

Imaging in Acute Pancreatitis

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Acute Pancreatitis: Definition

- International Symposium on Acute Pancreatitis (Atlanta, September 1992)
- “An acute inflammatory process of the pancreas, with variable involvement of other regional tissues or remote organ systems”

Pathophysiology

- Controversial
- Failure of acinar cells to release digestive enzymes
- Mast cell degranulation, platelet activation, and potent inflammatory response
- Biliary pancreatitis: pancreatic duct occlusion, common channel theory (bile reflux into PD)

Acute Pancreatitis: Causes

- Cholelithiasis:
 - 40%, occurs in 3-4% of patients with cholelithiasis
 - Risk of pancreatitis >> with smaller stones (3-4 mm)
- Alcohol:
 - 35%, more common in males
 - Mechanism: toxic effect, ↑ exocrine secretion AND contraction of SOD
- Idiopathic:
 - Third most common cause: 15%
- Others: 10%

“Other” Causes

- Pancreatic tumors
- Infections
- Drugs
- Toxins
- Hypertriglyceridemia
- Vascular diseases
- Trauma
- ERCP
- Surgical procedures / biopsy
- Genetic
- Cystic fibrosis
- Inborn errors of metabolism
- Reye’s Syndrome
- Kawasaki disease
- Hereditary acute pancreatitis
- Pancreas divisum
- Duodenal disorders
- Helminthic obstruction
- Foreign body obstruction

Acute Pancreatitis: Atlanta Classification (1992)

- **Mild:** Interstitial or edematous, no systemic repercussions
- **Severe (necrotizing):** Systemic organ failure, local complications (necrosis, infection, pseudocyst)
 - 3 or more Ranson criteria
 - 8 or more APACHE-II

- **Acute fluid collections:** no wall and occur early (<4 weeks)
- **Pseudocyst:** collection of pancreatic juice with a wall (fibrous or granulation tissue), 4 to 6 weeks
- **Necrosis:** non-viable pancreatic tissue, can be sterile or infected
- **Abscess:** circumscribed collection of pus, little or no necrosis **OR** secondarily infected pseudocyst

Acute Pancreatitis: Diagnosis

- Amylase and lipase: intra-acinar cell enzymes, released into blood/lymphatics
- > 3 x normal:
 - Lipase 100% sensit., 99% specif.
 - Amylase 72% sensit., 99% specif.
- All other laboratory tests are nonspecific, assess severity and systemic involvement

Revision of Atlanta Classification: 2009-2010

Definition At least 2 of the following:

- Acute epigastric pain, often radiating to back
- Serum amylase/lipase >3 times normal
- Characteristic imaging findings: US, CT, MR

Ultrasonography

- Abnormal in 35 to 90% of cases
- Main use: detection of gallstones as potential cause
- Pancreatic enlargement with parenchymal hypoechogenicity
- Fluid collections: large, wall?
- Very limited for staging

Acute Pancreatitis: CT

- Establish/confirm diagnosis
 - Questionable diagnosis and exclude other intra-abdominal conditions
 - Change in clinical status
 - Failure to improve (72 hs.)
- Assess severity
- Detect complications (pancreatic and extra-pancreatic)
- Guide percutaneous interventions

CT: Morphologic Characteristics

- Extrapancreatic findings:
 - CBD/GB stones
 - Biliary ductal dilatation
 - Venous thrombosis (portal vein, splenic vein, SMV), varices
 - Pseudoaneurysms
 - Pleural effusion, ascitis
 - Colonic involvement

CT Technique

- High resolution images (1-1.5 mm)
- Oral contrast usually not necessary
- Non-contrast phase: hemorrhage, Ca⁺⁺
- Post-contrast:
 - “Pancreatic” phase: 40 to 50 sec post-start of injection (enhancement 50 to 60 HU)
 - Portal venous phase: 65 to 75 sec
 - Orthogonal plane reformations routine
 - Thin MIP reformations

CT: Mild Pancreatitis

- Edematous or interstitial pancreatitis
- Inflammatory changes confined to gland
- Edema: diffuse enlargement and flattening of pancreatic indentations
- Preserved homogeneous pancreatic enhancement
- Peripancreatic stranding in anterior pararenal space is commonly

CT: Severe Pancreatitis

- Parenchymal necrosis: well demarcated zone without enhancement
 - <30% - 30-50% - >50%
 - >90%: central cavitory necrosis
- Peripancreatic necrosis (fat)
- Fluid collections: pancreatic/peripancreatic

Fluid Collections: CT

- Number, location, wall, fluid/fluid level, gas
- Location: anterior and posterior pararenal spaces, transverse mesocolon, or bursa omentalis
- Natural history: >50% regress spontaneously, remainder transform into pseudocysts

CT: Fluid Collections / Pancreatic Necrosis (<4 weeks)

- Acute peripancreatic collection: sterile or infected
- Acute post-necrotic collection
- Parenchymal and peripancreatic necrosis: sterile or infected
- Isolated pancreatic necrosis: sterile or infected
- Isolated peripancreatic necrosis: sterile or infected

Balthazar CT Criteria

GRADE A: Normal pancreas

GRADE B: Focal or diffuse enlargement: heterogeneous enhancement, no significant peri-pancreatic change

GRADE C: Glandular changes with high attenuation in peri-pancreatic fat (inflammation)

GRADE D: Single fluid collection, typically poorly defined.

GRADE E: Two or more poorly defined fluid collections, or gas within or nearby

CT Severity Index

Balthazar Stage	Points
A	0
B	1
C	2
D	3
E	4

% Necrosis	Points
0	0
30	2
30-50	4
>50	6

Severity Index

POINTS	SEVERITY
0 - 3	Low
4 - 6	Medium
7 - 10	High

Severity Index: Morbidity and Mortality

GRADE (Points)	MORBIDITY	MORTALITY
Low 0-3	8 %	3 %
Medium 4-6	35 %	6 %
High 7-10	92 %	17 %

Balthazar E et al, Radiology 1990; 174: 331-336.

Acute Pancreatitis: MR

- Depicts inflammatory changes and necrosis as CT
- Diagnosis of impacted stone: potential benefit from sphincterotomy and stone retrieval
- MRCP prevents unnecessary diagnostic ERCP
- ↓ CT (replace with MR), monitor fluid collections
- Demonstrates hemorrhage, improved over CT

MR Sequences

- Free-breathing or respiratory triggering preferable in ED setting, but varies
- Single-shot, half-Fourier T2-w SE (HASTE)
- 2D T1-w GRE
- Fluid sensitive: STIR, respiratory triggered FSE with FS
- Balanced steady-state: bright blood w/o cont
- IV contrast: 3D volumetric (THRIVE)
- DWI: b 0, b 600

**Tkacz JN et al, RadioGraphics Oct '09*

Early Complications: 1st Week

- Systemic: limited role for imaging
- Release of toxic vasoactive peptides and cytokines
- Cardiovascular: hypotension, shock
- Pulmonary: ARDS
- Renal insufficiency
- GI and abdominal hemorrhage, coagulopathy
- Metabolic: hyperglycemia, hypocalcemia

Intermediate: Weeks 1 to 8

- Local (intra- or peri-pancreatic)
- Infected necrosis
- Pancreatic abscess
- Pseudocyst
- GI tract involvement
- Vascular complications

Infected Necrosis

- Infection of focal or diffuse non-viable pancreas
- Incidence increases with extent of necrosis
- Source: GI tract, more commonly uni-microbia
- Gas on CT: 15%

Sterile vs. Infected Necrosis: Differential Diagnosis

- Clinical and laboratory findings insufficient
- **BOTH:**
 - Fever
 - Leucocytosis
 - Hemodynamic changes
 - Multi-organ failure

CT: Fluid Collections / Pancreatic Necrosis (>4 weeks)

- Pancreatic pseudocyst: sterile or infected
- WON (Wall outside necrosis):
 - Post-necrotic collection lined by epithelial wall
 - Includes necrotic tissue
 - Respects viable glandular tissue

Pseudocysts: Natural History

- Collection of fluid (pancreatic juice) enclosed by wall of granulation tissue
- At least 4 weeks
- Occur in <10% patients with acute pancreatitis
- Imaging: homogeneous, low attenuation on CT (<15 HU), thin wall, occasionally Ca⁺⁺
- Therapy needed only if symptomatic, regardless of size

Pancreatic Abscess

- Circumscribed collection of pus containing little or no necrosis
- Large proportion are infected pseudocysts
- Less common than infected necrosis: 3%
- Mortality < than infected necrosis: more amenable to percutaneous therapy alone

Vascular Complications

- Peripancreatic venous thrombosis
 - Stasis and mass effect
 - Frequency: splenic, SMV, portal
 - Chronic: “left-side” portal HTN
- Arterial complications
 - Auto-digestion of arterial walls by enzymes
 - Acute hemorrhage
 - Pseudoaneurysm formation and delayed bleed