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# Imaging changes of oil aspiration over time in children: a case series

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## Abstract

**Background** Oil aspiration pneumonia is an uncommon form of lung disease due to aspiration or inhalation of oil-containing products. The present study reports the changes process of radiological findings over time in four children.

**Case presentation** For 2 years, four cases (17 months until 3.5 years) with aspiration oil-containing (petroleum or benzene) products were referred to a tertiary center, Akbar Children's Hospital, Mashhad Medical University of Science. They presented with respiratory distress and fever. The radiography, low-dose CT scan, and ultrasound findings were evaluated. Assessment of serial imaging findings in our patients shows decreased volume, ground glass opacity, and septal thickening in the lower lobes of the lungs are a predominant pattern in the first and second days. Consolidation and nodular opacity appear after 48 h. In the second week, the nodular pattern (fluid-filled pneumatoceles) is the main pattern and persists for 1 month. CT scan images showed that opaque nodules are actually fluid-filled pneumatoceles. Finally, air-filled pneumatoceles gradually appeared from the third week and disappeared in 6–8 months.

**Conclusion** Our results show that four radiological phases of oil pneumonia, including ground glass opacities, segmental consolidation, fluid-filled pneumatoceles (nodule), and finally air-filled pneumatoceles, could be seen in radiography, CT scan, and ultrasound.

**Keywords** Oil, Aspiration, Radiology, Diagnosis

## Background

Aspiration happens when food, liquid, or other materials enter the airway and, eventually, the lungs. The aspiration of different substances into the airways and lungs may cause a variety of pulmonary complications. These disease entities most commonly involve the posterior segment of the upper lobes and the superior segment of the lower lobes.

Oil pneumonia, known as lipoid pneumonia, hydrocarbon pneumonitis, chemical pneumonitis, and chemical pneumonitis, but more appropriately called oil aspiration pneumonia, has increasingly come to the medical community's attention. Due to the low surface tension of the oil, some of it enters the trachea, and aspiration occurs when eating and swallowing. However, aspiration or inhaling exogenous or endogenous oil- or lipid-containing compounds is an uncommon form of lung illness [1]. The specific incidence of lipoid pneumonia is unknown. It can differ depending on the demographic characteristics and level of social culture in different societies [2]. Although due to the treatment of constipation with mineral oil, it is a disease

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of children and the elderly, exogenous oil aspiration pneumonia has been reported in all ages.

The patients may present with generalized symptoms such as abdominal pain, cough, dyspnea, hypoxemia, less frequent hemoptysis and fever, and diffuse crackles on pulmonary examination.

In these cases, imaging is crucial to the diagnosis. Oil aspiration has several radiological findings, which may mimic other diseases and cause diagnostic problems. Radiologic findings included alveolar consolidation, ground-glass opacities, alveolar nodules, pneumatoceles, and crazy cobblestone patterns reported in previous studies [3, 4].

Oil aspiration may mimic other diseases and cause diagnostic problems. To better understand the course of the disease to prevent diagnostic errors, we tried to evaluate the change in imaging findings of chest x-ray, CT scans, and ultrasounds over time in children. Our primary purpose is to report the radiological course of the disease in four children.

## Case presentation

### Case 1

The patient was a 3-year-old girl with normal birth weight and growth who complained of difficulty breathing after consuming about half a glass of benzene (petrol). She has been referred to the emergency department of Children's Hospital. At the time of the visit, the patient had tachypnea and tachycardia and $SpO_2 = 95\%$. In the chest x-ray, evidence of volume reduction and ground glass opacity was seen bilaterally in the lower lobes of the lungs (Fig. 1A). The septal thickening and lobular consolidation were seen in ultrasound (Fig. 2A). Bilateral nodular shadows were seen in a low-dose CT scan (Fig. 3A). She was discharged after 3 days without complication.

### Case 2

The patient was a 17-month-old boy who was hospitalized with one glass of oil poisoning (petroleum) and was discharged after 2 days. In the first chest x-ray, there was bilaterally para-hilar ground glass opacity. He is resubmitted after 2 days with fever and respiratory distress. At the time of the second admission, the patient had tachypnea. Right lower lobe consolidation was seen on the 4th-day chest x-ray (Fig. 1B). The ultrasound showed lobar consolidation and fluid-filled pneumatocele. He was discharged 10 days after admission without complication.

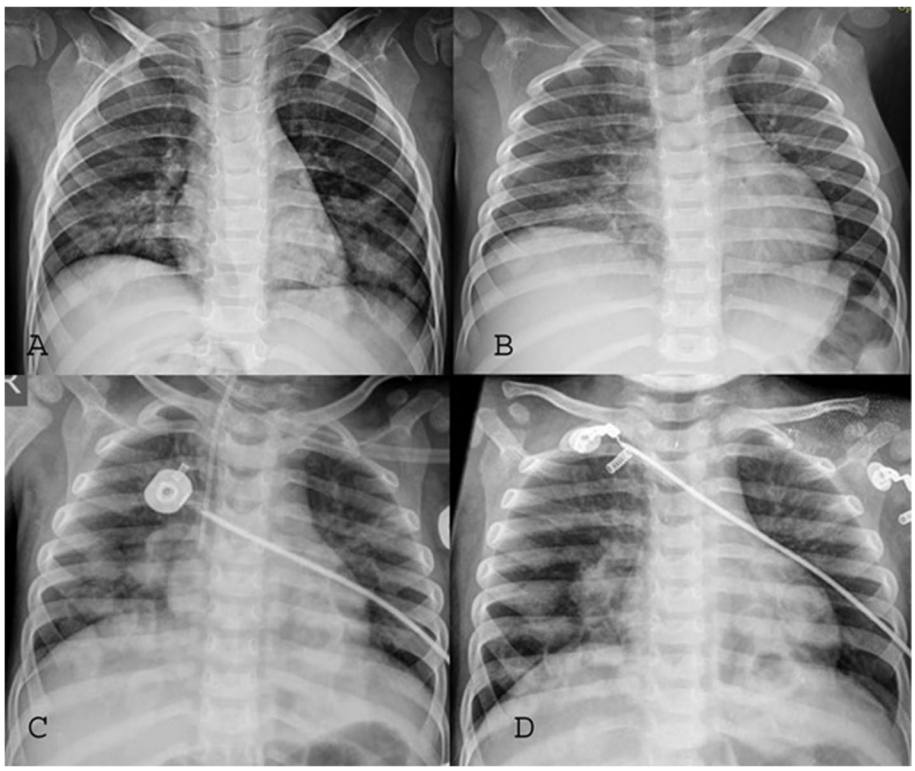


**Fig. 1** The changes of chest X-ray in oil pneumonia. **A** Evidence of volume reduction and ground glass opacity was seen bilaterally in the lower lobes of the lungs in the first visit. **B** Segmental consolidation in the right lower lobe on the fourth day. **C** Multiple fluids containing pneumatoceles 2 weeks later. **D** Multiple air-filled pneumatoceles 1 month later

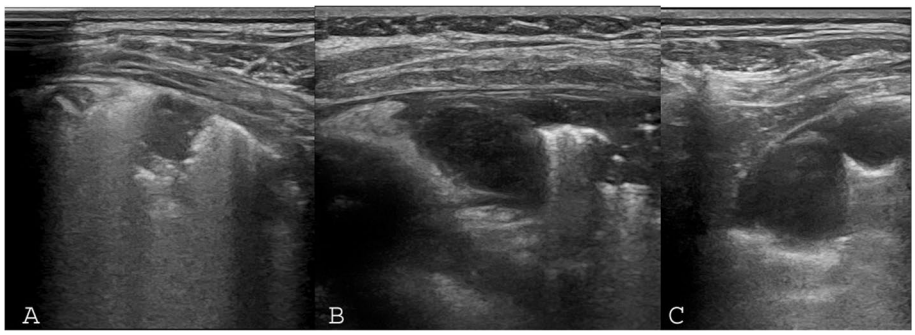


**Fig. 2** The changes of the oil pneumonia on ultrasound images in 3 childhood patients. **A** Multiple small peripheral nodular lesions with increased B lines (septal thickening) in the first week. **B** Segmental consolidation with fluid-filled pneumatocele in the second week. **C**, **D** Multiple fluid-filled pneumatoceles as nodular shadows and air-filled pneumatocele as crescent white line after 20 days

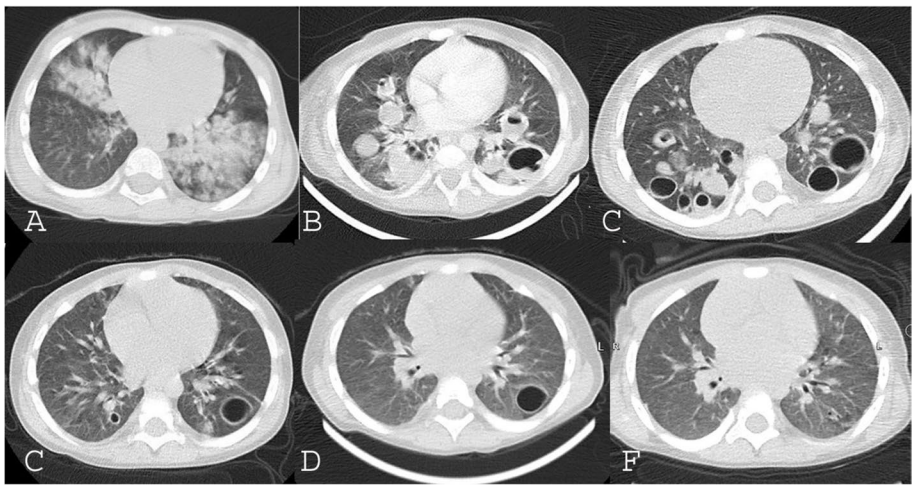


**Fig. 3** The changes process of low-dose CT-scan over time. **A** Bilateral multiple nodular lesions with ground-glass opacity in the first week. **B** Multiple fluids containing pneumatoceles in the second week. **C** Multiple air- or fluid-containing pneumatoceles after a month. **D** Decreased number of pneumatoceles 2 months later. **E** An air-filled pneumatocele 3 months later: **F** Focal air-trapping, fibrosis, and small cavity 6 months later

### Case 3

The patient is a 3-year- and 4-month-old girl who has difficulty breathing and pain on the left side of the chest after eating oil (petroleum). She had tachypnea and respiratory distress at admission time. The patient's blood pressure and oxygen saturation were normal. Lingular lobe consolidation was seen in the chest x-ray and CT scan. The ultrasound showed lobar consolidation and fluid-filled pneumatocele (Fig. 2B). She was discharged 10 days after admission without complication.

### Case 4

The patient was a 3-year-old boy hospitalized due to fever and cough after consuming oil (petroleum). He has been referred to the tertiary center for failure to respond to treatment. At the second admission, the patient had tachypnea with $SpO_2 = 88$. The evidence of nodular opacity was observed bilaterally in the lower lobes in chest x-rays (Fig. 1C). For further investigation, low-dose HRCT was requested for the patients, and multiple nodular lesions were reported bilaterally (Fig. 3B). Simultaneous ultrasound showed increased B lines with nodular lesions (Fig. 2C). After 1 week of hospitalization, he responds to corticosteroids, antibiotics, and nebulization treatment.

In the outpatient diagnostic and therapeutic follow-up at 1, 2, 3, and 6 months later, chest x-ray and low lung dose CT scan were performed. They have shown air-filled pneumatoceles removed after 6 months (Fig. 1D and Fig. 3C–F).

## Discussion

Oil aspiration is an uncommon incident that usually happens in children. Although imaging findings of this disease were reported in previous studies, knowing the radiological course to prevent diagnostic errors and choose the appropriate imaging modality can lead to reducing over-assessment and over-treatment and subsequently decreased morbidity. In addition, determining the disease phase may lead to an estimate of the recovery time and prognosis.

Many radiologic findings of oil aspiration pneumonia have been reported in previous studies. Gondouin et al. have done a retrospective multicenter study of exogenous lipoid pneumonia [3]: forty-four cases with lipoid pneumonia, all of which had abnormal imaging demonstrating alveolar consolidation in 57% of the cases, ground-glass opacities in 39% of the cases, and alveolar nodules in 23% of the cases [3].

Marchiori et al. investigated the most typical high-resolution CT findings in 53 patients (35 children and 18 adults) with verified lipoid pneumonia following mineral oil consumption. Ninety-six percent of these patients had bilateral anomalies, 86% had airspace stability, 47% had ground-glass attenuation, 22% had airspace nodules, and 20% had crazy cobblestone patterns [4]. The presence of airspace consolidation, the involvement of the upper right lobe, and the central and posterior distribution of the lesions were common in children. In contrast, the crazy-paving pattern and random localization were significantly more frequent in adults. The other findings were similar between the two groups.

Betancourt et al. investigated the spectrum of clinical and radiologic manifestations of oil aspiration; they found that within 30 min of the aspiration or inhalation incident, acute exogenous lipoid pneumonia can be seen radiographically, and in the majority of patients, pulmonary opacities can be recognized within 24 h [2]. Brechot et al. reported that the middle and lower lobes are primarily affected by the opacities, which are frequently segmental or lobar in distribution, bilateral, and ground-glass or consolidative in nature [5]. Poorly marginated nodules, pneumatoceles, pneumomediastinum, pneumothorax, and pleural effusions are some additional symptoms of acute exogenous lipoid pneumonia reported in the Haas et al. study [5, 6].

Pneumatoceles are more frequent in individuals who have aspirated or inhaled a lot of mineral oils or petroleum-based products, and they frequently form inside areas of ground glass or consolidative opacities, manifesting radiologically commonly 2–30 days after aspiration or inhalation [7].

The pneumatocele is an acquired fluid/air-filled cyst resulting from massive alveolar dilatation due to alveolar and bronchial necrosis. Destruction of the normal pulmonary elasticity and necrotic epithelial cells that act as an endo-bronchial check valve mechanism leading to air-trapping is probably pathogenesis [8, 9]. Air-filled pneumatoceles usually occur in the healing phase of pneumonia.

The radiologic signs of acute exogenous oil pneumonia frequently improve or disappear with time. Overall, even if exposure to mineral or vegetable oils or animal fats is stopped, the radiologic findings of chronic exogenous lipoid pneumonia often do not resolve immediately [10]. Opacities can be resolved in different periods, from 2 weeks to 8 months [11]. The resolution is complete in the majority; however, some scarring is possible. Cor pulmonale may be caused by fibrosis and loss of healthy lung structure [10].

The evidence of radiographic changes over time was in the form of a decrease in volume and bilateral ground glass opacity of the lower lobes of the lungs in the early stages, then segmental consolidation and multiple pneumatoceles containing fluid and air, and finally, in the form of multiple pneumatoceles containing air. Also, the evidence of changes in ultrasound over time was increased B lines with multiple peripheral nodular lesions in the early stages, then segmental consolidation and pneumatocele containing fluid, and finally pneumatoceles containing air. Also, the evidence of changes in the CT scans over time in the form of multiple nodular bilaterally in the early stages, then pneumatoceles containing fluid or air, improvement and reduction in the number of pneumatoceles containing fluid and air, and finally focal air trapping and small cavity.

Overall, assessment of serial imaging findings in our patients shows decreased volume, ground glass opacity, and septal thickening in the lower lobes of the lungs are a predominant pattern in the first and second days. Consolidation and nodular opacity appear after 48 h. In the second week, the nodular pattern (fluid-filled pneumatoceles) is the main pattern and persists for 1 month. CT scan images show that opaque nodules are actually fluid-filled pneumatoceles. Finally, air-filled pneumatoceles gradually appeared from the third week and disappeared in 6–8 months.

Our results show four radiological phases of oil pneumonia, including ground glass opacities, segmental consolidation, fluid-filled pneumatoceles (nodule), and finally air-filled pneumatoceles could be seen in radiography, CT scan, and ultrasound. There is an excellent correlation between every three modalities, and ultrasound can be proposed for follow-up as a non-radiation approach.

## Conclusion

Assessment of serial imaging findings in our patients shows decreased volume, ground glass opacity, and septal thickening in the lower lobes of the lungs are a predominant pattern in the first and second days. Consolidation and nodular opacities were induced after 48 h. In the second week, fluid-filled pneumatoceles are the main pattern and persist for 1 month. Finally, air-filled pneumatoceles gradually appeared from the third week, and they disappeared in 6–8 months.

### Abbreviations

CT Computerized tomography
$SpO_2$ Saturation of peripheral oxygen
HRCT High-resolution computed tomography

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### Authors' contributions

All authors were active participants in the drafting and revision of case series and in literature search and manuscript writing. All authors read and approved the final manuscript.

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### Availability of data and materials

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## Declarations

### Ethics approval and consent to participate

Written informed consent was obtained from the patients for publication of this case report and accompanying images.

### Consent for publication

Signed consent was taken from all patients.

### Competing interests

The authors declare that they have no competing interests.

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