INTRAHEPATIC GAS: CLINICAL FEATURES AND DIAGNOSTIC CHALLENGE

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Abstract

Intrahepatic air is a potentially ominous discovery and life-threatening disease is emphasized by variable clinical condition. In this article, we present three cases of portal venous gas, pneumobilia, gas-forming liver abscess.

Portal venous gas manifests as small air densities in the periphery of the liver located predominantly in the left lobe. This entity is most commonly caused by mesenteric ischemia and carries high mortality rate up to 75%. Treatment entails emergent laparotomy with possible resection of the affected segment of bowel.

Pneumobilia is typically visualized as a large confluence of air located within the central portion of the liver and is most commonly seen in patients following procedures involving the biliary tract. Management may be either surgical or non-operative, depending on the etiology and clinical presentation.

Gas-forming liver abscesses are common among diabetic patients with sepsis condition. Emergent pigtail drainage and adequate antibiotic management combined with good control of blood sugar is the key step for good prognosis for such patients.

CT findings of intrahepatic air should be carefully evaluated to determine the clinical condition and further differential diagnosis with appropriate management.

Key Words: Intrahepatic air, Portal venous gas, Pneumobilia, Gas-forming liver abscesses

Introduction

Intrahepatic air on computed tomography scan is a potentially ominous discovery that presents a diagnostic challenge for physicians and surgeons.1,3 Life-threatening disease is emphasized by clinical condition.4,5 We present three cases with portal venous gas, pneumobilia, and gas-forming liver abscess for various clinical conditions and further management.

Portal venous gas is a branching area of low attenuation extending to within 2 cm of the liver capsule.1,8,9 It is most commonly caused by mesenteric ischemia and is associated with a mortality rate of 39–75%.8,10 Some benign etiologies of portal venous air, usually asymptomatic, do not require surgical intervention.11

Pneumobilia generally manifests as air centrally located within the liver and is most commonly seen in patients following surgery or proce-
cases involving the biliary tract.\textsuperscript{12-13}

Gas-forming liver abscesses are common among diabetic patients with sepsis condition.\textsuperscript{14-16} Emergent pigtail drainage and adequate antibiotic management should be performed immediately. We herein present a case of each of the aforementioned conditions.

**Case Report**

**Portal vein gas**

A 54-year-old male with a past medical history of alcoholism presented with a five-day history of right upper quadrant abdominal pain, nausea with two episodes of vomiting, fever and chills. He was admitted to our hospital with diagnosis of acute pancreatitis. Physical examination was significant for signs of dehydration and tenderness in the right upper quadrant with mild muscle guarding. Laboratory analysis revealed the presence of a leucopenia with a bandemia (23%), as well as elevated liver function tests. Abdominal CT scan revealed portal venous gas with ischemic bowel disease, and pancreatitis over tail. (Fig. 1) The patient was admitted and received exploratory laparotomy and operation finding revealed ischemic bowel disease combined with necrotizing pancreatitis. Surgery with arterial embolectomy of SMA and drainage of pancreatic abscess was done. About 100 cm terminal ileum was resected and end to side ileocolostomy. Lesser sac was explored, and necrotic tissue was debrided. Despite intensive care and management, the intra-abdominal abscess, sepsis, and short bowel syndrome with malnutrition persisted. Finally, the patient died of multiple organ failure.

**Pneumobilia**

The patient was a 53-year-old man with a past history of s/p cholecystectomy and choledocholithotomy in 1996 at KMUH. The patient started to have abdominal pain in September 2008. He visited our ER. No leukocytosis and no elevated CRP were noted. Blood culture x 1 set showed growth of Enterobacter cloacae. A second episode of abdominal pain occurred in November 2008, and he went to KMUH where abdominal CT was done and he was found to have gas in the biliary tract. This time, the patient had again developed abdominal pain, and this was accompanied with one episode of vomiting. There was no fever or diarrhea. He came to our ER. Elevated hepatic enzymes were noted but there was no leukocytosis or elevated CRP. He was admitted for further evaluation and management. On admission, abdominal echo showed suspicious hepatic tumor and s/p left segmentectomy. The bilirubin level was elevated at about 3.94. Blood cultures were done. Abdominal CT scan showed right IHD dilatation with stone and pneumobilia (Fig. 2). Blood cultures were done. Cefazolin 1 g IV q8h was started. The patient was referred to general surgery. However, the patient later decided to go back to KMUH for the possibility of stone removal.

**Gas-forming liver abscess**

A 56-year-old male with a past medical history of Diabetes mellitus presented with severe right upper quadrant abdominal pain and severe cough and dyspnea. Surgical intervention was considered. Abdominal CT scan was done and revealed a liver abscess with rupture complicated with pyoperitoneum (Fig. 3). Pigtail drainage of liver abscess was done. Due to progressive...
dyspnea, he was transferred to ICU for intensive care, and owing to sepsis and respiratory failure, was placed on ventilator support. Pus culture and blood culture revealed K. pneumoniae. After pig-tail drainage and antibiotic treatment, the patient's clinical condition improved and he did not receive surgical intervention.

Discussion

Intrahepatic air may be detected by abdominal plain film, abdominal sonogram or computed tomography scan. It is a potentially ominous discovery that presents a diagnostic challenge for physicians and surgeons.

Portal venous gas (HPVG) (Fig. 1) is diagnosed radiographically by the appearance of tubular lucencies branching from the portal hepatis to within two centimeters of the peripheral liver margin predominantly in the anterior-superior aspect of the left lobe. Hepatic portal venous gas was first described in abdominal plain radiographs in 1955 by Wolfe and Evans. This definition was derived from the work of Sisk, who injected radiologic contrast into the portal vein and detected it in the liver periphery, within 2 cm of the capsule. Liebman and colleagues analyzed all cases of HPVG reported in the literature by 1978 and found an oft-cited mortality rate of 75%. The mechanism for the appearance of gas in the portal vein is not well understood. The proposed factors predisposing the portal venous system to the accumulation of gas include the following: (1) escape of gas produced by gas-forming organisms in the bowel lumen or in an abscess, which then circulates into the liver; or (2) the presence of gas-forming organisms in the portal venous system with passage of gas into the circulation. Modern abdominal CT has resulted in the detection of HPVG in more benign conditions. The underlying clinical events associated were intestinal ischemia and necrosis (75%), ulcerative colitis (8%), and intra-abdominal abscess (6%). The overall mortality has varied from 39%~75%, depending on the severity and underlying disease. Many nonfatal conditions such as Bowel distensions are caused by iatrogenic procedures following colonoscopies and barium enemas. Infectious disease including diverticulitis, abdominal abscess, cholangitis, colitis and abdominal tuberculosis also induced HPVG.

HPVG can be differentiated from biliary gas (pneumobilia) because the latter is associated with air within the central portion of the liver, which does not extend toward the liver capsule to the same extent as seen in HPVG. Two conditions have to be distinguished between those who have HPVG with or without associated pneumato...
When associated with pneumatosi
sis intestinalis, the cause is usually an intestinal
ischemia and should justify emergent laparotomy
with possible resection of the affected segment
of bowel. Mesenteric ischemia may be due to a
variety of processes including thromboembolic
vascular disease, non-occlusive hypoperfusion,
and intestinal obstruction. Hepatic portal venous
gas therefore predicts high risk of mortality (50%)
if detected by plain radiography or by CT in a pa-
tient with additional evidence of necrotic bowel. If
detected by CT in patients after surgical or endo-
scopic manipulation, the clinician is advised that
there is no evidence of increased risk.

Increased use of CT scan and ultrasound in the inpatient set-
ting allows early and highly sensitive detection
of such severe illnesses and recognition of an in-
creasing number of benign and non-life threaten-
ing causes of HPVG.

Pneumobilia (Fig. 2) is defined as the pres-
ence of gas in the biliary tree of the liver. Its pres-
ence suggests an abnormal communication be-
tween the biliary tract and adjacent organs. The
etiology of pneumobilia was found to have both iatrogenic and non-iatrogenic causes. Iatrogenic
causes of pneumobilia include biliary-enteric
anastomosis, biliary sphincterotomy, biliary stent-
ing, endoscopic retrograde cholangiopancreatog-
raphy and upper gastrointestinal endoscopy. The
most common non-iatrogenic etiology is spontane-
ous biliary-enteric fistula, recurrent bouts of acute cholecystitis or peptic ulcer disease.
Emphysematous cholecystitis is distinguished
from other causes of pneumobilia based on the
appearance of gas in the gall bladder lumen, wall
and pericholecystic soft tissue. Other infections
due to gas-forming bacteria, such as Clostridium
perfringens or Klebsiella pneumoniae, may cause
pneumobilia.

Pneumobilia must be differentiated from
Intrahepatic portal vein gas. Pneumobilia is found
in a more central location within the liver than
portal venous gas, as the flow of bile is directed
toward the liver hilum. Pneumobilia usually ap-
pears as isolated bubbles in various sizes from 2-5
mm. Portal venous air has a branching pattern that
is extensively smaller and more numerous than
pneumobilia. The clinician should consider the
conditions, both benign and life-threatening that
cause it. The presence of pneumobilia requires a
prompt search to rule out serious infectious etio-
lologies. This is especially true in ill-appearing pa-
tients without an alternative iatrogenic explanation
for their pneumobilia.

Pyogenic liver abscess has become a health
problem in Taiwanese society with high incidence
of 17.59/100,000 in 2004. Gas-forming pyo-
genic liver abscess (GFPLA) (Fig. 3), which ac-
counts for 7 to 24% of pyogenic liver abscess,
has a high fatality rate (27.7 to 37.1%) in spite
of aggressive management. Diabetes mellitus
alone, without demonstrable infectious foci, is an
important predisposing factor for pyogenic liver
infection range 64–76%. Gas forming liver
abscess is more common in diabetic patients than
non-diabetic patients. These studies showed
a statistically higher incidence of septic shock,
bacteraemia and mortality in patients with GPLA
compared to non-GPLA patients. Klebsiella
pneumoniae is the most common pathogen in
Taiwan. Apart from Klebsiella spp, other
organisms reported to cause GPLA include E.coli,
Salmonella, and Clostridial infections. The
mechanism involves fermentation by formic hy-
drogenlyase, an enzyme that is only produced in
an acidic environment when the local pH reaches
6 or less as a result of acid accumulation. Formic
acid accumulated within the abscess is converted
to carbon dioxide and hydrogen gas by formic
hydrogenlyase. The high level of glucose in tis-
sue and compromised immunity in diabetic pa-
tients provide microbes with a microenvironment
in favor of vigorous metabolism and growth. The
frequency of development of metastatic infec-
tion from liver abscesses due to K. pneumoniae
is 10 to 21%, which is much higher than that for
liver abscesses due to organisms other than K.
pneumoniae. Ultrasonography is not as sensi-
tive as computed tomographic scans in detecting
abscesses. Presentations can be nonspecific lead-
ing to a delay in diagnosis. These cases highlight
the need to consider GPLA in diabetic patients

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presenting with fever, abdominal pain, nonspecific symptoms or septic shock. Management of GPLA includes haemodynamic support, broad spectrum intravenous antibiotics and urgent drainage that can be either percutaneous or surgical, as the risk for rupture is high. The mortality rate remains high at up to 37.1% contributed by a combination of delayed diagnosis, rapid deterioration and multiple metastatic lesion infections. In order to reduce fatality, adequate antibiotics, good control of blood sugar to stop the rapid catabolism, and, most importantly, an adequate drainage to improve the tissue perfusion to facilitate the gas transportation are desirable.

Conclusion

The identification of gas within the liver is one of the most important observations that can be made on the plain film of the abdomen confirmed by discovery on CT scan. The first distinction must be made as to the clinical condition. Various kinds of entities may be attributed to either benign or life-threatening conditions. Early diagnosis and treatment of the three conditions is based on correlation of the clinical presentation and a high index of suspicion on radiographic evaluation. CT findings should be carefully evaluated to determine an appropriate course of clinical management.

References

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肝內游離氣體：臨床特徵與診斷挑戰

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摘要

透過不同的臨床狀態，強調肝內游離氣體的表現是一種不容易被發現且威脅生命的疾病。在這篇文章中，我們提出三個案例，分別為肝門靜脈氣體、膽道氣體、產氣性肝膿瘍。

肝門靜脈氣體：是指有少許空氣在肝的周圍尤其是靠近左葉。這大部分起因於腸系膜缺血，往往容易引發高達75%的死亡率。因此，這個治療必需緊急剖腹探查且切除可能受影響腸系膜。

膽道氣體：典型可看到許多空氣聚集在肝中心的範圍，且多發現於病人接受膽道檢查或手術後。故可透過病因及臨床特徵，來判定是否須動手術。

產氣性肝膿瘍：通常好發在糖尿病伴隨敗血症的病患中。所以，緊急膿瘍引流、抗生素控制，並結合良好血糖控制，是病人有良好預後的必要步驟。

電腦斷層掃描發現的肝內游離氣體，是必須小心地評估並確定臨床特徵，進一步透過不同的診斷給予適當治療。

關鍵詞：肝內游離氣體，肝門靜脈氣體，膽道氣體，產氣性肝膿瘍

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