

*Review Article*

Emphysematous Infections of the Upper Abdomen: Emphasis on Multi-Detector Computed Tomography Findings

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ABSTRACT

Emphysematous infections of the abdomen are potentially fatal conditions that require immediate medical and/or surgical management. Normally, intra-abdominal gas is confined to the lumen of the gut and its presence outside is considered a pathologic finding. Emphysematous infections are due to anaerobic bacteria and are a common cause of intra-abdominal gas, requiring early diagnosis and treatment. Here we describe the Multi-Detector Computed Tomography (MDCT) imaging findings in various emphysematous infections of the abdomen which can facilitate its diagnosis at an early stage and reduce resulting morbidity and mortality.

Keywords: Computed Tomography; Emphysematous; Ultrasonography; Diabetes mellitus

INTRODUCTION

Emphysematous or gas forming infections of the abdomen are relatively uncommon but potentially life threatening conditions that occur as a result of anaerobic bacteria. The presence of gas within the parenchyma of solid organs or the walls of hollow viscera may be due to a variety of pathologic or benign entities. [1] Gas associated with infection is generally thought to consist of carbon dioxide and nitrogen secondary to the fermentation of glucose by some species of bacteria. [1] The initial clinical manifestation of these entities may be insidious, but rapid progression to sepsis will occur in the absence of early therapeutic intervention. [1] X-rays and

ultrasonography are the initial imaging modalities but their sensitivity and specificity is low. Computed Tomography (CT) is the imaging modality of choice for evaluating emphysematous infections of the abdomen. CT is both highly sensitive and specific in the detection of abnormal gas and well suited to reliable depiction of the anatomic location and extent of the gas. [1] MDCT with its higher spatial resolution and multiplanar imaging is superior to conventional CT. In this article we describe a brief overview of various emphysematous infections of the abdomen and their MDCT findings. These infections include emphysematous cholecystitis, emphysema-

tous pancreatitis, emphysematous pyelitis and emphysematous pyelonephritis.

Emphysematous Cholecystitis:

Emphysematous Cholecystitis is a rare form of acute cholecystitis. The radiographic features of emphysematous cholecystitis were first described by Hegner in 1931. [2] It affects men twice as compared to women while the reverse is true in majority of cases of acute cholecystitis. [3] It commonly occurs between 50 and 70 years of age. Diabetes mellitus is the most common predisposing factor.

Emphysematous cholecystitis is associated with an increased prevalence of acalculous disease and gallbladder perforation. [3] Clinical manifestation is often insidious and may then progress rapidly, requiring emergent surgical intervention. Microorganisms commonly isolated are Clostridial species, Escherichia coli, and Klebsiella species.

Emphysematous cholecystitis has been characterised on conventional radiography into three stages. [4] Stage 1 emphysematous cholecystitis is characterized by gas within the gallbladder lumen; stage 2, by gas in the gallbladder wall; and stage 3, by gas within the pericholecystic tissues. The differential diagnosis for an area of hyperlucency seen in the right upper quadrant at conventional radiography should include overlying bowel gas, hepatic abscess, retroperitoneal air, enterobiliary fistula, gallstone ileus, incompetent sphincter of Oddi, and focal biliary lipomatosis. [1]

MDCT is the most sensitive and specific imaging modality for identifying gas within the gallbladder lumen or wall. MDCT reveals presence of air loculi in the wall and/or lumen of the gall bladder (Fig. 1A,B). MDCT can detect very small gas collections which cannot be visualised on ultrasound or X-rays.



Figure 1: A) and B) Axial contrast enhanced MDCT images showing distended gall bladder with presence of air (black arrows) in the lumen and wall. A hyperdense calculus is also seen in the lumen (white arrow in B)

Emphysematous cholecystitis is definitively treated with cholecystectomy although percutaneous cholecystostomy may be used as an initial temporizing procedure in critically ill patients. [5] Overall mortality in these cases is 15%.

Emphysematous Pancreatitis:

Acute pancreatitis is a common, potentially life threatening condition. Alcohol abuse and gall stones are the most common causes of acute pancreatitis. When complications (eg, abscess formation, superinfection with gas-forming bacteria) occur, overall mortality rate escalates rapidly from 4% rapidly to more than 50%. [6,7] The infecting organisms are usually coliform bacteria and may reach the pancreatic bed by way of the bloodstream or lymphatic channels, a fistula from adjacent bowel, transmural passage from the transverse colon, or reflux of enteric organisms into the pancreatic duct or biliary tree via a patulous ampulla of Vater. [7-9]

Patients with emphysematous pancreatitis are usually debilitated and often have underlying immunocompromised conditions such as poorly controlled diabetes or chronic renal failure. Early diagnosis is critical in appropriate and timely management. [1] Conventional radiography may demonstrate the presence of mottled gas in the region of mid

abdomen. This finding is not specific for pancreatitis because abscess involving the lesser sac or perinephric space may also have this appearance. [1] Ultrasonography has a very limited value in diagnosis of emphysematous pancreatitis or its complications. CT is the investigation of choice in assessing the presence of intrapancreatic parenchymal gas and evaluating its extent and location. CT shows presence of multiple loculi of gas in the pancreatic parenchyma, partially or completely replacing pancreatic tissue (Fig. 2A,B,C,D). The prognosis for emphysematous pancreatitis is grave, and successful treatment requires aggressive management of the infection with systemic antimicrobial therapy and control of septic shock. [1]

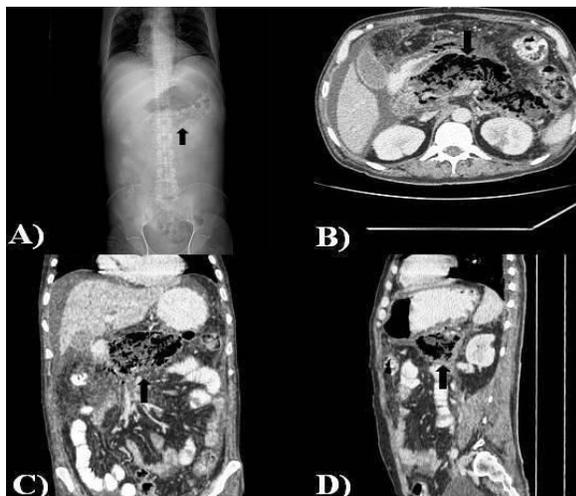


Figure 2: A) Scout image showing presence of gas bubbles in the region of pancreas (black arrow). Axial (B), Coronal (C) and Sagittal (D) MDCT images of the same patient showing presence of large amount of air in the entire pancreatic parenchyma (black arrows).

Emphysematous Pyelitis:

Emphysematous pyelitis is the term used to describe the presence of gas limited to the renal excretory system. [1] It is a benign condition with a low overall mortality rate as compared to emphysematous pyelonephritis. [10]

Emphysematous pyelitis is a rare infection of the urinary collecting system due to gas forming bacteria. [11] It is often associated with underlying diabetes although the relationship with diabetes mellitus is lower than in emphysematous pyelonephritis. [10] Emphysematous pyelitis is seen more commonly in women, is often associated with underlying diabetes or obstructing stone disease, and carries a mortality rate of up to 20%, which is significantly lower than that of emphysematous pyelonephritis. [12] The clinical manifestation of emphysematous pyelitis tends to be non-specific, similar to the clinical presentation of uncomplicated acute pyelonephritis. [10] Common bacterial causes of emphysematous pyelitis are *E. coli*, *K. pneumonia* and *Aerobacter*. [11]

A typical feature seen in conventional radiography of emphysematous pyelitis is the presence of gas outlining the ureters and pelvicalyceal system. [13] Ultrasound findings include high-amplitude shadowing along the non-dependent surfaces. [13] CT is the ideal modality to diagnose and evaluate a patient with emphysematous pyelitis. CT best delineates gas within the collecting system and helps reliably identify ureteric stones. [1] Gas is seen as hypoattenuating filling defects in the calyces and pelvis of the kidney with presence of normal renal parenchyma (Fig. 3A,B). CT also helps to exclude complicated forms of emphysematous pyelitis, such as the presence of renal or perirenal fluid collections, frank abscesses, or emphysematous pyelonephritis. [1] In the absence of obstruction, surgical or percutaneous drainage procedures are rarely needed, and emphysematous pyelitis will likely respond to intravenous antimicrobial therapy and careful attention to underlying comorbid conditions. [1]

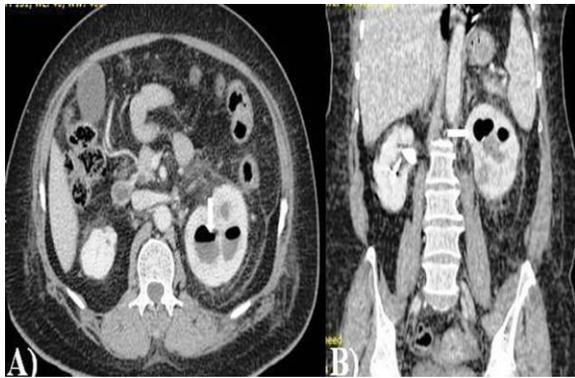


Figure 3: Axial (A) and Coronal (B) MDCT images at the level of kidneys showing presence of air in the calyces without any renal parenchymal abnormality suggestive of emphysematous pyelitis.

Emphysematous pyelonephritis:

Emphysematous pyelonephritis is a life-threatening necrotizing infection of the kidneys with gas forming bacteria. It is characterized by gas formation within or surrounding the kidneys. Underlying poorly controlled diabetes mellitus is present in up to 90% of patients who develop emphysematous pyelonephritis. [1] Other predisposing factors include immunosuppression and Urinary tract obstruction secondary to calculi, neoplasm or sloughed papilla. Patients present with varying degrees of renal failure, lethargy, acid-base irregularities, and hyperglycemia. [1] Rapid progression to septic shock may be seen, and emphysematous pyelonephritis carries an overall mortality rate of approximately 50%. [14] Flank pain and, rarely, crepitus over the lower back or thigh may be seen at physical examination. [15] E coli is the causative bacterial source in approximately 70% of cases, with Klebsiella, Candida, and Pseudomonas species isolated less frequently. [12]

X-rays may be normal or show presence of gas bubbles in the region of renal fossa. Sometimes mottled gas may be seen in the renal fossa. On ultrasonography, enlarged kidney with high-amplitude echoes within the renal parenchyma often with dirty posterior acoustic shadowing is seen.

MDCT is the investigation of choice in evaluating emphysematous pyelonephritis. MDCT findings include enlargement and destruction of kidney along with presence of bubbly or linear streaks of gas. Fluid collections and gas-fluid levels may also be present (Fig. 4A,B,C,D). Focal tissue necrosis with or without abscess is also commonly seen.

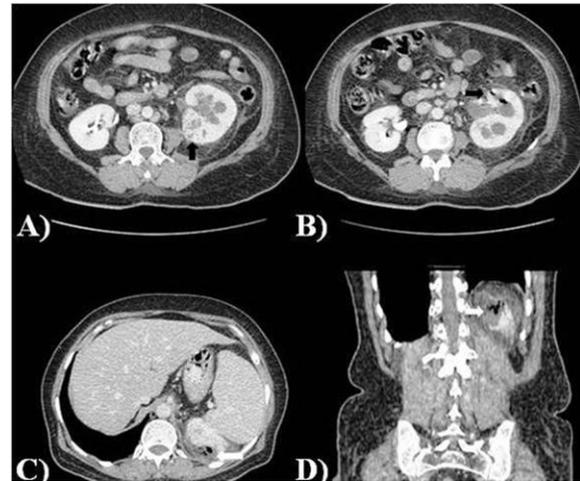


Figure 4: Axial (A and B) MDCT images showing pyelonephritis in left kidney (black arrow in A) along with presence of gas bubbles in the renal cortex (black arrow in B). No associated fluid collection seen suggesting a diagnosis of Type I emphysematous pyelonephritis. Axial (C) and Coronal (D) MDCT images of another patient showing presence of fluid collection with air bubbles in the left kidney (white arrows) suggestive of Type II emphysematous pyelonephritis.

CT classification scheme proposed by Wan YL et al [16] divides emphysematous pyelonephritis into two types and has a prognostic significance. Type I emphysematous pyelonephritis is characterized by parenchymal destruction with streaky or mottled gas collections but no fluid collections (Fig. 4A,B). Type II emphysematous pyelonephritis is characterized by bubbly or loculated gas within the parenchyma or collecting system with associated renal or perirenal fluid collections (Fig 4C,D) that are thought to represent a favorable immune response. Type I emphysematous pyelonephritis has a 69% mortality rate versus 18% for type II

although transformation from type I to type II has been observed following conservative treatment. [1,17]

CONCLUSION

Emphysematous infections of the abdomen are life-threatening conditions. Initial presentation may be insidious, but rapid progression to sepsis will occur in the absence of early therapeutic intervention. MDCT remains the most sensitive and specific radiological tool in determining the presence of anomalous gas collections in the abdomen, its anatomic location and extent. Therefore, with regard to emphysematous infections, appropriate radiologic evaluation combined with accurate interpretation of findings will help ensure rapid diagnosis and optimal treatment planning.

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