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Radiological examination of the abdomen

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Case presentation

- Right upper quadrant pain
  - Postprandial 'complaints'
  - What to suspect?
    - Cholecystolithiasis
    - Cholecystitis

Cholecystolithiasis

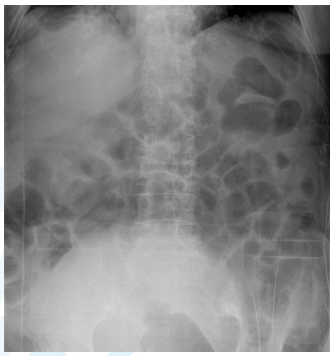
- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

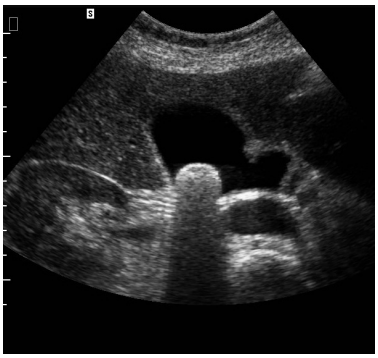
Cholecystolithiasis

- Plain abdominal X-ray
  - Only 10% calcified stones!
- Ultrasonography
  - Standard examination(1)!
- Computer tomography
  - Suspicion of complicated cholecystitis
- Magnetic resonance imaging
  - Overview bile duct anatomy
  - Common bile duct anomalies

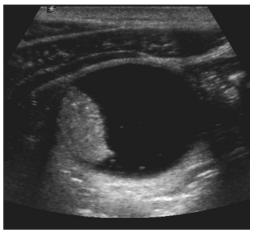
(1) Yarmish GM, et al. (2014) J Am Coll Radiol 11:316-22.

Cholecystolithiasis – XR vs US





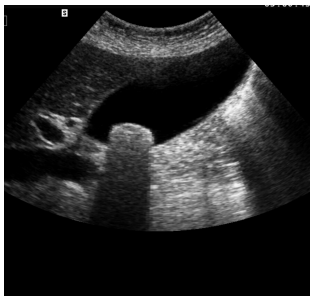
Sludge ball



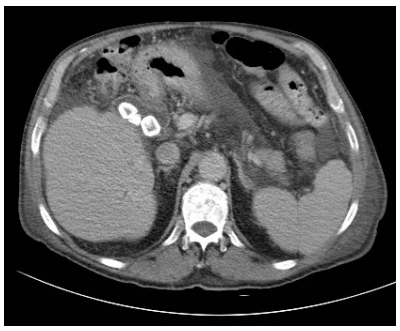
Cholecystolithiasis – CT vs US

CT

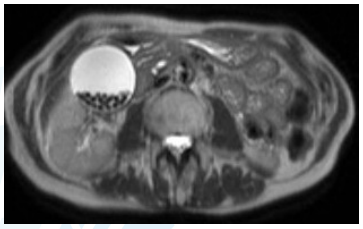
US

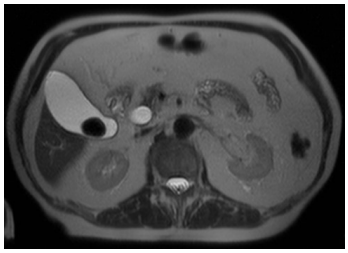


Cholecystolithiasis – XR vs CT



Cholecystolithiasis – MR





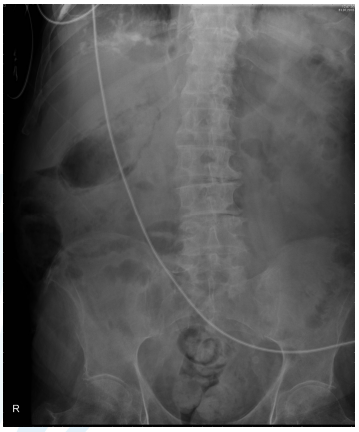
Cholecystitis

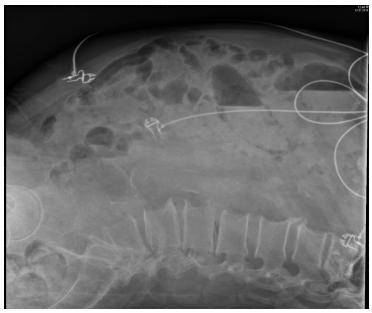
- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Cholecystitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
    - Calcifications
    - Gas-fluid levels
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Emphysematous cholecystitis



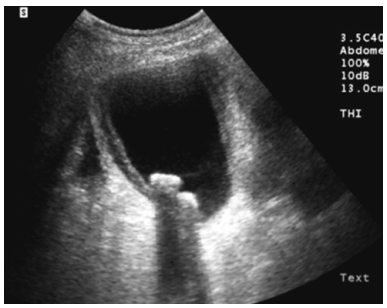


Cholecystitis

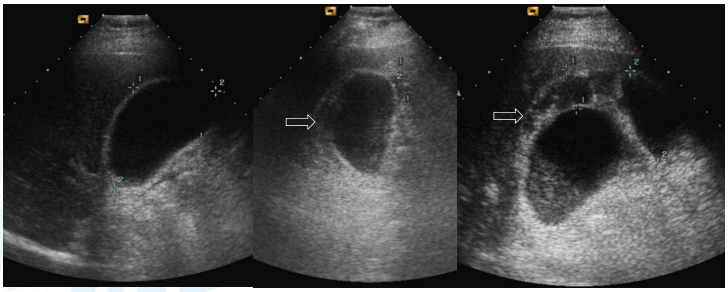
- Proposed imaging techniques
  - – Plain abdominal X-ray?
  - – Ultrasonography?
    - Standard examination
  - – Computer tomography?
  - – Magnetic resonance imaging?
  - – Other?

Acute cholecystitis – US

- Gallbladder wall thickening
- Fluid gallbladder bed
- Inflammation surrounding fat
- Sonographic Murphy's sign



Acute cholecystitis – US

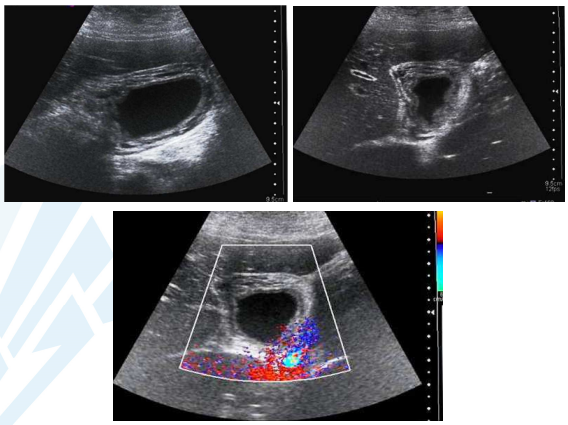


Day 1 Day 3 Day 10

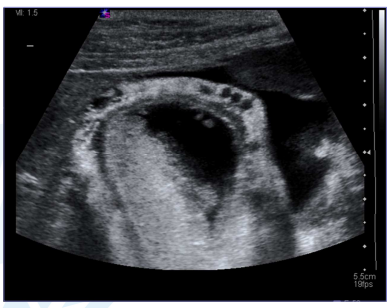
Acute cholecystitis – US

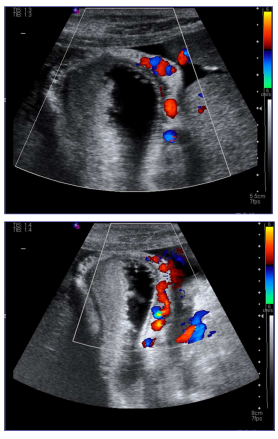
Empyema

Differential diagnosis: cardiac failure



Differential diagnosis: collaterals

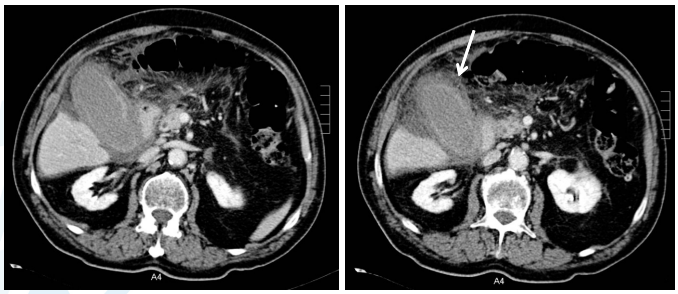




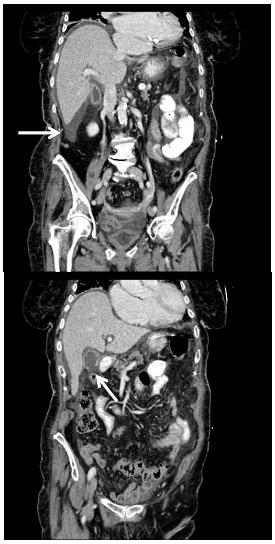
Cholecystitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
    - Suspicion of complications
  - Magnetic resonance imaging?
  - Other?

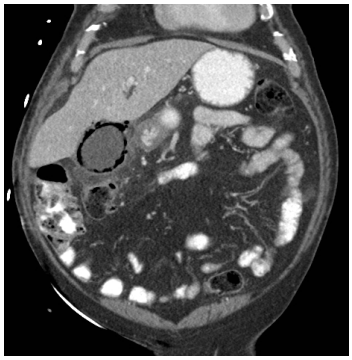
Acute cholecystitis – CT



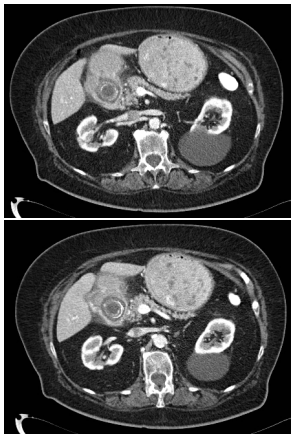
Gallbladder perforation



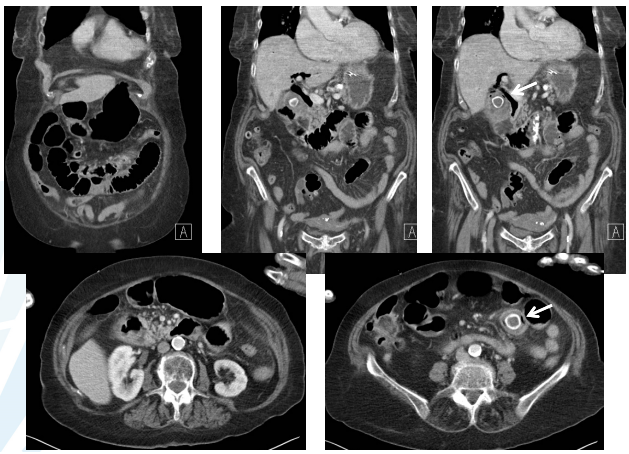
Emphysematous cholecystitis



Bouveret syndrome



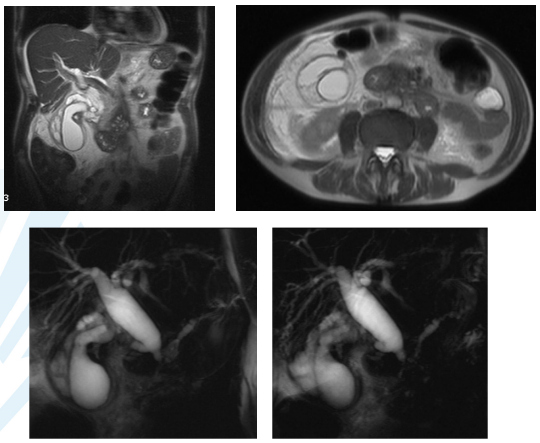
Gall stone ileus



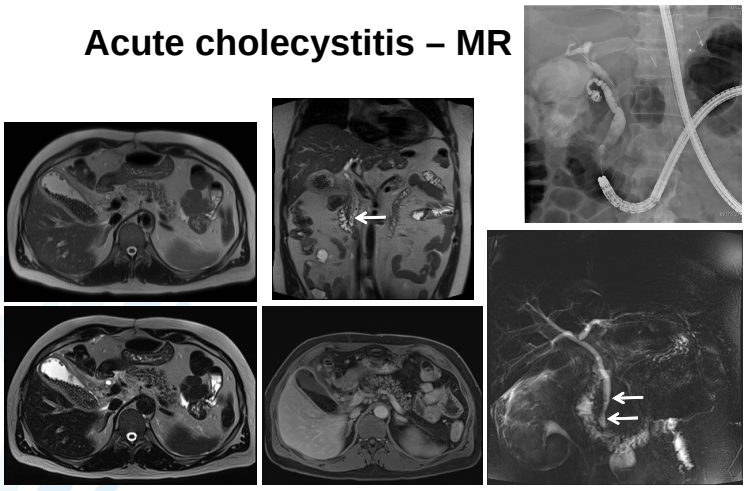
Cholecystitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
    - Gallbladder morphology
    - Bile duct anomalies

Intramural abscesses



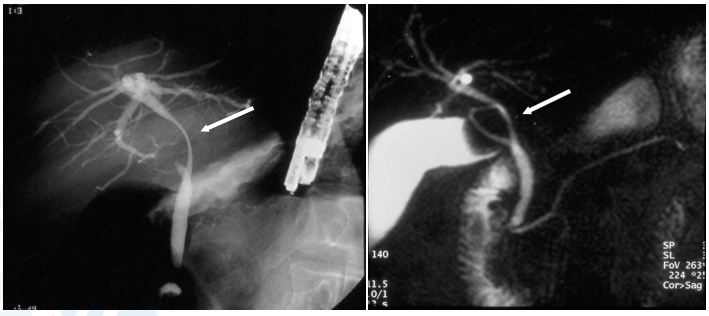
Acute cholecystitis – MR



Bile duct stones

Chole-(cysto)-lithiasis – MR

Mirizzi-syndrome



ERCP MRCP

Acute cholecystitis – drainage

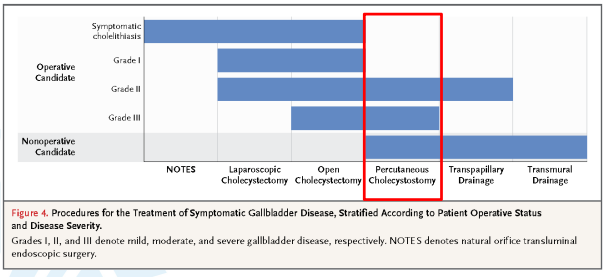
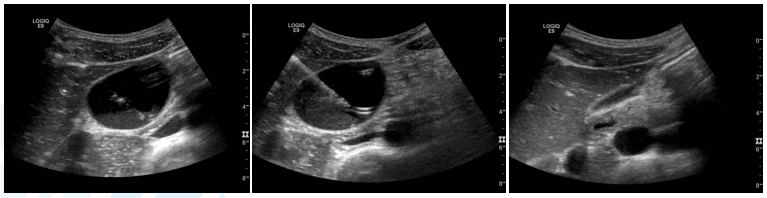


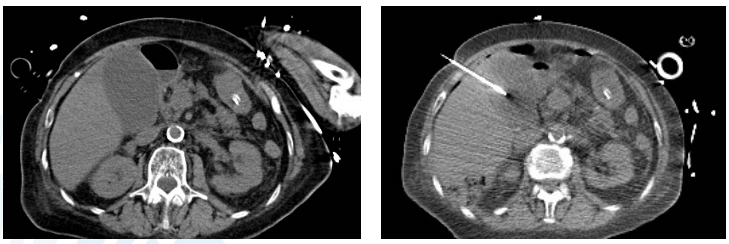
Figure 4. Procedures for the Treatment of Symptomatic Gallbladder Disease, Stratified According to Patient Operative Status and Disease Severity.
Grades I, II, and III denote mild, moderate, and severe gallbladder disease, respectively. NOTES denotes natural orifice transluminal endoscopic surgery.

(1) Baron TH, et al. (2015) New England Journal of Medicine 373:357-365.

Acute cholecystitis – drainage



Acute cholecystitis – drainage



Right upper quadrant pain

Klinisch probleem	Onderzoek	Aanbeveling [classificatie]	Opmerkingen	Dosis
Galblaasaandoening (bv. galstenen, pijn na cholecystectomie	RX abdomen enkel	Niet geïndiceerd [C]	Slechts 10% van de galstenen is gecalcificeerd en zichtbaar op RX abdomen enkel.	II
	Echografie	Geïndiceerd [B]	Basisonderzoek voor diagnose van galblaasstenen. Een lithiase van de ductus choledochus kan echter dikwijls niet worden uitgesloten.	0
	MR-cholangiografie	Gespecialiseerd onderzoek [B]	Laat toe het geheel van de galwegen en afwijkingen van de ductus choledochus te visualiseren. Heeft als voordeel tov echoendoscopie een meer accurate evaluatie van geassocieerde biliaire pancreatitis, leverletsels en abcessen, zowel hepatisch als subfrenisch.	0
	Echoendoscopie	Gespecialiseerd onderzoek [B]	Aanvullend op echografie, toont beter afwijkingen aan de ductus choledochus en de ampul van Vater.	0
	CT	Alleen geïndiceerd in bijzondere gevallen [B]	Beperkte rol voor evaluatie van de ductus choledochus. Nuttig voor evaluatie van de galblaaswand, vooral bij galblaastumoren en bij gecompliceerde cholecystitis met abcesvorming.	III
30 G	Scintigrafie	Alleen geïndiceerd in bijzondere gevallen [B]	Nuttig bij diagnose van acute cholecystitis. Geïndiceerd wanneer het klinisch beeld niet overeenstemt met de resultaten van het echografisch onderzoek (bvb. bij de acalculeuze vorm).	III
Postoperatieve lekkage galwegen	Echografie CT MRI	Geïndiceerd [B]	Aantonen van collecties. In geval van subfrenische of retroperitoneale uitbreiding is CT aangewezen. Voor het aantonen van een actieve lek dient een MRI met hepatobiliair contrast uitgevoerd te worden in de excretoire fase.	0 III 0
	ERCP	Geïndiceerd [B]	Nuttig voor de preciese lokalisatie van de lekkage. Een lekkage kan eventueel onder ERCP worden behandeld, bvb. plaatsen van een prothese.	III
31 G	Scintigrafie	Gespecialiseerd onderzoek [B]	Alleen geïndiceerd in bijzondere omstandigheden, bvb. het opsporen van een occult lek.	III

Case presentation

- Left lower quadrant pain
  - Tenderness and changed bowel habits
  - Fever
  - What to suspect?
    - diverticulitis

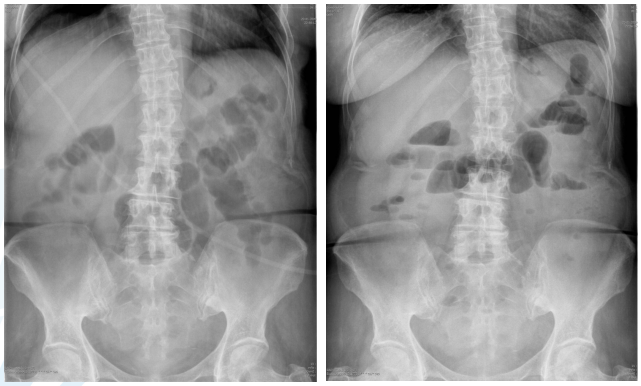
Acute diverticulitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Acute diverticulitis

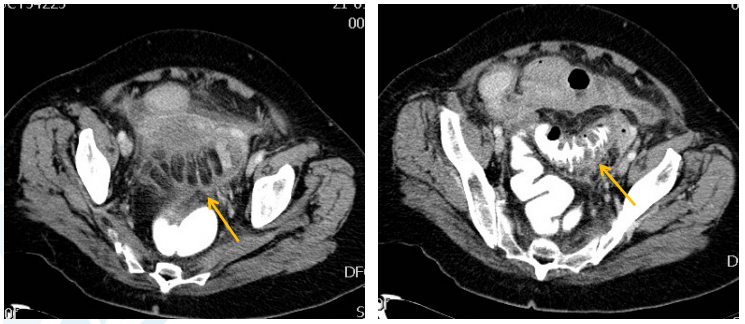
- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Plain film

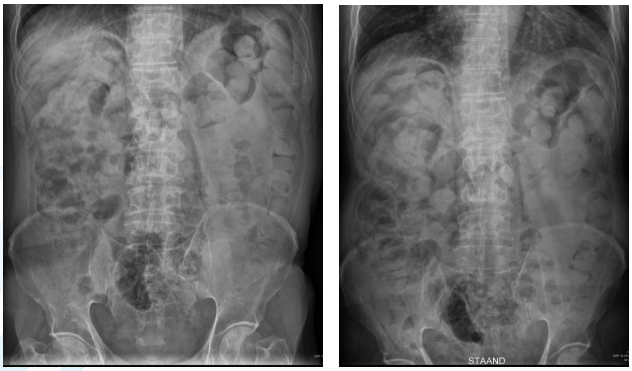


Women 67y: vomiting, fever, CRP:336, tenderness

CT

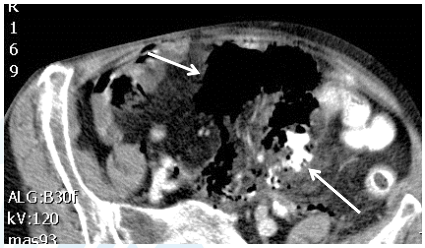


Plain film



Male 78y: pain, elevated CRP

CT



Plain radiography

- Initial evaluation of the patient with an acute abdomen
  - Perforation
  - Obstruction
- Minimal role in the diagnosis of diverticulitis
  - 0% sensitivity for acute diverticulitis[1]

1. Ahn SH, Mayo-Smith WW, Murphy BL, et al. Radiology. 2002 Oct;225(1):159-64.

Acute diverticulitis

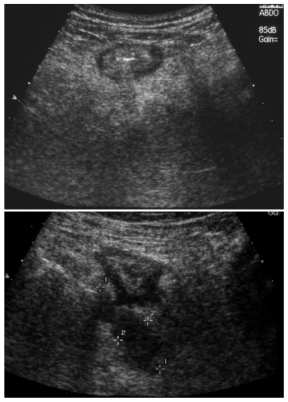
- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Ultrasound

- Often the first-step imaging modality
- Expanded its role in the evaluation of diverticulitis
- Operator dependent

Ultrasound

- Ultrasonographic findings
  - Hypo-echoic wall thickening > 5 mm
  - "Target" sign
  - Increased echogenicity of the pericolic fat
  - Presence of inflamed diverticula
  - Intramural of pericolic abscesses
  - Increased Doppler flow
  - Local tenderness
    - at least 2 criteria for diagnosis of diverticulitis



Ultrasound

- Sensitivity 85-98% Specificity 80-98%

Sensitivity and specifity of ultrasonography in the detection of diverticulitis

Number of patients	Sensitivity	Specificity	PPV	NPV	Study
130 (52)	98	98	96	99	Schwerk, WB 1992
123 (52)	85	80	76	88	Verbanck, J 1989
143 (74)	84	93	93	84	Zielke, A 1997
161 (74)	98	99	96	99	Schwerk, WB 1993
230 (23)	96	98	85	99	Federmann, G, et al 1989
64 (33)	85	84	85	84	Pradel, JA, et al 1997
934	91	100	96	100	Chou, YH, et al 2001
NA	77	99	NA	NA	Hollerweger, A, et al 2001
247	97	76	NA	NA	Moll, R, et al 2002

PPV: Positive predictive value; NPV: Negative predictive value; NA: Not available. Parentheses indicate the number of patients with proven diverticulitis, if noted.

1. Schwerk WB, Schwarz S, Rothmund M. Dis Colon Rectum 1992; 35:1077.

Acute diverticulitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Computer Tomography

- Gold standard in assessing diverticulitis
- Over the past decade CT has replaced contrast enema [1-2]:
  - Can be performed in acutely ill patients
  - Allows detection of extraluminal and extramural disease

1. Lawrimore J Intens care Med 2004;19:194
2. Liljegren et al. 2007,9: 480-488

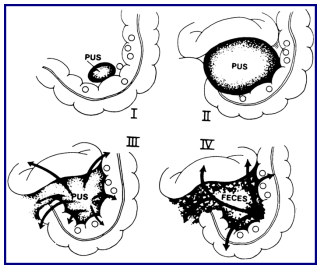
Computer Tomography

- Role of Computer Tomography
  - Diagnosis
    - High sensitivity (79-99%) [1-2]
  - Staging severity
    - non complicated vs. complicated
  - Clinical implications and prognostic outcome!
  - Decision making in therapy
    - Medical: Antibiotherapy
    - Surgical: Primary anastomosis vs. temporary colostomy
    - Interventional: Role for percutaneous drainage

1. Destigter KK, et al. (2009) Clin Colon Rectal Surg 22:147-55.
2. Hammond NA, et al. (2010) Am Fam Physician 82:766-70.

CT Staging: modified Hinchey (1-2)

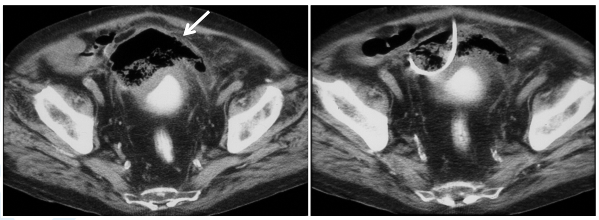
- Stage 0
  - intraserosal
- Stage 1
  - A. inflammation
  - B. abscess in mesocolon
- Stage 2
  - abscess outside mesocolon
- Stage 3-4
  - abscess in peritoneal cavity
- Clinical implications!!!



1. Hinchey EJ, Schaal PG, Richards GK. (1978) Adv Surg 12:85-109
2. Neff CC, vanSonnenberg E. (1989) Radiol Clin

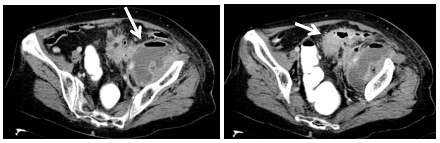
Stage 1-2 diverticulitis – CT

- Size matters:
  - < 3 cm: can be treated with antibiotics
  - > 4 cm: best managed with drainage

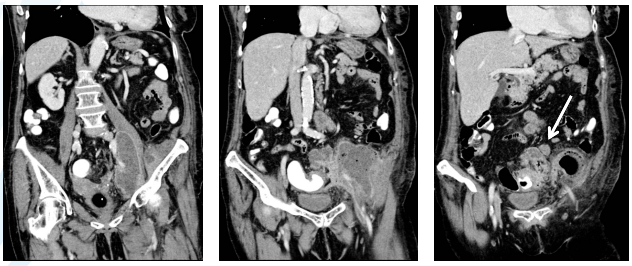


1. Siewert B, et al. (2006) AJR Am J Roentgenol 186:680-6.

Diverticulitis: differential diagnosis



Perforated colon carcinoma

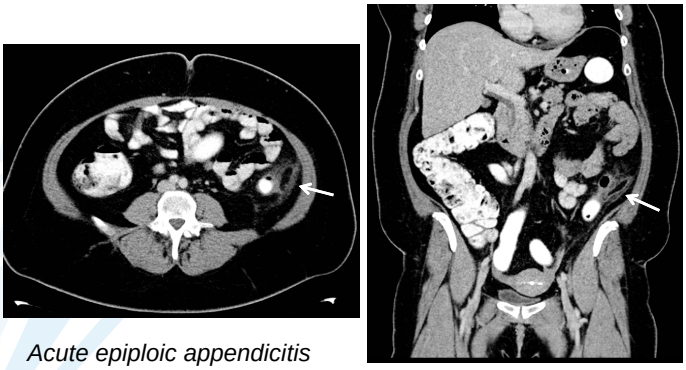


Diverticulitis: differential diagnosis

- Diverticulitis vs. tumor
  - In nearly 10 % of the patients no differentiation is possible with a (perforated) carcinoma
- After the acute inflammation has been resolved
  - Every patient with suspected acute left-sided diverticulitis needs a mucosal study (coloscopy)

Padidar AM, Jeffrey RB Jr, Mindelzun RE, Doph JF Differentiating sigmoid diverticulitis from carcinoma on CT scans: mesenteric inflammation suggests diverticulitis AJR 1994; 163: 81-83

Diverticulitis: differential diagnosis



Acute epiploic appendicitis

Acute diverticulitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Limited role of MRI in the diagnosis of diverticulitis

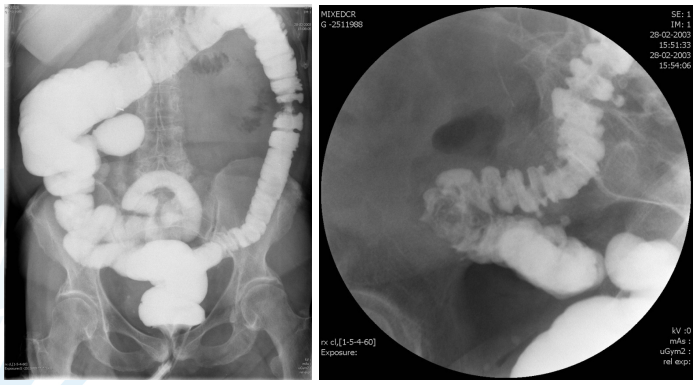
- Complimentary to CT
  - when CT is equivocal
- Sensitivity: 86% Specificity: 92%*
- Advantages:
  - Excellent contrast resolution
  - Lack of ionizing radiation
- BUT: expensive and low accessibility

** Buckley O, Geoghegan T, McAuley G, et al. Pictorial review: magnetic resonance imaging of colonic diverticulitis. Eur Radiol. 2007 Jan;17(1):221-7.*
** Ajaj W, Ruehem S, Goehde S et al. Dark-lumen magnetic resonance colonography in patients with suspected sigmoiddiverticulitis: a feasibility study. Eur Radiol 2005; 15: 2316–22.*

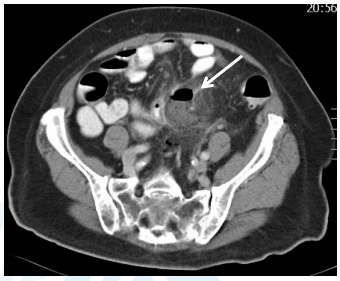
Acute diverticulitis

- Proposed imaging techniques
  - Plain abdominal X-ray?
  - Ultrasonography?
  - Computer tomography?
  - Magnetic resonance imaging?
  - Other?

Enema with gastrografin



CT



Contrast enema (1)

- Previously the standard examination method
- High accuracy, widespread availability, low morbidity, and cost
- Sensitivity of 59-90%
- Replaced by CT and US:
  - extra-colonic extent/complications

1. Ambrosetti P, et al. (2002) Eur Radiol 12:1145-9.

Left lower quadrant pain

Klinisch probleem	Onderzoek	Aanbeveling [classificatie]	Opmerkingen	Dosis
Constipatie	RX abdomen enkel	Alleen geïndiceerd in bijzondere gevallen [B]	Alleen nuttig bij oudere patiënten of in psychiatrische gevallen (fecalomen, medicamenteuze ileus).	II
	Meting van de transit tijd	Gespecialiseerd onderzoek [B]	De progressie van contrastmiddelen wordt door opeenvolgende opnames RX abdomen opgevolgd.	III
24 G	RX-defecografie of MR-defecografie	Gespecialiseerde onderzoeken [B]	Constipatie kan verband houden met problemen van de bekkenbodem. MR-defecografie is een alternatief voor deze indicatie.	III 0
Abdominale infectie *(zie ook 20N en 21N)*	Echografie en/of CT	Geïndiceerd [C]	Echografie wordt vaak het eerst uitgevoerd. Erg goed voor de evaluatie van infecties in het supra-mesocolisch of pelvis gebied. CT is beter voor lokaliseren of uitsluiten van een infectie, zeker in de post-operatieve periode. Bij vermoeden van een gecompliceerde appendicitis of een diverticulitis geniet CT de voorkeur.	0 III
25 G	Scintigrafie	Als routine niet geïndiceerd [C]	Nuttig bij verdenking van sepsis waarvan de oorzaak niet door de gewone technieken kan worden gedetecteerd.	II/IV