RADIOLOGICAL CASE

CLINICS IN DIAGNOSTIC IMAGING (19)

E T F Ho, W C G Peh

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CASE REPORT

A 47-year-old Chinese woman, who had surgery and radiotherapy for ovarian carcinoma one year ago, was admitted for management of bowel adhesions and fistula formation. She underwent an elective total pelvic exenteration, bowel resection and urinary diversion via a colonic conduit. The initial post-operative recovery was satisfactory and oral feeding was resumed. However, twelve days after the surgery, she developed intermittent abdominal pain, which subsequently progressed in severity. Her leucocyte count increased from normal levels to 29.5 x 10^9/L. Computed tomography (CT) of the abdomen was performed (Fig 1). What does it show and what procedure should be performed? Despite this intervention, the patient's abdominal pain persisted. The next day she developed shortness of breath, hypoxia (PaO_2 6.3 kPa on 40% oxygen mask) and hypotension. What do her chest radiographs (Fig 2a and b) show? What is the diagnosis and the likely underlying cause?

Fig 1 – Post-contrast CT of the abdomen. [K = left kidney]

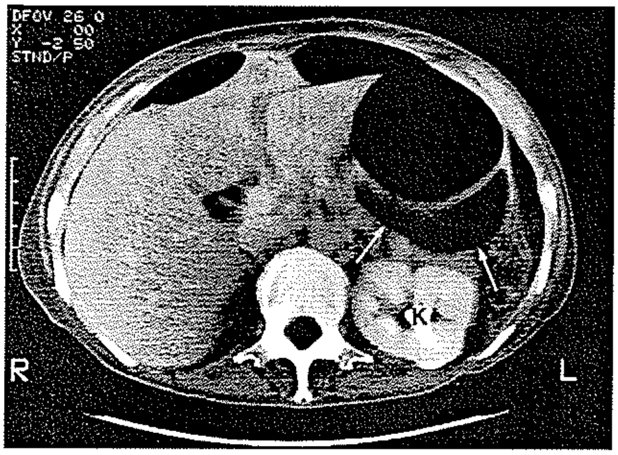
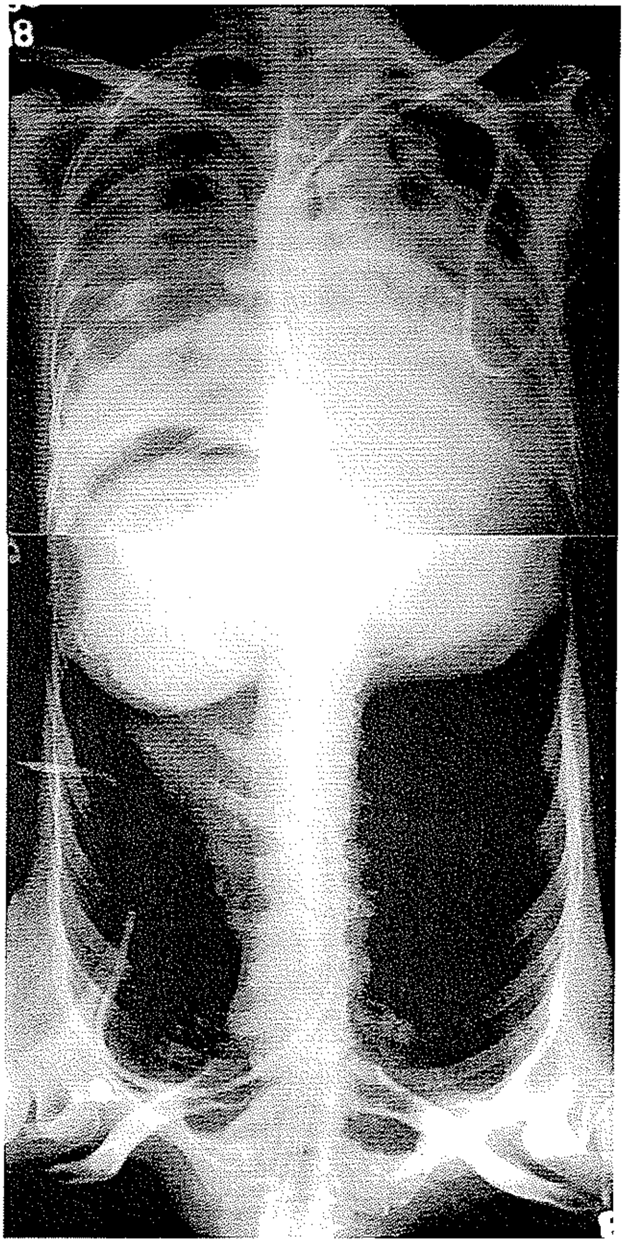


Fig 2 – (a) Chest radiograph taken several hours after onset of acute dyspnoea. (b) Earlier post-operative chest radiograph.



Department of Anaesthesiology
The University of Hong Kong
Queen Mary Hospital
Hong Kong

E T F Ho, FFARCSI, MRCP (UK), FRCA
Associate Professor

Department of Diagnostic Radiology
The University of Hong Kong

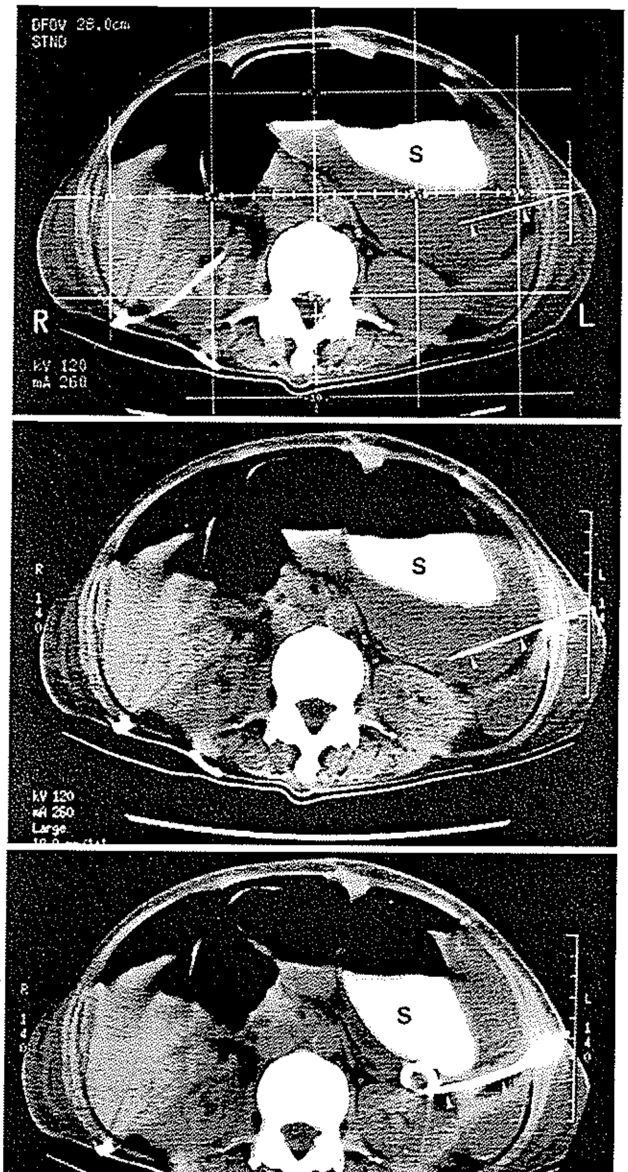
W C G Peh, FRCR, FHKAM, FAMS
Associate Professor

Correspondence to: Dr W C G Peh

IMAGE INTERPRETATION

CT of the abdomen showed a large intra-peritoneal fluid collection (arrows) adjacent to the air and fluid-filled stomach (Fig 1). This was later drained percutaneously, under CT guidance, using a pigtail catheter (Fig 3a, b, c). The chest radiograph demonstrated diffuse opacities in both lung fields (Fig 2a), in contrast to the normal appearance of the earlier post-operative radiograph (Fig 2b). The free intra-peritoneal air under the right hemi-diaphragm (Fig 2a) was not previously present. The absence of heart enlargement, pleural effusion or pulmonary vessel engorgement suggested a non-cardiogenic pulmonary oedema.

Fig 3 -- CT route planning for percutaneous drainage. (a) Super-imposed grid and anticipated needle path (arrow heads) for procedure. A right nephrostomy catheter had been previously placed for relief of post-irradiation obstructive nephropathy. (b) Small gauge needle (arrow heads) is introduced into the fluid collection. (c) Drainage catheter is in the correct position. Note the decrease in the fluid collection's size. [S = contrast-filled stomach]



DIAGNOSIS

Acute respiratory distress syndrome (ARDS) secondary to intra-abdominal sepsis

CLINICAL COURSE

The patient was resuscitated and admitted to the intensive care unit. She required endotracheal intubation, and mechanical ventilation with 75% oxygen and positive end-expiratory pressure (PEEP). An emergency laparotomy was done which showed complete breakdown of the bowel anastomosis causing the intra-abdominal fluid collection and sepsis. The oxygen requirement improved the day after her laparotomy and anastomosis repair. She was weaned off the ventilator the following day, requiring only 30% oxygen by mask. The patient was well enough to be transferred back to the general ward four days after her laparotomy. Her follow-up chest radiographs showed serial resolution of the pulmonary lesions (Fig 4a, b, c).

DISCUSSION

Acute or adult respiratory distress syndrome (ARDS) is a term applied to the final common pathway of acute lung injury associated with a variety of predisposing factors (Table I). The clinical picture includes respiratory distress with hypoxaemia refractory to oxygen therapy, decrease in lung compliance, pulmonary oedema, and radiographic evidence of diffuse air space and interstitial opacities. In the early phase of the disease, the lung fields are generally clear with radiographic changes occurring 24 to 36 hours after the initiating event. There is typically radiographic progression to a confluent and homogeneous air space filling pattern, which may remain unchanged for days to weeks. Sudden improvement in appearance, due to re-expansion of lung volume, may be brought about by mechanical ventilation with PEEP (Fig 4a,b,c). In the stable phase, the development of new radiographic opacities often indicates complications such as pneumonia, aspiration or empyema[1].

The reported annual incidence of ARDS in the United States is 150,000 cases, but this figure has been challenged and may be different in other countries. Part of the problem in determining the true prevalence of ARDS is due to a lack of agreement on the precise definition criteria. This, in combination with the heterogeneity of diseases leading to ARDS, has hampered evaluation of the natural history of the syndrome, its epidemiology, and the efficacy of various therapeutic interventions. The European-American Consensus Committee on ARDS was formed to focus on these issues and on the pathophysiological mechanisms of the "acute lung injury"[2]. Since 1967, when ARDS was first described by Ashbaugh, there have been significant advances in the understanding of the clinical conditions and the pathophysiological changes causing the alveolar-capillary membrane injury. Despite all these advances, the reported mortality rate remains in excess of 50%. However, recent reports have shown improved survival largely in patients younger than 60 years and in those with sepsis as the risk factor for ARDS[3].

The management of ARDS aims at providing supportive care and treating the underlying aetiological condition. Current treatment strategies concentrate on optimizing tissue oxygen delivery by increasing arterial oxygen tension and cardiac output. This would normally be done with the help of central haemodynamic monitoring to determine the appropriate fluid management. Shoemaker et al (1993) has shown that both inadequate delivery and insufficient consumption of oxygen precede the appearance of ARDS[4]. Therapy to augment oxygen delivery and consumption is therefore useful in preventing or attenuating post-operative and post-traumatic ARDS.

Fig 4 – Serial chest radiographs after onset of ARDS. (a) Day 2. After PEEP, the lung fields are expanded but the typical "bat's wing" opacification remains. (b) Day 5. Dramatic resolution with remnant mild patchy consolidation, especially at the right base. (c) A month later, the lungs are clear except for a trace of fluid in the right costo-phrenic angle.

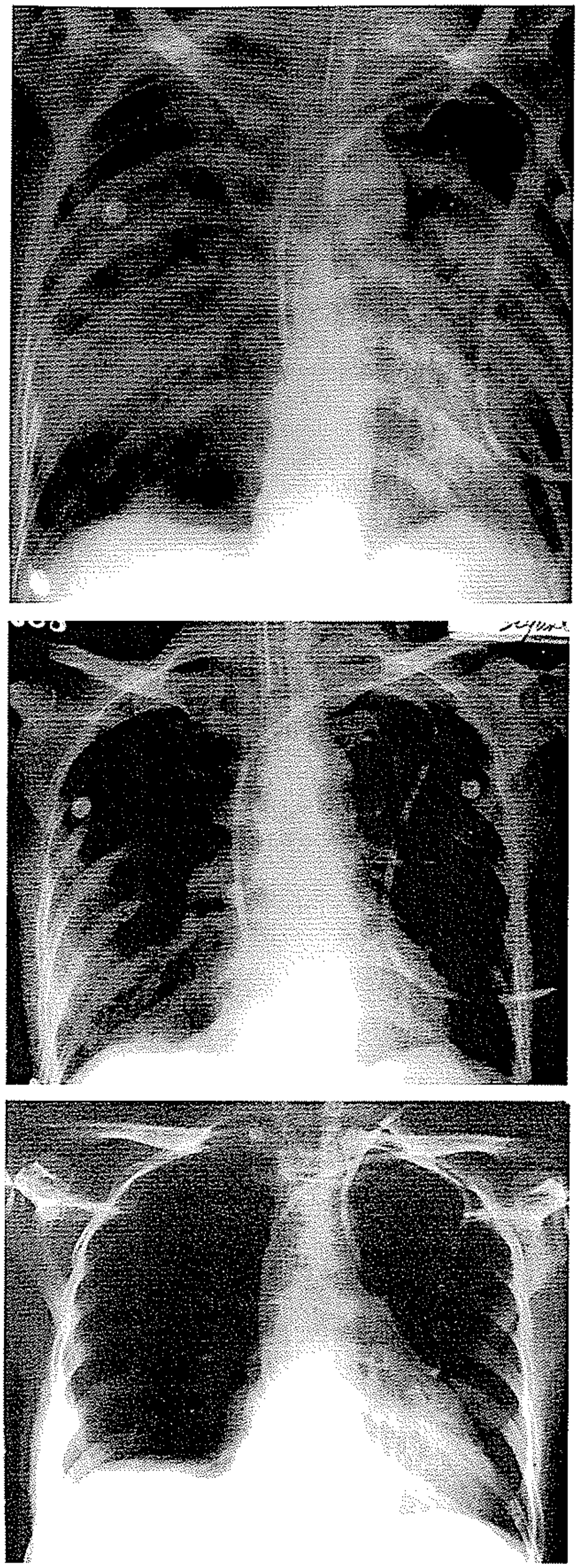


Table 1 – Predisposing factors for ARDS

I. Direct lung injury
Aspiration pneumonitis
Smoke and toxic chemical inhalation injury
Lung trauma
Bacterial or viral pneumonia
Oxygen toxicity
II. Indirect lung injury
Sepsis
Trauma
Burns
Multiple injuries and fractures
Head injury
Shock
Haematological
Massive transfusion
Disseminated intravascular coagulation
Cardiopulmonary bypass
Drug overdose and allergic reaction
Pancreatitis

Oxygenation is impaired in ARDS and high percentage of inspired oxygen is required, even with mechanical ventilation. Oxygenation can be improved using PEEP and other measures like high tidal volume or inverse inspiratory-expiratory ratio. However, with the decreased lung compliance, there is increasing recognition that ventilation with high inspiratory pressure produces lung injury or barotrauma.

Barotrauma is best detected by CT, with the earliest sign being interstitial pulmonary emphysema manifested as pulmonary air cysts. However, the most frequently seen result of barotrauma is a pneumothorax[5]. CT has also been used to study the morphological changes of the lung during ARDS and the response to therapy.` Using CT scans, Gattinoni et al (1991) showed that the dense non-aerated lungs are mainly confined to the dependent area, and the gas exchange impairment is proportional to the size of the dense area[6]. In the initial phase, as the aerated and non-aerated regions of the lung are not fixed, PEEP can re-expand reversible collapsed lung units and produce clearing of the densities. It was postulated that although the diseased part of the lungs has low compliance, the normal aerated part of the lungs has normal compliance. Therefore, even with normal tidal volume setting for ventilation, over-distention of the normal lung units may occur. Controlling the peak airway pressure by using pressure controlled ventilation may prevent such secondary lung injury. The tidal volume can also be reduced to avoid over-stretching of the alveoli[7]. Other approaches to improve oxygenation include the use of new therapeutic agents, for example nitric oxide and artificial surfactant, or new techniques such as extra-corporeal membrane oxygenation.

Since 1980s, it has been recognised that most patients with ARDS who died succumbed to sepsis and multi-organ failure rather than respiratory failure[8]. Therefore, in order to reduce the mortality rate, there is increasing interest in using therapeutic intervention to reduce the inflammatory process and prevent multi-system organ failure. Several inflammatory mediators, both locally in the lungs and in the systemic circulation, have been implicated in its pathophysiology. However with multiple mediators involved, interfering with just one single factor might not affect the overall outcome of the disease process. Therefore, the most important step is still the eradication of the source of sepsis, particularly in its early stages before the onset of multiple organ failure. It is recognised that early localisation and drainage of abdominal abscess, whether percutaneously or surgically, can improve survival rate[9].

Intra-abdominal sepsis is one of the common causes of multi-organ failure and yet one of the most difficult sources of sepsis to localise clinically. Intra-peritoneal fluid collections cannot be reliably diagnosed on abdominal radiographs, unless there are secondary signs of sepsis such as gas collections or adjacent localised ileus. Ultrasound, being free of ionising radiation hazard, should be used as the primary form of imaging for clinically suspected intra-abdominal sepsis (Fig 5). CT is regarded as the gold standard for imaging abscesses of the abdomen and pelvis. It delineates abnormalities particularly well after the administration of oral, rectal, fistula or intravenous contrast[10]. However, ultrasound has the advantage of not requiring prior preparation and being portable. These factors make ultrasound especially useful in the setting of the intensive care unit (Fig 6a and b).

Route planning for percutaneous drainage of an intra-abdominal collection depends on anatomical considerations as well as radiologist expertise and the availability of a particular imaging modality. The most frequently used modalities are ultrasound, fluoroscopy and CT. Fluoroscopy requires contrast administration while cephalocaudal angulation is more difficult with CT. Ultrasound, besides being portable, allows three-dimensional imaging, real-time monitoring of safe needle access and can be used in combination with fluoroscopy, if necessary. The trochar-cannula technique of drainage allows a single-step puncture and is ideal for superficial collections. In the modified Seldinger technique, an 18 to 21 gauge needle is first introduced into the collection and exchanged for a drainage catheter over a guide wire following serial track dilatation (Fig 3). If drainage or patient recovery is sub-optimal, follow-up imaging using ultrasound or CT may be indicated[10].

Fig 5 – A 44-year-old Chinese man who developed persistent fever after a left hepatectomy for recurrent pyogenic cholangitis. Ultrasound shows a large right subphrenic and subhepatic collection. 500 mL of fluid was subsequently aspirated under ultrasound guidance. [Liver is labeled; right hemi-diaphragm is arrowed]

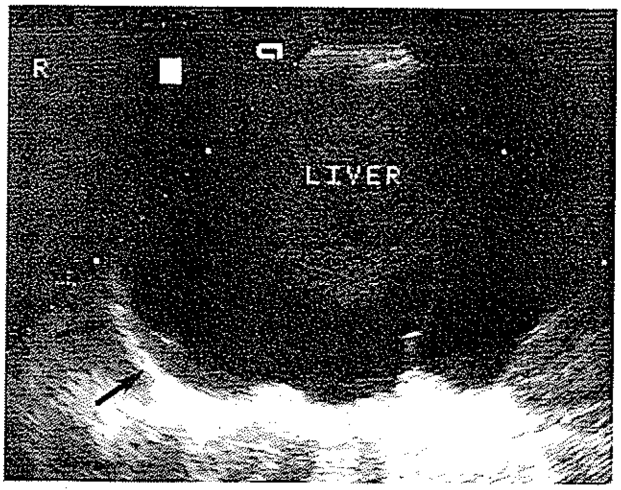
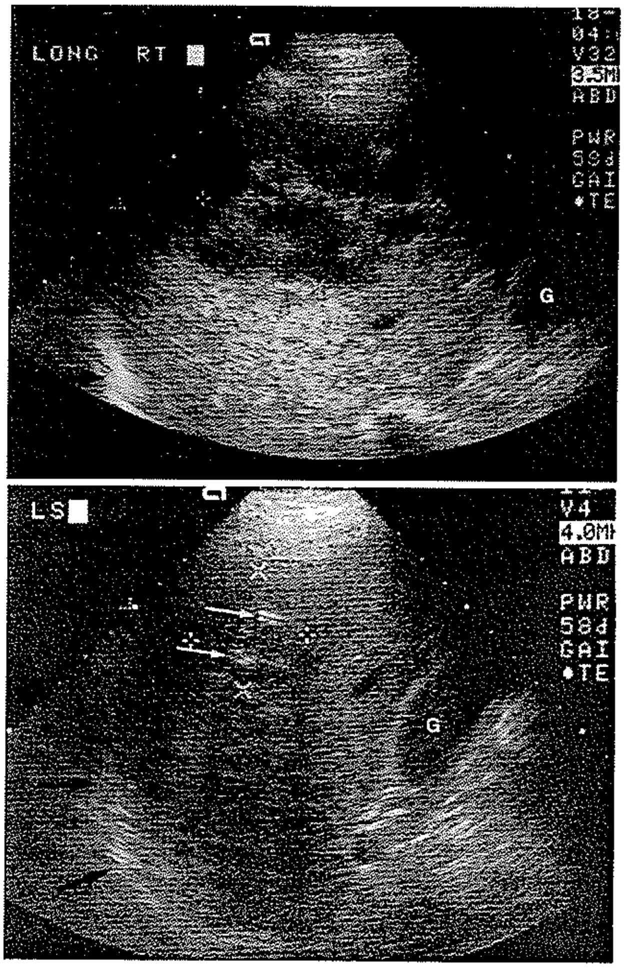


Fig 6 – Liver abscess in a 40-year-old Chinese man. (a) Initial ultrasound film shows a 70 mm diameter irregular cavity, with echogenic debris within, in the right lobe of the liver. (b) After percutaneous insertion of a pigtail catheter (turns of the 'pigtail' tip are seen with white arrows), repeat ultrasound shows a resolving abscess. [G = gallbladder, position of the right hemi-diaphragm is shown by black arrows]



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ABSTRACT

A 47-year-old Chinese woman developed acute shortness of breoth 12 days after a mojor abdominal surgery. Abdominal CT demonstrated a large intro-peritoneal fluid collection, subsequently proved to be due to an anastomosis breakdown. Chest radiograph showed bilateral diffuse air space shadowing. Clinical ond radiological findings were compatible with the diagnosis of ocute respiratory distress syndrome (ARDS) secondory to intra-obdominal sepsis. The oetiology ond management of ARDS, and the role of the radiologist in the diagnosis and treatment of intra-abdominal fluid collections are discussed.

Keywords: *acute respiratory distress syndrome (ARDS), abdominal sepsis, pulmonary oedema, interventional radiology*