Imaging findings of appendiceal pathologies

Poster No.: C-1478
Congress: ECR 2010
Type: Educational Exhibit
Topic: GI Tract
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Keywords: Acute appendicitis, Appendiceal tumours, abdominal MRI
DOI: 10.1594/ecr2010/C-1478
Learning objectives

1) To illustrate the radiologic findings of appendiceal pathologies as shown with conventional radiology, US, CT and MR

2) To make the radiologist aware of the typical and atypical appearances of appendiceal pathologies with emphasis on the findings on CT and MR and on the differential diagnoses

Background

Appendix can be involved in many different pathologies as inflammations or tumours, although clinical findings are often similar and different diagnostic modalities are required for further evaluation. Knowledge of all possible appearances is necessary for an adequate preoperative diagnosis.

We illustrate the most important radiological findings in acute appendicitis, periappendiceal abscess, appendiceal mucocele, appendiceal mucinous and non mucinous adenocarcinoma, with pathological correlation. Moreover we illustrate the main conditions that have to be considered as differential diagnoses (Crohn’s disease and intestinal duplication).
Imaging findings OR Procedure details

Acute appendicitis

Acute appendicitis is the most common cause of acute abdominal pain in children. However, in patients with atypical clinical symptoms, acute appendicitis may be difficult to diagnose clinically, and further investigation with imaging techniques is required to avoid delay of surgery and to minimize rates of false-negative laparotomy.

In some situations, an ultrasound examination is used to clarify the symptoms [1]. Nevertheless, the limiting factors to the use of ultrasound include a retro-cecal location and obesity of the patients. In these cases, it is useful to make an evaluation with the computed tomographic (CT) techniques and magnetic resonance imaging (MRI). Although the anatomical images obtained with the MRI and the CT techniques are similar, the MRI procedure has major advantages: it uses the non-ionizing technique (most cases of suspected acute appendicitis occur in children) and it shows the extent of the oedema. MRI is also shown to be more specific in the determination of an acute appendicitis, relative to the ultrasound technique [2].

• Case 1

A 15 year-old male patient presented with a history of recurrent abdominal colic, fever and diarrhoea. As he had not leukocytosis, he was treated with analgesic and antipyretic drugs. Colonoscopy was negative. The clinical features suggested the possibility of Chron's disease. The ultrasound examination showed a tubular structure located anterior to the right psoas muscle and posterior to ascending colon with apex inferior to VI hepatic segment. It had hypo-echogenicity of the lumen and hyper-echogenicity of the walls (Fig. 1) on page 10. Multiple lymph-nodes were present anterior to the homo-lateral psoas muscle (Fig. 2) on page 11. Intestinal duplication or appendicular mucocele were suspected as differential diagnosis and MR exam was performed. MR imaging (Fig.3) on page 12 confirmed the presence of a large edematous structure in the right lower quadrant originating from cecum, measuring 12 cm length (Fig. 4) on page 13, with thickened and enhancing wall (Fig. 5) on page 14 and multiple retro-peritoneal lymph-nodes (Fig. 6) on page 15.
It was considered to be active inflammation of the appendix. Antibiotics were administered, but 3 days later physical examination revealed a positive Rovsing sign and blood tests showed increased levels of Neutrophils 78% (40-75), Basophils 1.3% (0-1), Bilirubin 1.82 mg/dl (<1.20), FA 329 U/l (80-306). The patient subsequently underwent laparoscopic surgery on the same day and the diagnosis of acute retro-cecal appendicitis was confirmed by means of surgery and by microscopy (Fig. 7) on page 16.

**Periappendiceal abscess**

Acute appendicitis can be difficult to diagnose clinically in cases of atypical symptoms. When the appendicitis is not identified in time, it may lead to a formation of an abscess. In such a situation the symptoms may be unclear and an additional examination is required. Before surgery is performed, CT may be done to evaluate and confirm the chronic pathological condition.

- **Case 2**

A 86 year-old man had experienced right lower quadrant pain for a few months. A CT of the abdomen was performed, that revealed a periappendiceal abscess most likely originating from a perforated appendicitis (Fig. 8) on page 17.

**Appendiceal tumours**

Appendiceal tumours are rare, contributing 0.5% of all gastrointestinal malignancies. Most are carcinoid tumours (85%). They are usually incidental findings after appendicectomy. Most tumours (75%) occur at the tip of the appendix and are <2 cm in diameter. They have a metastatic potential and local involvement.

The criteria that direct us towards major (hemicolecction) or minor surgery (appendectomy) are controversial. Tumor size is still considered the most important prognostic factor, with a presumed increase in the risk of metastasis for tumors greater
than 2 cm. Appendiceal tumours lacks of specific clinical features and its clinical presentation may not differ from that of acute appendicitis. It is usually diagnosed incidentally during surgery for acute appendicitis and occasionally during other abdominal procedures (colectomy, cholecystectomy, salpingectomy).

In our case, the diagnosis of all patients with symptoms of acute appendicitis was made only after histological analysis of the surgical specimen [3].

Mucocele of the appendix is a rare lesion, characterized by distension of the lumen due to accumulation of mucoid substance. If untreated, one type of mucocele may rupture producing a potentially fatal entity known as pseudomyxoma peritonei. The type of surgical treatment is related to the dimensions and to histology of the mucocele. Appendectomy is used for simple mucocele or for cystadenoma. Right hemi-colectomy is recommended for cystadenocarcinoma [6].

**Appendicular mucocele**

- **Case 3**

A 33 year-old female with right lower quadrant pain for a few months. Abdominal ultrasound revealed a cystic mass and intraluminal fluid (Fig.9) on page 18. Barium enema study demonstrated a smooth and round-shaped filling defect at the cecum level (Fig. 10) on page 19. Small-bowel follow-through examination showed an extrinsic impression of the ileo-cecal valve zone. (Fig.11) on page 20. Axial contrast material-enhanced CT scan showed a cystic lesion in the expected region of the appendix (Fig. 12) on page 21. MR images revealed the presence of an elongated cystic mass (Fig. 13) on page 22, with hyper-vascularity of the margins (Fig. 14) on page 23. After surgery, macroscopic finding confirmed the imaging suspicion of appendicular mucocele (Fig. 15) on page 24.

**Appendicular adenocarcinoma (non mucinous and mucinous)**

- **Case 4**

A 73 year-old male underwent appendectomy for suspected appendicitis during a work period abroad. The histology revealed a carcinoma of the appendix. After returning to
Italy, a CT showed involvement of cecum and of the terminal ileum, associated with hepatic metastasis (Fig.16) on page 26.

- **Case 5**

A 53 year-old male underwent abdominal CT for right lower quadrant pain, with unclear diagnosis after an US exam. CT revealed thickness of the terminal ileum, ileo-cecal valve zone, cecum and a segment of the ascending colon. It showed associated perilesional fat tissue infiltration with multiple lymph-nodes. Diffuse hepatic metastasis were present. Leakage of contrast medium from intestine indicated perforation with mucus-collection in the peritoneum. A bacterial overgrowth was present at surgical-pathological findings (Fig.17) on page 26.

Peritoneal pseudomyxoma is a pathological condition that compromises the peritoneum, characterized by production of large quantities of mucinous liquid with gelatinous aspect, that progressively fills the peritoneal cavity [1]. The primary lesion in most cases originates from adenoma or mucinous appendicular adenocarcinoma or ovarian tumors. The dissemination occurs by rupture of the lesion with release of neoplastic cells of mucus into the abdominal cavity in a process known as disseminated peritoneal adenomucinosis.

In the fifth case the primary lesion is a mucinous adenocarcinoma of the appendix, macroscopically expressed as a mucocele rupture, with dissemination into peritoneal cavity. The appropriate treatment for these tumors (Appendicular adenocarcinoma mucinous or not) is right hemicolecction and lymphoadenectomy [4].

**Differential Diagnosis**

Right lower quadrant pain is a relatively common presenting complaint in many emergency rooms worldwide. When it presents in a young patient, a diagnosis of appendicitis is commonly made clinically [5].

However, it is important to consider other causes of right iliac pain such as Crohn's disease, ovarian hemorrhage/torsion, cecal carcinoma and ureteral colic.
Crohn's disease

Crohn's disease is a chronic inflammatory bowel disease that can affect any part of the gastrointestinal tract and most commonly involves the terminal ileum [7], frequent in younger patients (15-40 years).

• Case 6

A 41 year-old male underwent MR exam for pain in the right lower quadrant. Barium enema showed the presence of multiple stenotic segments associated with markedly distended prestenotic parts in correspondence of terminal ileum (Fig.18) on page 27. MRI confirmed the thickness of the walls of the terminal ileum and multiple fistula (Fig.19) on page 28. The diagnosis was Chron's disease.

Intestinal duplication

Duplication of vermiform appendix is reported with an incidence of 0.004% [8] and may be associated with other congenital duplications or other anomalies. Because of rarity, we report a case of duodenum duplication.

• Case 7

A 30 year-old female presented to us with abdominal pain and vomiting. Abdominal ultrasound, the CT and the MR revealed a cystic cavity in correspondence with duodenum (Fig.20) on page 29. She underwent surgery, that confirmed the diagnosis of intestinal duplication.
Images for this section:
Fig. 1: Case 1. A 15-year-old boy with diarrhea and fever. US showed a blind-ending tubular structure located anterior to the psoas muscle, with apex inferior to VI hepatic segment and with hypo-echogenicity of the lumen and hyper-echogenicity of the walls (4 mm).
Fig. 2: Case 1. A 15-year-old boy with diarrhea and fever. US showed lymph-nodes located anterior to psoas muscle.
Fig. 3: Case 1. MR T2 TrueFISP (True fast Imaging with Steady State Procession), breath holding, coronal and sagittal sections. The appearance of acute appendicitis on MR images was similar to that seen on sonography: a markedly hyperintense center, representing intraluminal fluid, thickened and edematous walls.
Fig. 4: Case 1. MR T2 TrueFISP (True fast Imaging with Steady State Procession), breath holding, fat sat, COR and SAG. The fat-suppressed sequences revealed more easily the location of inflammation and free fluid collections in cases of acute appendicitis than did the other sequences.
Fig. 5: Case 1. MR post Gd-DTPA T1, FLASH 3D (three-dimensional Fast Low Angle SHot), COR, breath holding. Administration of an intravenous MR contrast showed significant enhancement of the thickened wall on T1-weighted images. Multiplanar reconstruction revealed the morphology of the tubular structure of retrocecal appendix, not clear to US exam.
Fig. 6: Case 1. MR: multiple retro-peritoneal reactive lymph-nodes.
Fig. 7: Case 1. Macroscopic and microscopic findings confirmed an acute suppurative inflammation of the appendix (diffuse stratification of fibrin on the serosa). Histopathologic specimen showed acute appendicitis with mixed granulocytic and lymphocytic infiltration of the mucosae (on the left) and muscular layer (in the middle), perivascular inflammatory cells in muscularis mucosae, serositis with vascular congestion (on the right).
Fig. 8: Case 2. Abdominal CT of a 86 year-old man with experience of right lower quadrant pain revealed a periappendiceal abscess originating from a perforated appendicitis. Coronal and sagital sections showed the relations of the abscess with the close organs.
Fig. 9: Case 3: appendiceal mucocele. 33 year-old female with right lower quadrant pain for a few months. Abdominal US revealed a cystic mass with intraluminal fluid.
**Fig. 10:** Barium enema study demonstrated a nonfilling, smooth and round-shaped filling defect at the cecum level.
Fig. 11: Small-bowel follow-through examination showed an extrinsic impression of ileocecal valve zone.
Fig. 12: Axial contrast material-enhanced computed tomographic (CT) scan shows a cystic lesion in the expected region of the appendix.
**Fig. 13:** Case 3. MRI Coronal TRUEfisp of appendiceal mucocele: hyperintensity in T2 demonstrated a fluid-filled distended and elongated structure. It had smooth margins and 12 cm length and originated from the cecum blind-ended.
Fig. 14: Case 3. Appendiceal mucocele. MR COR, 3D FLASH, contrast-enhanced fat-suppressed T1 demonstrated hyper-vascularity of the margins. Multi-planar reconstruction illustrated the complete elongated morphology of the peripherally vascularized lesion, that reached the inferior renal pole.
**Fig. 15:** Case 3. Macroscopic finding of appendiceal mucocele showed the obstruction of distended out flow of appendix in cecum for deposit of mucous secretion.

![Fig. 15](image1)

**Fig. 16:** Case 4. Adenocarcinoma non mucinous of appendix. CT showed thickened infiltrated walls of ileum-cecum and parts of ascending colon. Diffuse thickness of pericolic and peri-ileal adipose tissue was associated, indicating infiltration of periappendiceal fat. Multiple lymph-nodes were present in the pericolic and mesenterial fat and in the retro-peritoneal space. Multiple metastasis were distributed within the liver.

![Fig. 16](image2)
Fig. 17: Case 4. A 53 year-old male with right lower quadrant pain. US exam revealed a heterogenous mass. CT showed a thickness of the terminal ileum, the ileo-cecal valve zone, cecum and a segment of the ascending colon, with associated perilesional fat tissue infiltration. Leakage of contrast medium from intestine indicated perforation with mucus-collection in the peritoneum. A bacterial overgrowth was present at surgical-pathologic findings.
Fig. 18: Case 6. Barium enema showed the presence of multiple stenotic segments associated with markedly distended prestenotic parts in correspondence of terminal ileum.
Fig. 19: Case 6. A 41 year-old male underwent MR exam for pain in the right lower quadrant. Oral contrast was administrated. MRI confirmed the thickness of the walls of the terminal ileum and multiple fistula associated with markedly distended prestenotic parts. The diagnosis was Chron's disease.
Fig. 20: Case 7. A 30 year-old female presented to us with abdominal pain and vomiting. Abdominal ultrasound, CT and MR revealed a cystic cavity in correspondence with duodenum. Diagnosis was intestinal duplication.
Conclusion

Appendiceal pathologies can be difficult to diagnose and can create difficulties in interpretation of sonography and conventional radiology in presence of atypical symptoms and in younger patients. CT and MR imaging are valuable technique for depiction of appendiceal pathologies especially in atypical cases allowing a detailed anatomic study of the region, soft tissue involvement and complications.

Ultrasound is commonly used in the diagnosis of appendicitis (Fig.1) on page 32. Given its wide availability and better resolution due to technological advances, it has been shown to have a sensitivity of up to 93% in the diagnosis of acute appendicitis [1]. Ultrasound can also aid in the diagnosis of other causes of right iliac fossa pain. Advantages of ultrasound over other modalities in the imaging of Crohn's are that it involves no ionizing radiation, no bowel preparation is needed and can be carried out any number of times without concern of a cumulative radiation dose. Limiting factors are local tenderness, that compromises abdominal compression and the fact that the technique is operator dependent.

MRI examination requires administration of an oral contrast media e.g. Selgan (Fig.2) on page 32, to realize homogeneous endoluminal opacification and optimal discrimination of wall-lumen with minimum absorption, absence of side effects and low costs. The patient lies prone.

The principal sequences are:

- Truefisp (or SSFP Steady state precession), gradient echo, refocalizes all gradients in one interval of repetition (TR), and combines fast imaging with high signal (Fig.3) on page 33. Advantage are: high resolution, image similar-T2 in 1.5 sec/slice, insensitive to movement-artifacts, high contrast lumen-wall and identification of wall thickness. Disadvantages are the "chemical shift" artifacts.

- FLASH 3D (three-dimensional Fast Low Angle SHot) post Gd-DTPA T1, breath holding, can give the option of the multi-planar reconstruction (MPR), with high spatial resolution (2 mm slice-thickness, 512 matrix) (Fig.4) on page 34.
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