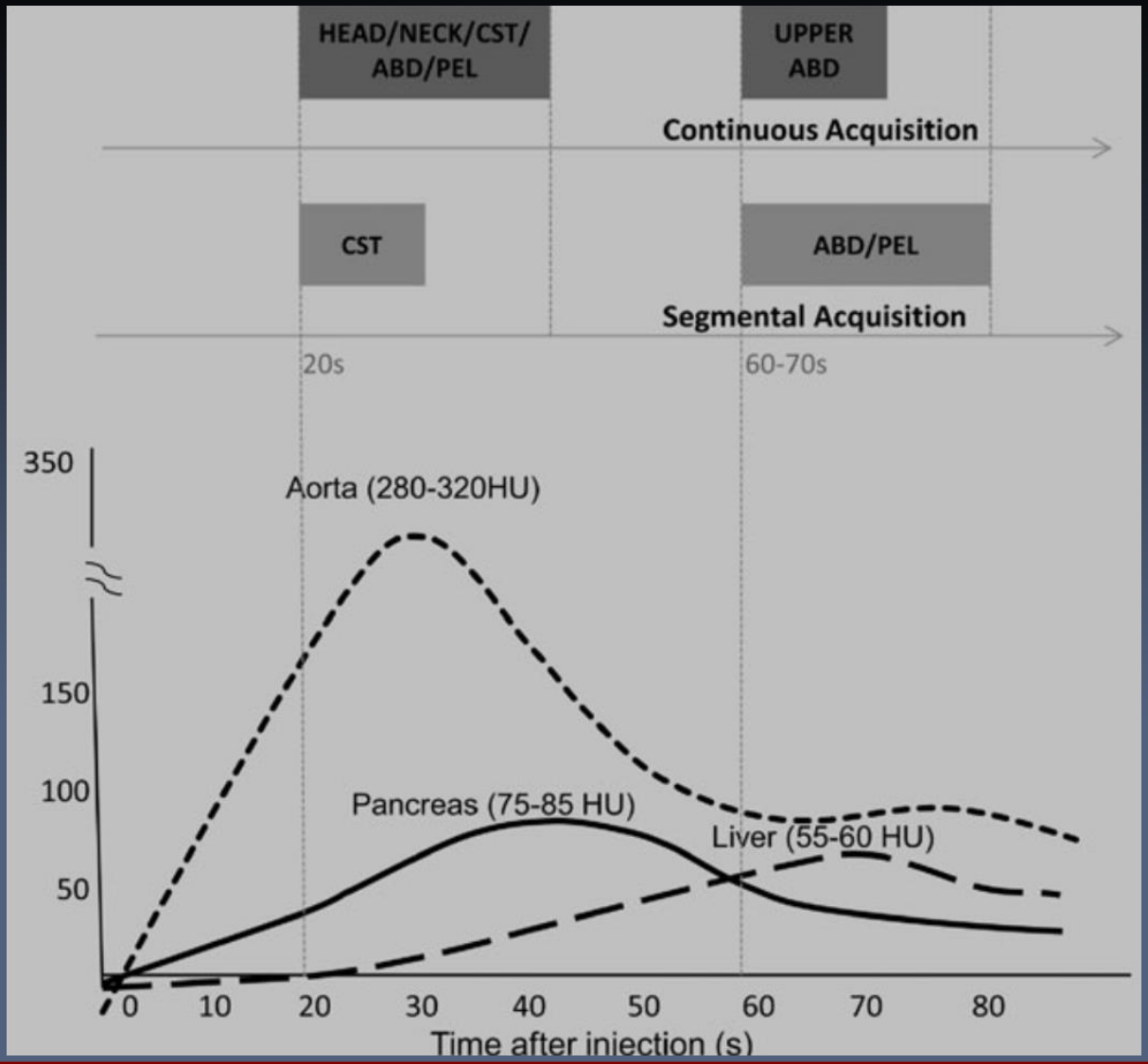


Fig. 1 Graph demonstrates time after injection versus contrast enhancement of the aorta, liver, and pancreas. Peak contrast enhancement of the aorta is 30–35 s; pancreatic parenchyma, 35–45 s; and hepatic parenchyma, 55–60 s. The pancreas enhances to a slightly greater extent than the liver. Pancreatic curve is hypothetical. Aortic and hepatic curves are based on simulations in Bae, KT. [54]

Western Trauma Association

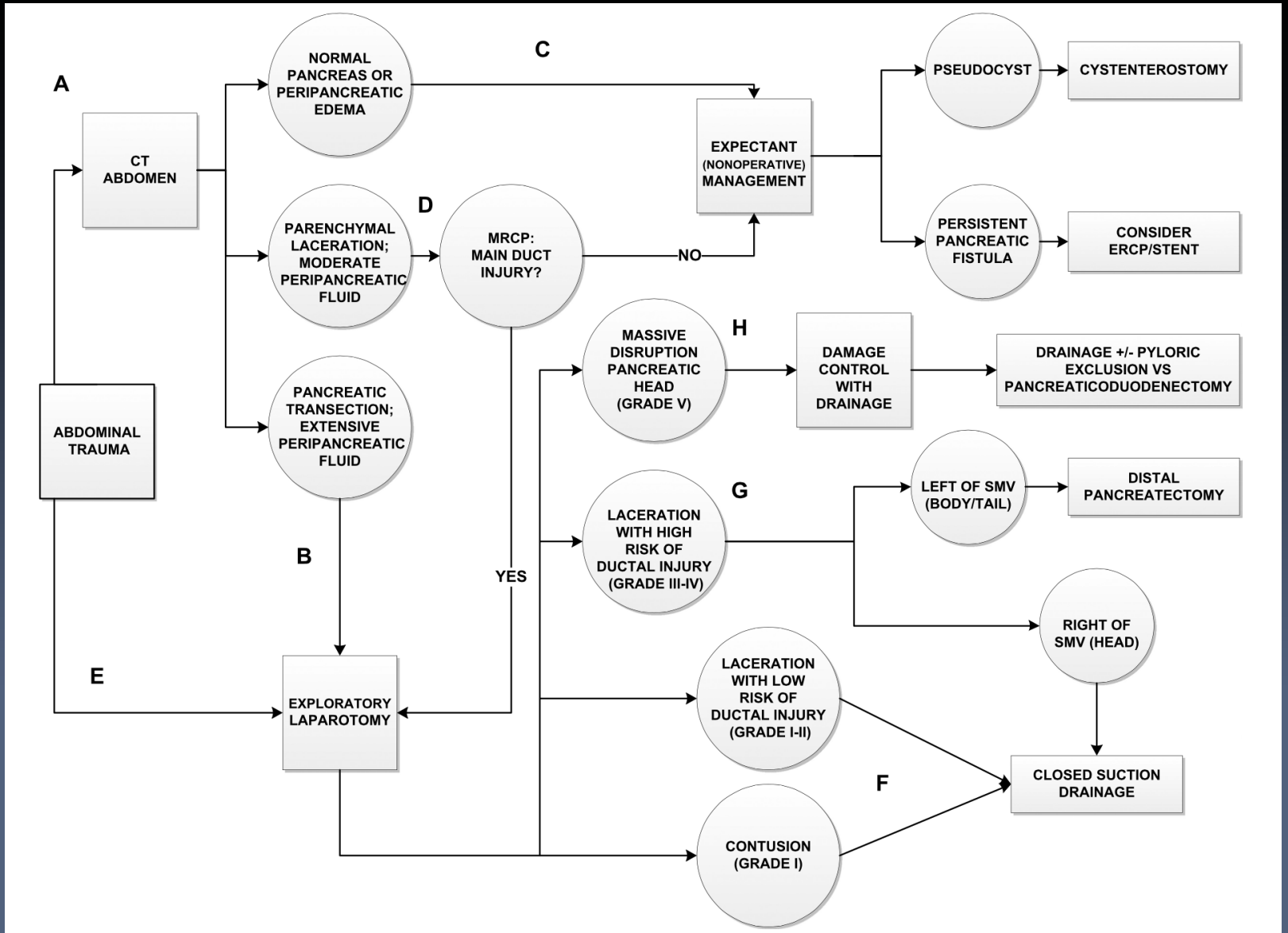
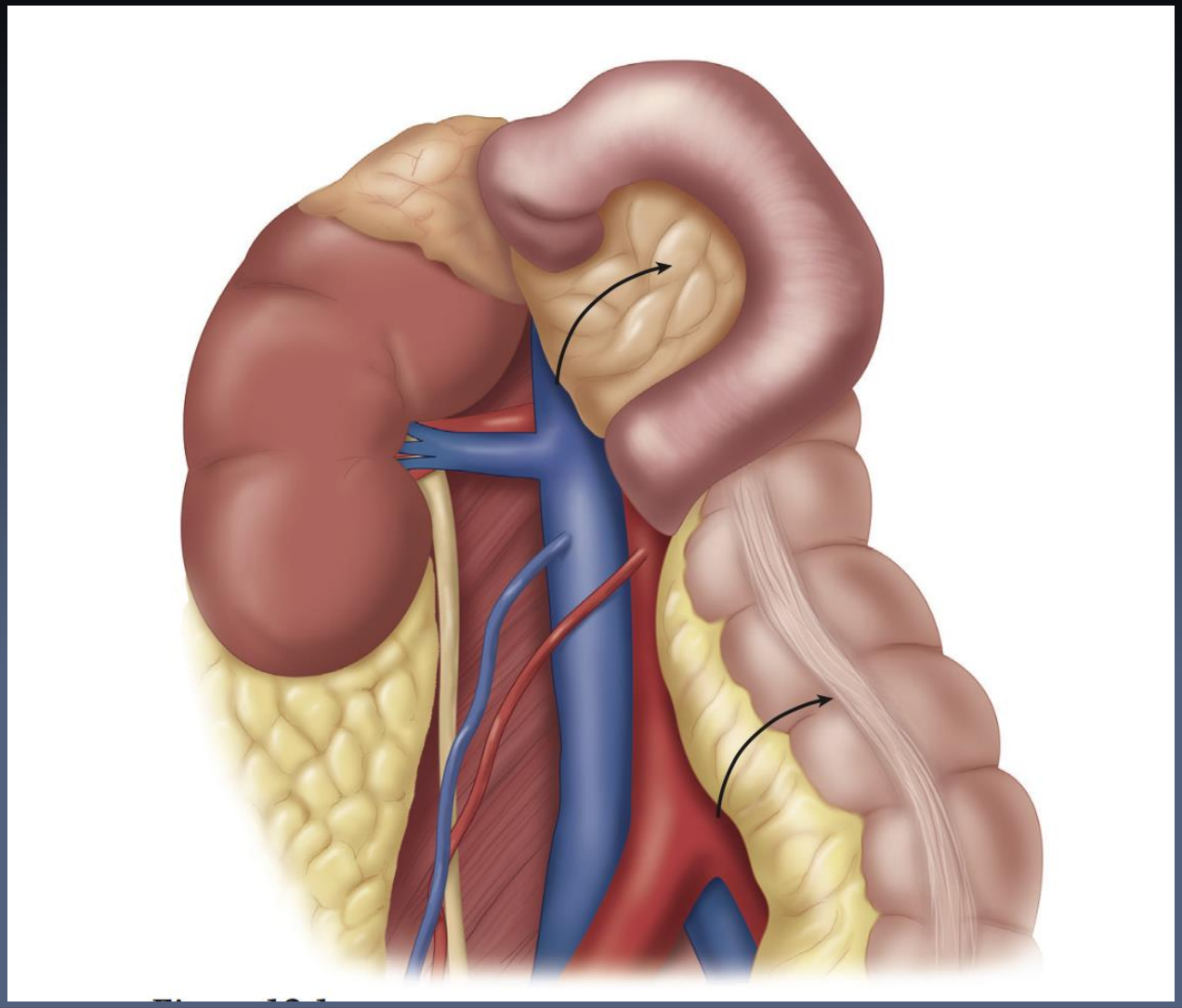


Figure 1. Western Trauma Association management algorithm for pancreatic injuries.

Exposure - Kocher



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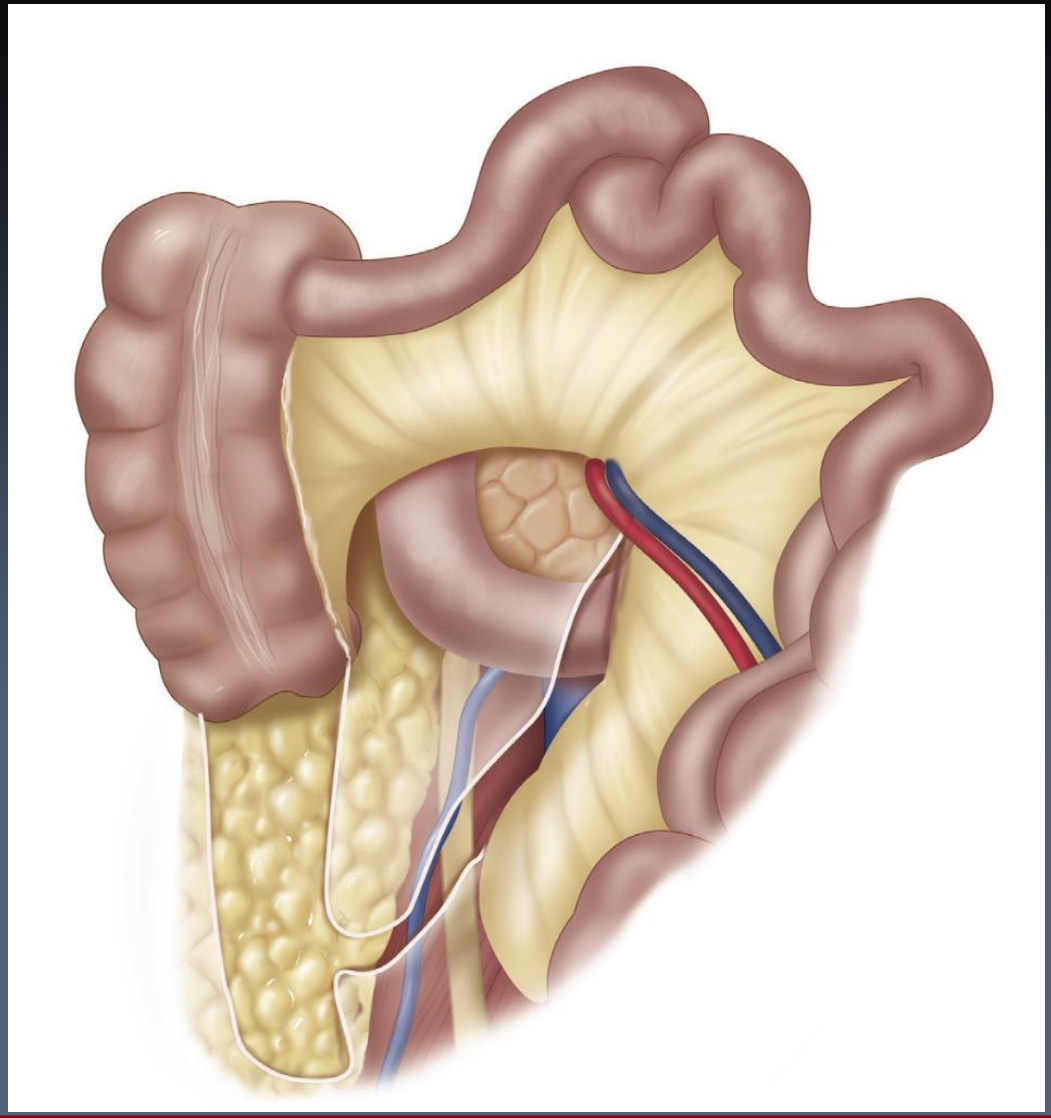
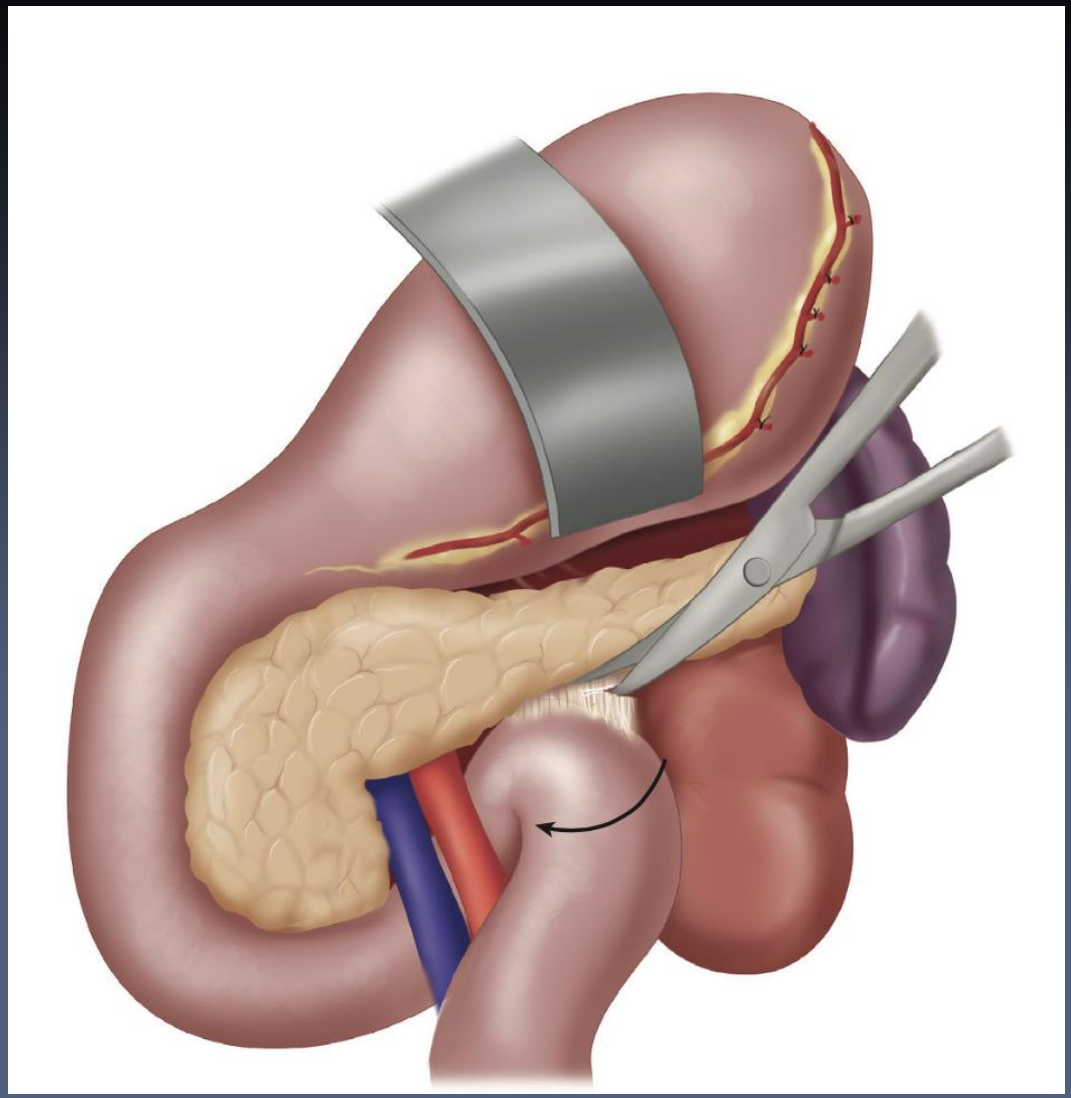
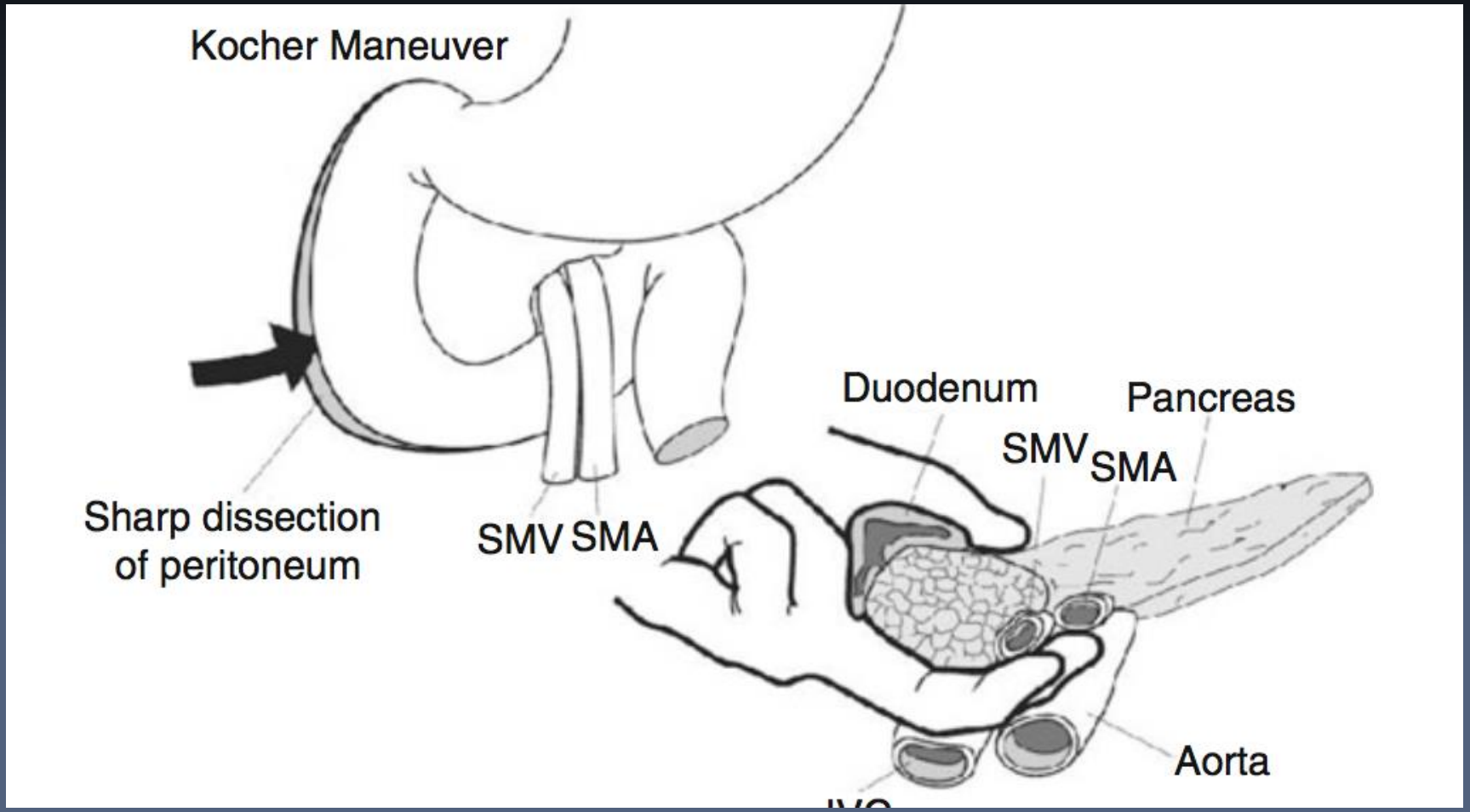


Exposure – ligament of Trietz



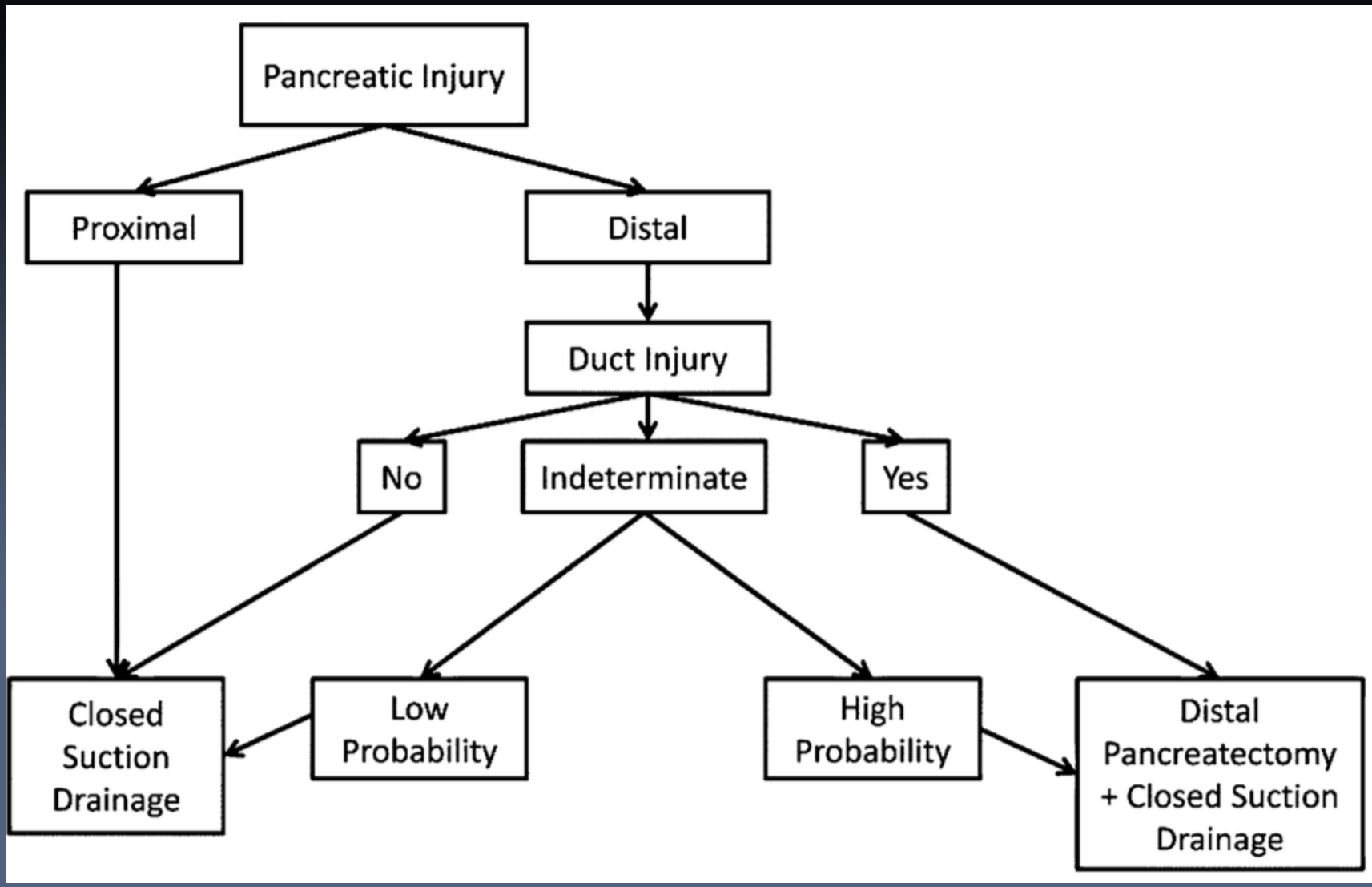
Exposure


Kocher Maneuver
Duodenum
Pancreas
SMV
SMA
Sharp dissection
of peritoneum
SMV
SMA
Aorta

Intraoperative evaluation of pancreas

- Direct inspection
  - Ductal injury
  - Transection
  - Laceration >50%
  - Central perforation
  - Maceration
- Patton et al
  - No intra-operative pancratography
  - Complication rate of 30%
  - Pancreas specific mortality of 1.6%
- Sharp et al
  - Validation in 2012

Validation of intra-operative evaluation by Sharp et al



Pancreatic injury surgical approach

- Grade I and II
  - Debridement
  - Closed suction drainage
  - No need to suture pancreas

Grade		Injury Description
I	Hematoma	Major contusion without duct injury or tissue loss
	Laceration	Major laceration without duct injury or tissue loss
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference

Pancreatic injury surgical approach

- Grade III
  - Distal pancreatectomy
  - Mortality of 9%
  - Complication of 19%

  - Main pancreatic duct ligated if possible
  - Roux en Y Pancreato-jejunostomy avoided if possible

III	Laceration	Distal transection or parenchymal injury with duct injury

Pancreatic injury surgical approach

- Grade IV and V
  Little data for optimal approach
- Closed suction drainage
- Aim for controlled pancreatic fistula

IV	Laceration	Proximal (to right of superior mesenteric vein) transection or parenchymal injury
V	Laceration	Massive disruption of pancreatic head

Pancreatic injury surgical approach

- Grade IV and V
- Combined pancreatic and duodenal injuries
  - Triple drainage – Stone 1979 – 237 patients
  - Pyloric exclusion
- Feliciano et al
  - 24% simple repair
  - 61% complex repair +/- pyloric exclusion
  - 10% Pancreaticoduodenectomy

Mortality

- Simple 25% vs PD 46%

IV	Laceration	Proximal (to right of superior mesenteric vein) transection or parenchymal injury
V	Laceration	Massive disruption of pancreatic head

Pancreatico-duodenectomy indications

- Massive disruption of pancreatic head
  - Uncontrolled hemorrhage
  - Severe combined injuries
  - Related or proximity vascular injuries
- Complete the injury
- Damage control
- Second look for completion of resection

Non operative management

- Grade I and II
  - NPO
  - TPN
  - Amylase
  - Vigilance for higher grade of injury
- NOM with pancreatic duct injury
  - Complication in 48%
  - Psuedocysts
  - Fistula
- Octreotide
- Pasireotide

EAST guidelines 2009

- Delay in diagnosis of main Pancreatic duct injury causes morbidity
- CT suggestive but not diagnostic of injury
- Amylase and lipase are suggestive but not diagnostic of injury
- Grade I and II = Drainage alone
- Grade III =resection and drainage
- Closed suction drainage

Outcomes

- Mortality
- Early
  - Hemorrhage
  - Associated injuries
- Late
  - Sepsis
  - MSOF
  - Respiratory failure

Pancreatic Trauma outcomes 1997 onward

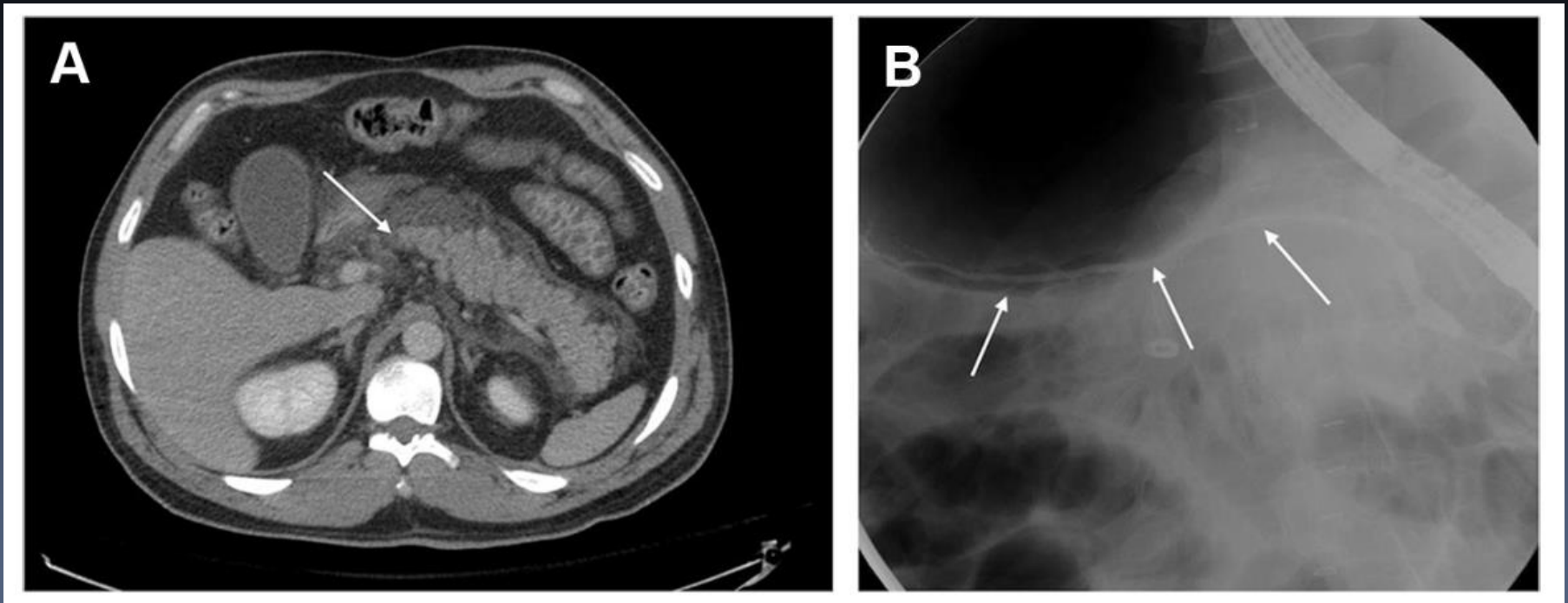
Patton et al. [10]	81 % Penetrating 19 % blunt	13 % Overall 1.6 % PRM	31 % Overall 15 % Fistula 14 % Pancreatic abscess 8 % Pancreatitis 3 % Drain tract infection 1.6 % Pseudocyst
Vasquez et al. [7]	100 % Penetrating	27.4 % Overall	29.7 % Overall 15 % Intra-abdominal abscess 11 % Fistula 9 % Postoperative hemorrhage 4 % Pseudocyst 4 % Pancreatitis
Lin et al. [31]	100 % Blunt All major ductal injuries	15.5 % Overall	46.7 % Overall 24.4 % Intra-abdominal abscess 13.3 % Sepsis/MSOF 8.9 % Pancreatic duct stricture 4.4 % Pseudocyst 4.4 % Pancreatitis 2.2 % Fistula
Krige et al. [16]	100 % Blunt	16.4 % Overall	74.5 % Overall 14.5 % Fistula 13.6 % Pseudocyst 2.7 % Pancreatic ascites 50.9 % Nonpancreatic abdominal
Heuer et al. [17]	95.5 % Blunt	19 % Overall	50 % Organ failure 32.9 % Multiple organ failure 14.6 % Sepsis
Sharpe et al. [28]	69 % Penetrating	16 % Overall No PRM	8.5 % Pancreatic fistula 8.1 % Pancreatic abscess

Morbidity

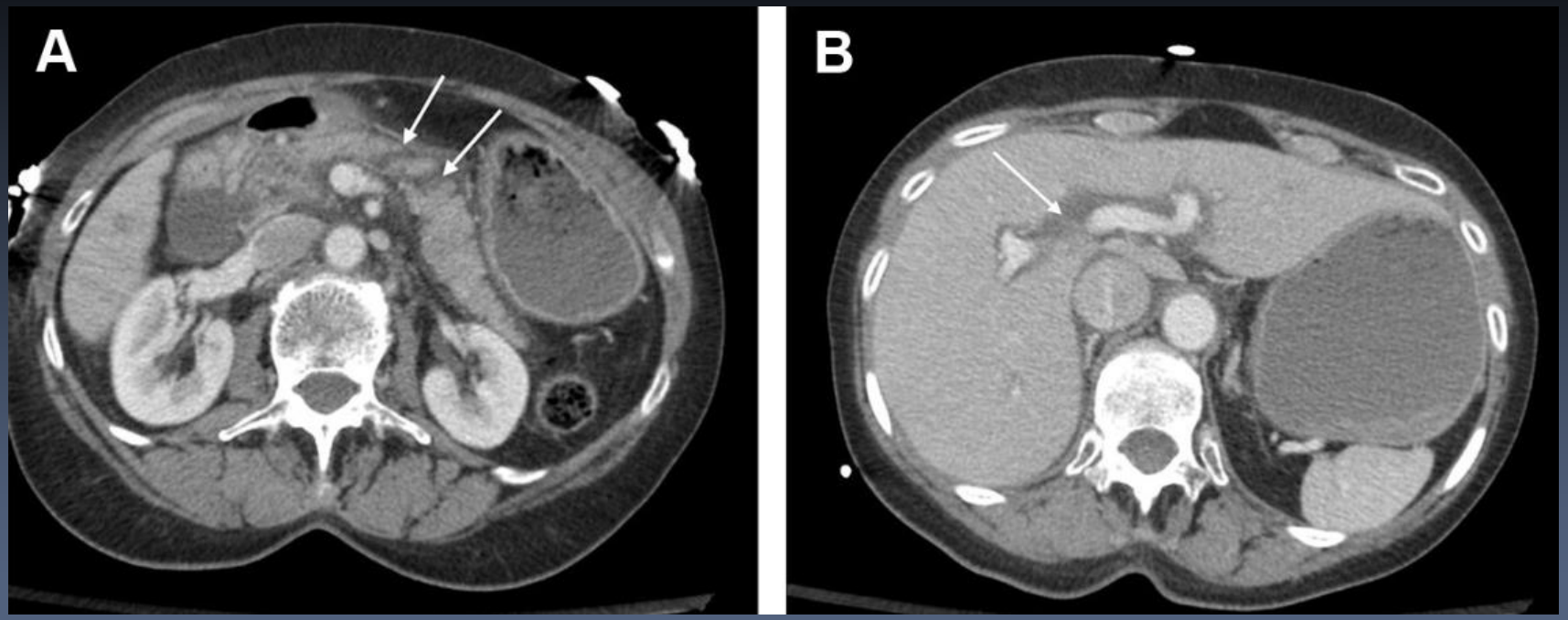
- Grade I - 9%
- Grade II – 17%
- Grade III - 36%
- Grade IV - 50%
  Smego et al 1985
- Pancreatic fistula
  - Up to 15% of patients
  - Independent predictor with PD injury
- Pancreatic abscess
  - Colon and PD injury independent predictors

Morbidity

- Pancreatic pseudocysts
  - Missed injury
  - Non-operative management
- Post traumatic pancreatitis
  - Nausea vomiting
  - Hyperamylasemia
- Exocrine insufficiency
  - Unlikely due to trauma related resection
- Hemorrhage – delayed
  - Erosion

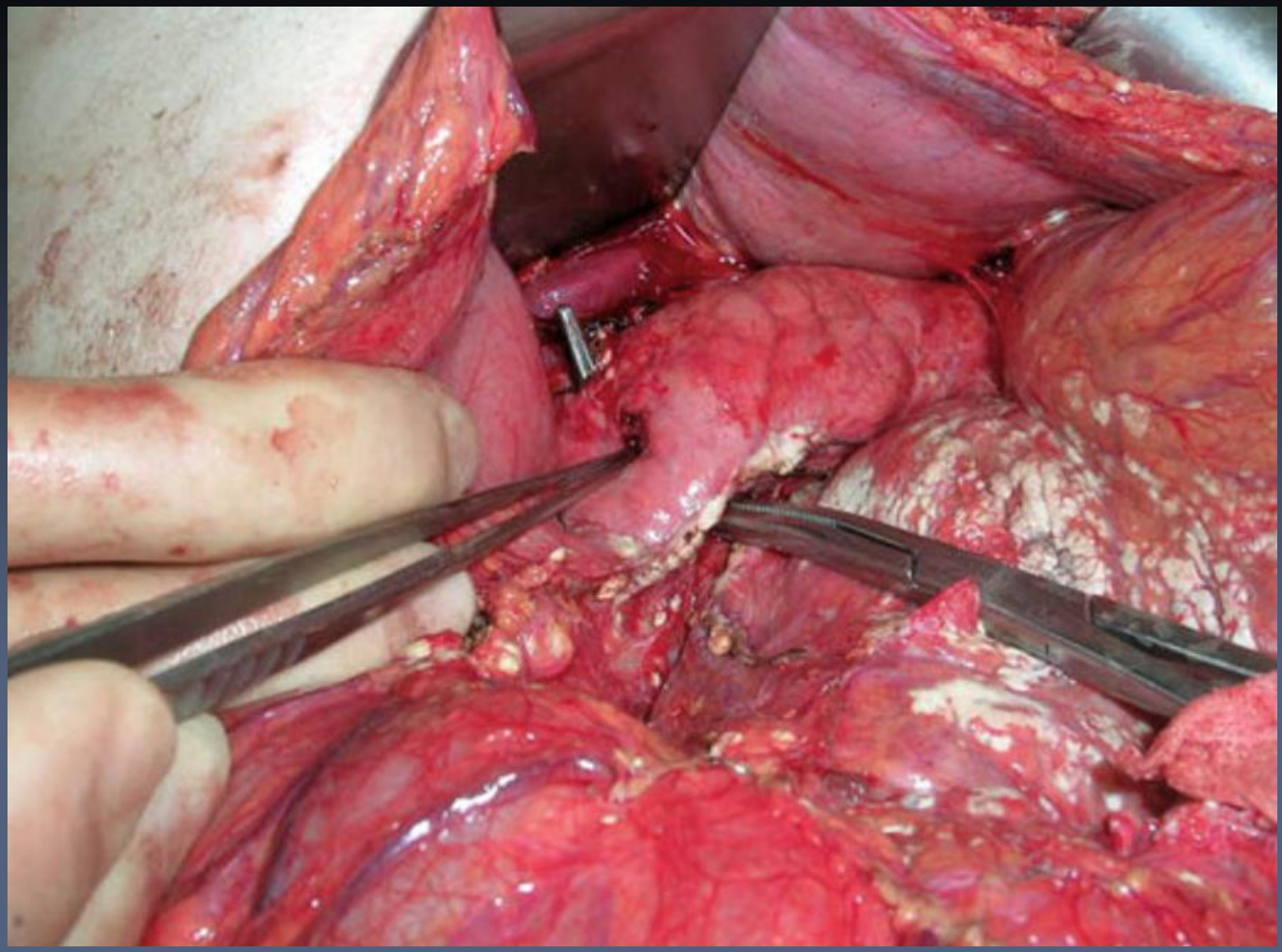


Cleft. ERCP with intact duct
At exploration, no injury identified



IVC
Fluid

Pancreatic duct injury missed due to being sealed by hematoma, central perforation, vertical laceration or severe contusion in the tail.



Duodenal Injury

- Incidence
  - 5%
- Blunt
  - Blow to the mid-section
  - Causes
- Penetrating
  - GSW
  - Stab
- Diagnostic workup
  - Physical exam
  - Imaging/Blood
- Intervention
  - Timing
  - Non-operative management

Duodenal Trauma Mortality

Series	Total Patients (% Penetrating)	Stab Wound Died/Total (%)	Gunshot Died/Total (%)	Penetrating Died/Total (%)	Blunt Died/Total (%)	Overall Died/Total (%)
Houston 1977[1]	175 (87)	2/18 (11)	16/134 (12)	18/152 (12)	6/23 (26)	24/175 (14)
Atlanta 1979[2]	321 (92)	0/31 (0)	37/263 (14)	37/294 (13)	4/27 (15)	41/321 (13)
Dallas 1980[3]	247 (78)	0/23 (0) ch32fn1	18/157 (11) ch32fn1	31/193 (16)	12/54 (22)	43/247 (17)
New York 1985[4]	100 (100)	5/30 (17)	20/70 (29)	25/100 (25)	—	25/100 (25)
Los Angeles 1987[5]	115 (82) ch32fn2	0/42 (0) ch32fn2	4/52 (8) ch32fn2	4/94 (4) ch32fn2	0/11 (0) ch32fn2	14/115 (12)
WTA 1990[6]	164 (62)	2/31 (6)	22/71 (31)	24/102 (24)	6/62 (10)	30/164 (18)
Detroit 2004[7]	222 (88)	8/34 (24)	38/162 (23)	46/196 (23)	4/26 (15)	50/222 (23)
Overall	**1344 (85)**	**17/209 (8)**	**155/909 (17)**	**185/1131(16)** ch32fn1, ch32fn2	**32/203 (16)**	**227/1344 (17)**

Duodenal Trauma associated injuries

Organ Injury	Patients (%)
Major vascular	596 (48)
Liver	543 (44)
Colon	378 (31)
Pancreas	368 (30)
Small bowel	363 (29)
Stomach	279 (23)
Kidney	237 (19)
Gallbladder/biliary tree	176 (14)
Spleen	41 (3)

Based on combined data from references 1–3, 5–7.

Combined mortality

Table 32-5 Combined Pancreaticoduodenal Trauma: Mortality by Mechanism of Injury in Large (>100 Patients)

Series	Total Patients	Duodenum Alone Died/Total (%)	Pancreas Alone Died/Total (%)	Combined Pancreaticoduodenal Died/Total (%)
Los Angeles 1987[5]	115	10/89 (11)	—	4/26 (15)
Detroit 2004[7]	222	26/147 (18)	—	24/75 (32)
Atlanta 1981[9]	283	—	22/228 (10)	17/55 (31)
Dallas 1985[10]	500	—	75/409 (18)	29/91 (32)
Boston 2009[16]	230	4/60 (7)	14/132 (11)	9/38 (24)
Overall		**40/296 (14)**	**111/769 (14)**	**83/285 (29)**

Timing of Death

Table 32-6 Timing of Death Following Pancreatic or Duodenal Trauma

Series	Total Patients	Deaths (%)	Early Deaths Due to Hemorrhage/CNS (%)	Late Deaths Due to Sepsis/MOF/Other (%)
WTA 1990[6]	164	30 (18)	22 (73)	8 (27)
Memphis 1991[12]	131	21 (16)	14 (67)	7 (33)
Memphis 1997[14]	134	17 (13)	11 (65)	6 (35)
Cleveland 1997[27]	72	12 (17)	8 (67)	4 (33)
Seattle 2003[15]	193	24 (12)	18 (75)	6 (25)
Detroit 2004[7]	222	50 (23)	40 (80)	10 (20)
Overall	**916**	**154 (17)**	**113 (73)**	**41 (27)**

AAST Duodenal Organ Injury Scale

Grade		Injury Description
I	Hematoma	Involving single portion of duodenum
	Laceration	Partial thickness, no perforation
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference
III	Laceration	Disruption 50–75% circumference of D2
		Disruption 50–100% circumference of D1, D3, D4
IV	Laceration	Disruption >75% circumference of D2
		Involving ampulla or distal common bile duct
V	Laceration	Massive disruption of duodenopancreatic complex
	Vascular	Devascularization of duodenum

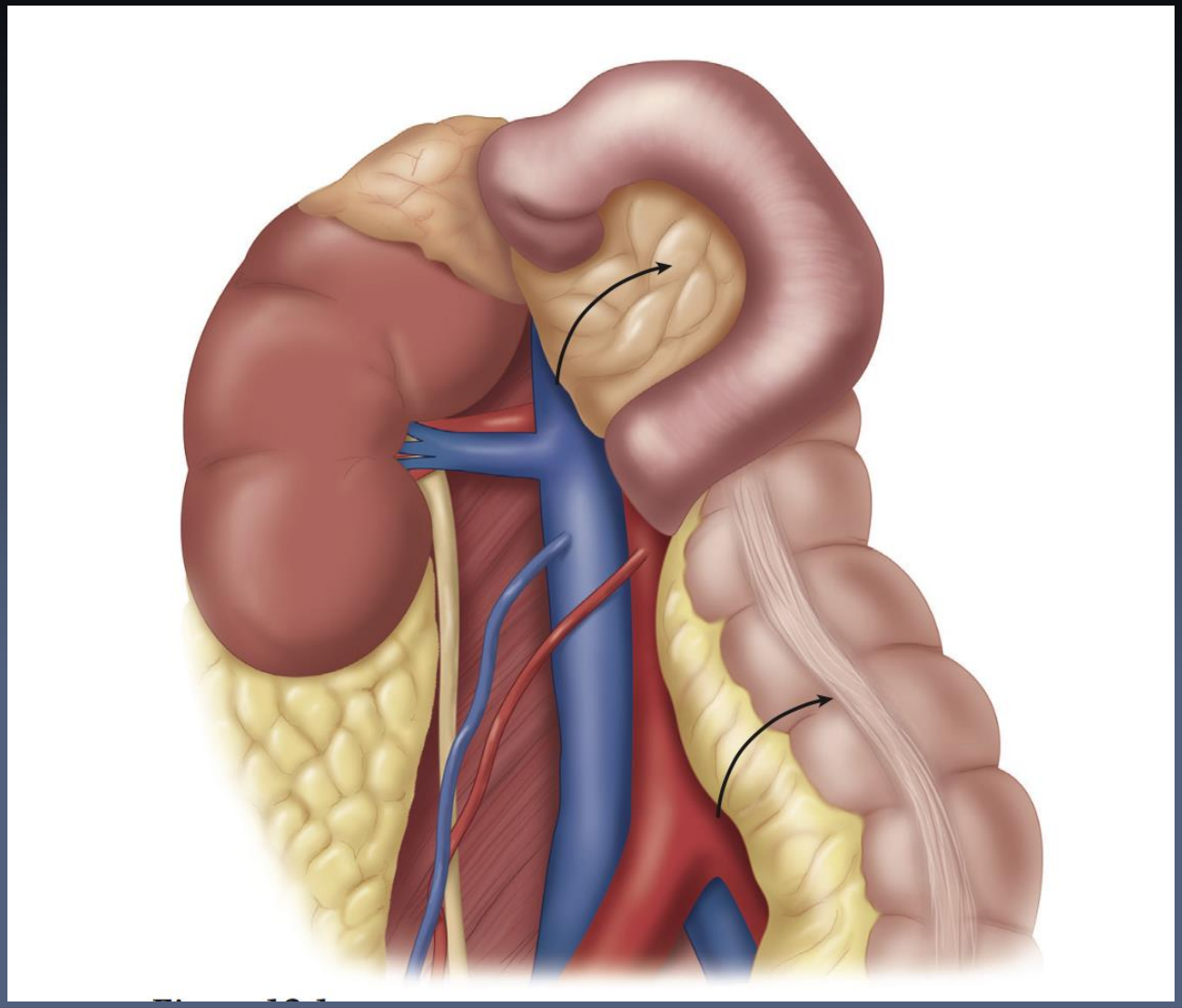
Diagnosis

- CT
  - Sensitive
  - Peri-duodenal fluid
  - Wall thickening
  - Extravasation
- Upper GI
  - Corkscrew appearance
  - Extravasation

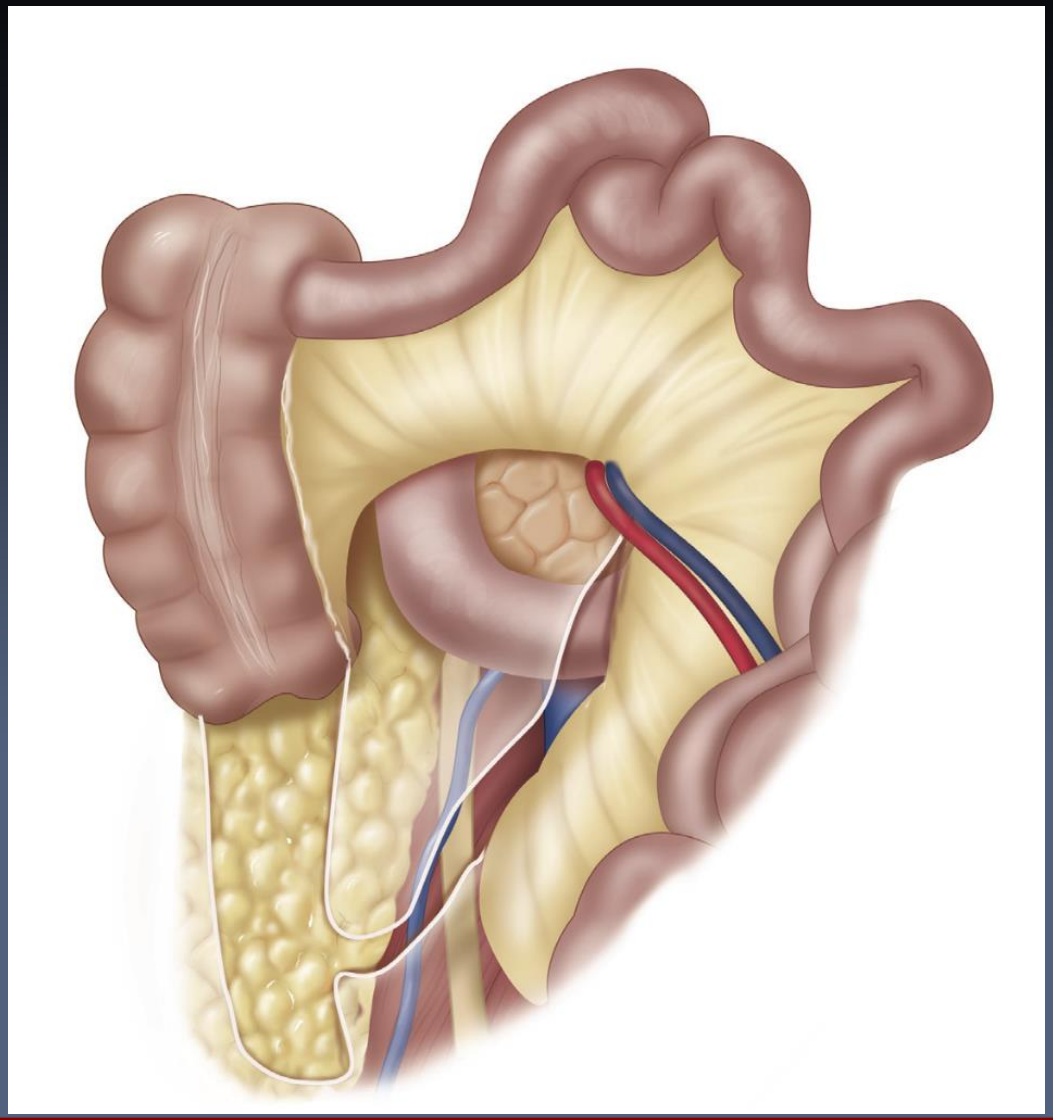
Operative management

- Wide exposure

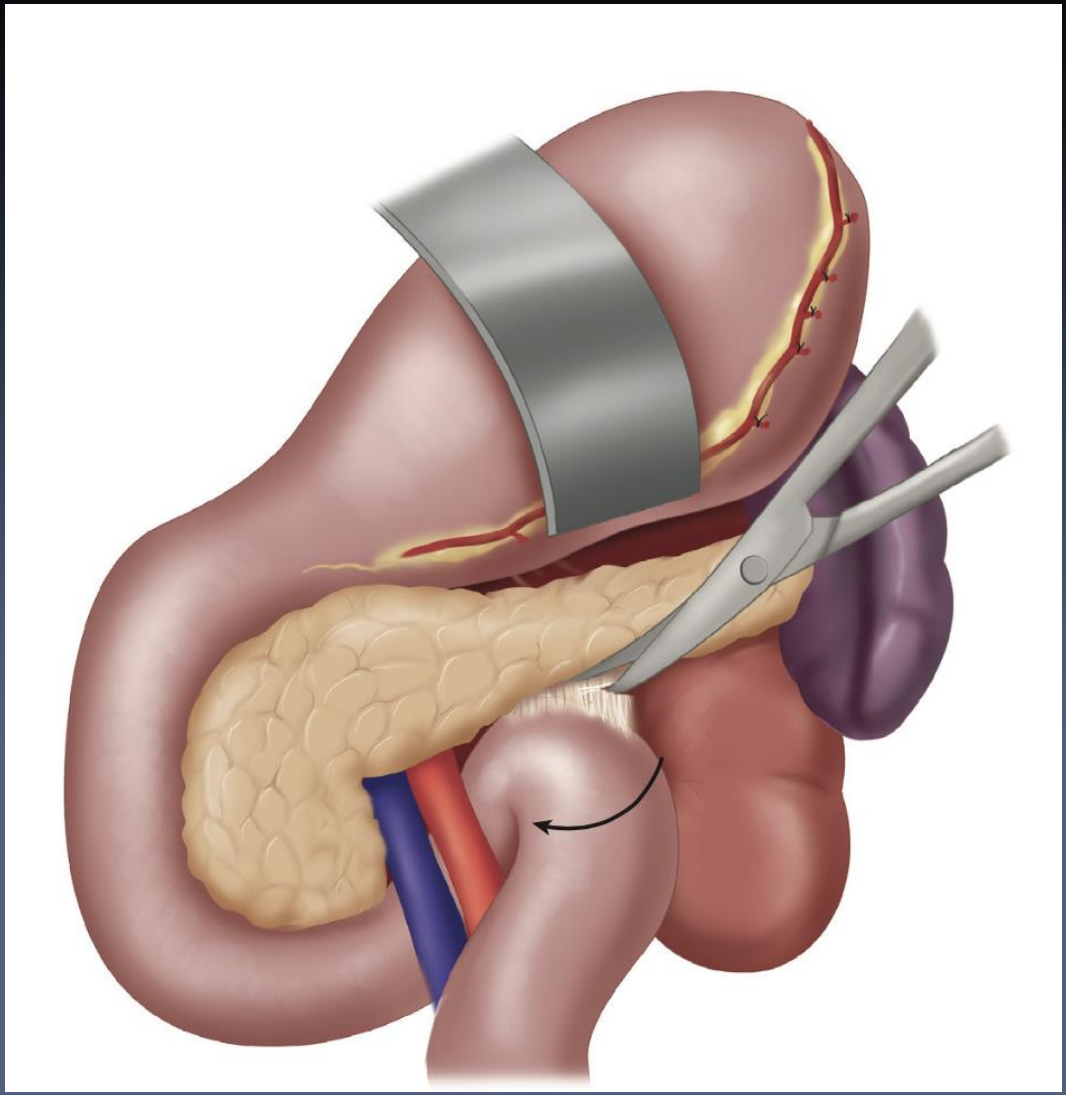
Exposure - Kocher



Exposure – Cattell Braasch



Exposure – ligament of Trietz



Operative management

- Wide exposure
  - D1
  - D2
  - D3
  - D4
- Biliary Tree
- Pancreas

- Dye instillation
  - One and done

Table 1 Duodenal Injury Location (n = 46)

Location	No. Wounds (%)
D1	4 (9)
D2	30 (65)
D3	9 (20)
D4	3 (7)

Forty-six wounds were discovered in 29 patients. The majority of these (65%) were contained in the second portion of the duodenum.

Duodenal Laceration – not hematoma

- Grade I and II Injury

  Primary repair
  - <50% of circumference
  - Transverse closure
    - 2 layer – choice of suture
  - Serosal patch to buttress
  - Omental patch

Closed suction Drain

I	Hematoma	Involving single portion of duodenum
	Laceration	Partial thickness, no perforation
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference

Duodenal Injury

- Resection/Reconstruction
  - Primary repair
    - Debridement
  - Billroth II
    - D1
  - Duodeno-jejunostomy
    - D3 D4
- External drainage

III	Laceration	Disruption 50–75% circumference of D2
		Disruption 50–100% circumference of D1, D3, D4

Duodenal injury

- Pancreaticoduodenectomy (PDT)
  Destruction of Biliary pancreatic Duodenal axis
- Damage control Surgery

IV	Laceration	Disruption >75% circumference of D2
		Involving ampulla or distal common bile duct
V	Laceration	Massive disruption of duodenopancreatic complex
	Vascular	Devascularization of duodenum

Duodenal injury

- Diversion
  - Pyloric exclusion
  - Technique
    - Marginal ulcer 10%
  - NTDB
- Triple drainage
  - Technique
  - Jejunostomy
  - Retrograde duodenal tube
  - Gastric decompression tube
- External drainage
  - Closed suction drain

Duodenal wall hematoma

- Exploration – large – AAST grade II
  - Make the injury worse ?
- Technique
  - Longitudinal incision
  - Evacuation
  - Serosal repair
- External drainage

I	Hematoma	Involving single portion of duodenum
	Laceration	Partial thickness, no perforation
II	Hematoma	Involving more than one portion
	Laceration	Disruption <50% of circumference

PD for Trauma

- Complete the injury
- Timing of repair
  - Hemodynamics
  - Hemostasis
  - Ligation of CBD and PD
- Cholangiogram
  - Approach
- Pancreatogram
  - Increases morbidity
- Revisit need to proceed
  - Consider Triple drainage
  - Closed suction drainage
  - Primary repair

Non-Operative management Duodenal Hematoma

- NPO
- NGT decompression
- TPN
- Length of treatment
  - 3 weeks
- Index of suspicion
  - Associated injuries
- Repeat Imaging

- Consider post-pyloric feeding tube

NTDB -- 2008

- Pyloric exclusion
- AAST Grade III IV V
  - No PDT

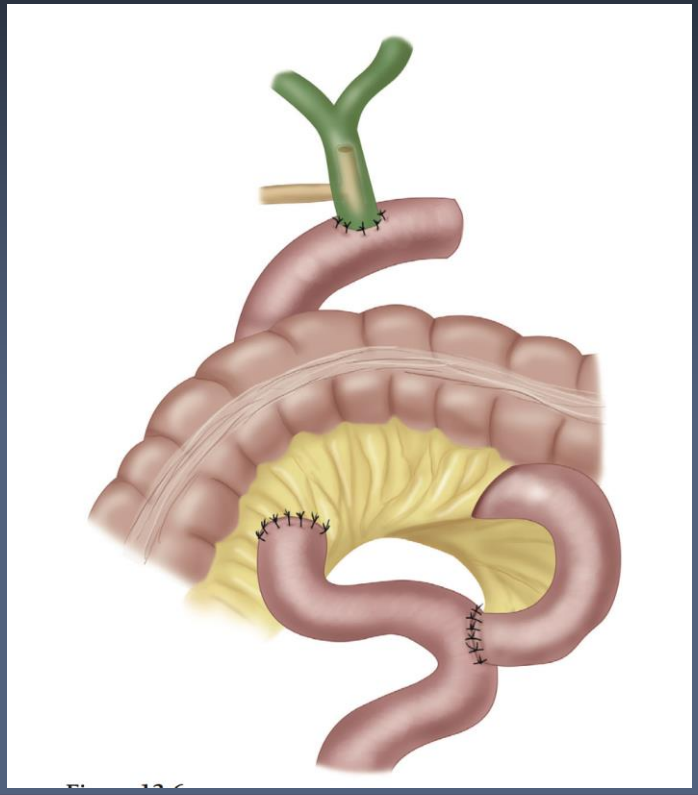
TABLE 3. *Adjusted Odds Ratio for Mortality and Complications (Pyloric Exclusion vs Primary Repair)*

	Adjusted OR (95% CI)*	Adjusted *P* Value*
Deaths	2.7 (0.1–379.6)	*0.69*
Any septic abdominal complication	0.9 (0.2–3.1)	*0.80*
Complications		
Dehiscence	—	*0.99*
Intra-abdominal abscess	1.9 (0.4–9.0)	*0.40*
Wound infection	0.5 (0.1–4.7)	*0.55*
Pancreatitis	1.8 (0.4–8.1)	*0.45*

Biliary Trauma

IV	Laceration	Disruption >75% circumference of D2
		Involving ampulla or distal common bile duct

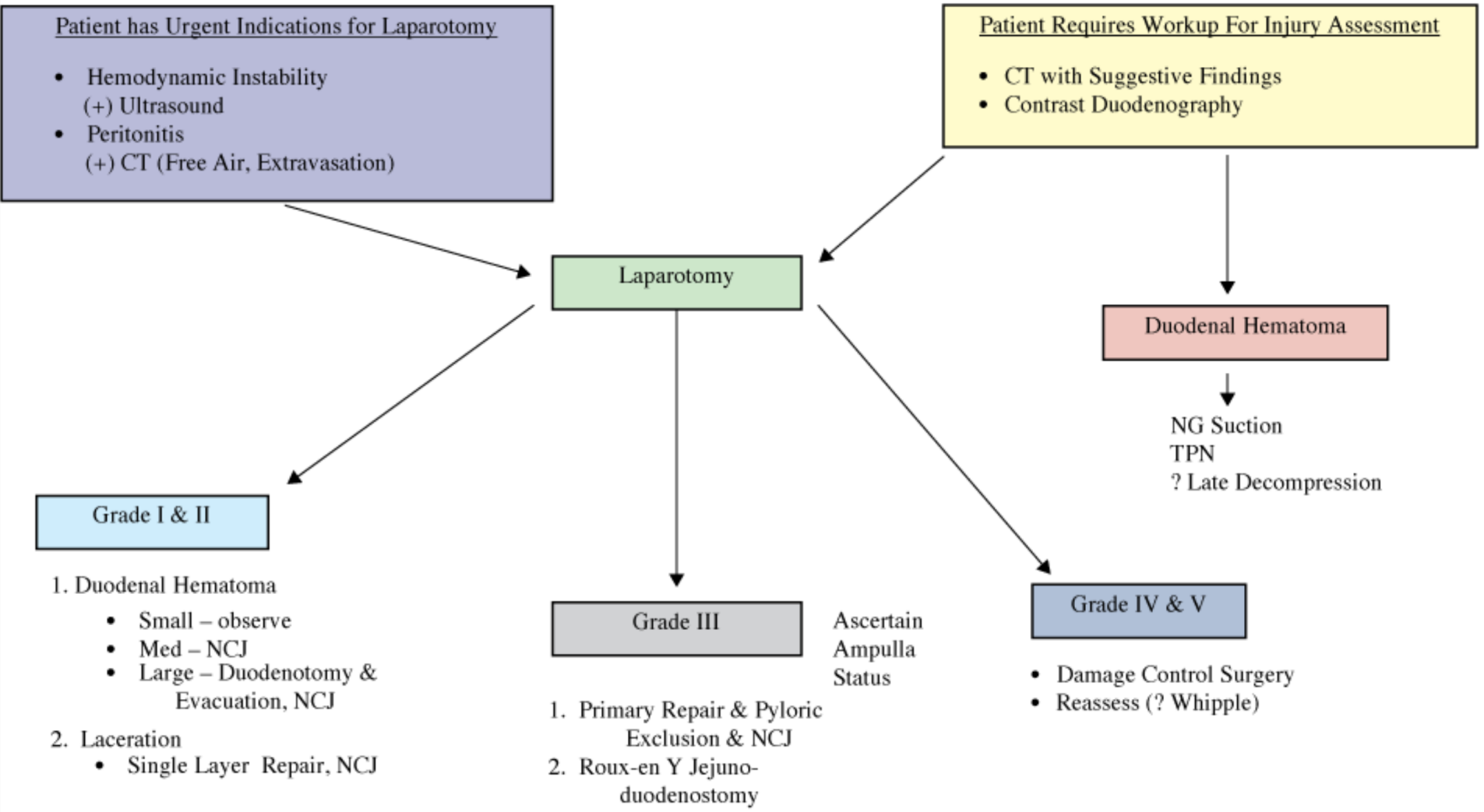
- Injury <50% - primary repair
- Delayed repair after resuscitation
- T-tube ?
- Closed suction drainage



Complications

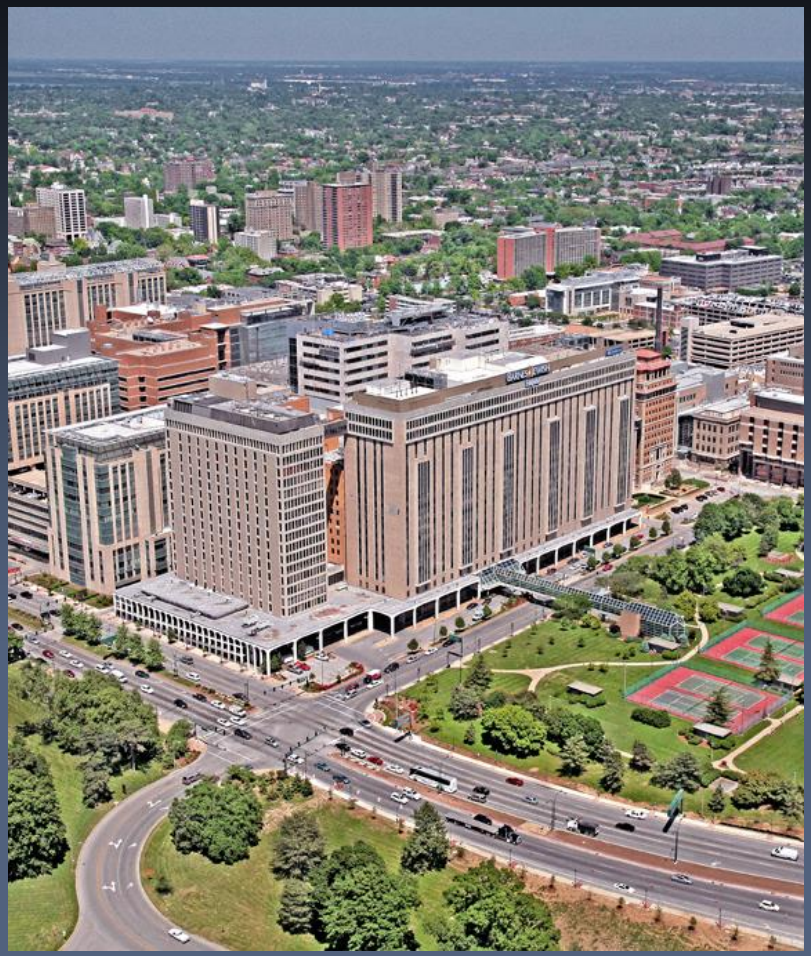
- Abscess
  - 30% occurrence
  - IR drainage
  - antibiotics
- Enterocutaneous fistula
  - Controlled drainage
  - Nutrition
    - Distal Feeding (J-tube)
    - TPN
- Associated injuries
  - Pancreas
  - Biliary Tree

Algorithm for Duodenum Injury



Source: Mattox KL, Moore EE, Feliciano DV: *Trauma, 7th Edition:*
www.accesspharmacy.com

Pancreatic and Duodenal Injury



22nd Annual
Trends in Trauma

Slide Headline