EXOGENOUS LIPOID PNEUMONIA: SERIAL CHEST PLAIN ROENTGENOGRAPHY AND HIGH-RESOLUTION COMPUTERIZED TOMOGRAPHY FINDINGS

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Between May 1988 and July 2002, six patients with pneumonia due to diesel, animal, or vegetable oil aspiration were admitted to Kaohsiung Medical University Hospital. The purpose of this study was to demonstrate distinctive radiographic findings of oil-induced lipoid pneumonitis on initial serial chest roentgenograms and high-resolution computerized tomography (CT) scans. Initial chest roentgenograms (n = 6), CT scans (n = 6), and roentgenography and CT follow-up studies were analyzed retrospectively by two chest radiologists and two surgeons, focusing on the pattern and distribution of parenchymal abnormalities. The most common location was the right middle lobe, followed by the right lower lobe, the left lower lobe, and the lingular lobe. Follow-up chest roentgenograms (n = 6) showed complete disappearance of the parenchymal lesions in only one patient and partial decrease in the extent of lesions in five patients. Lipoid pneumonia presents non-specific findings on chest roentgenography. It is commonly located in both lower and the right middle lobes. On high-resolution CT, the lesions appear most commonly as areas of consolidation, ground-glass attenuation mixed with paving pattern, and poorly defined nodules.

Key Words: lipoid pneumonia, oil aspiration, computerized tomography

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Exogenous lipoid pneumonia is an uncommon condition that results from aspiration or inhalation of fatty material. In 1925, Laughlen described exogenous lipoid pneumonia when he reported discovering oil droplets in the lungs during autopsies of three children and one adult who had received mineral oil nose drops or oral laxatives [1]. From then to the 1950s, many clinical and experimental studies were conducted [2–9].

Exogenous lipoid pneumonia always results from aspiration or inhalation of mineral, animal, or vegetable oil. Because the lesions manifest variable patterns and distribution in radiographic examinations, the abnormalities may be misinterpreted as bacterial pneumonia, interstitial fibrosis, or bronchogenic carcinoma [10]. Diagnosis of lipoid pneumonia is confirmed by a history of ingestion or inhalation of the oily material and detection of lipid-laden macrophages in bronchoalveolar lavage fluid, transbronchial lung biopsy, or an excisional lung specimen following lobectomy [11].

Computerized tomography (CT) is the modality of choice in establishing the diagnosis of exogenous lipoid pneumonia. However, exogenous lipoid pneumonia can have unusual features on CT that may lead to misinterpretation [12]. Recognition of the varied clinical and radiographic manifestations of these disease entities is imperative for prompt and accurate diagnosis, resulting in decreased morbidity and mortality. Plain chest roentgenography and CT findings

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of lipoid pneumonia have been reported in several articles. However, in Taiwan, to the best of our knowledge, these findings have only been published in a few papers [13].

The aim of our study was to demonstrate the pattern and distribution of pulmonary parenchymal abnormalities of extrinsic lipoid pneumonia on initial plain roentgenograms and CT scans, and the evolution of these parenchymal lesions in follow-up studies.

Materials and Methods

Patients

Our study included six patients, five males and one female, aged 32 to 80 years (median, 46 years). They were chefs, fishermen, and a taxi driver; all had accidentally aspirated salad or diesel oil during their occupational activities. Diagnosis was confirmed by lung biopsy (n = 1), bronchoalveolar lavage (n = 2), and a positive history of oil inhalation (n = 3). Differential diagnoses, such as pneumonia, pulmonary tuberculosis, and other inflammatory diseases, were excluded by detailed clinical and laboratory studies and from pathohistologic studies on a resected lung specimen. Microscopic examination of bronchoalveolar lavage fluid revealed fat-laden macrophages.

Thin-section CT and plain chest roentgenography

All patients were examined using thin-section CT and chest roentgenography. CT was performed with a ProSpeed scanner (GE Medical Systems, Milwaukee, WI, USA). Thin sections (1.0 collimation) were obtained through the thorax at 10 mm intervals. The scans were reconstructed using a bone algorithm. Both mediastinal (level 30–50 HU, width 400 HU) and lung (level –700 HU, width 1,500 HU) window images were available.

Initial chest roentgenography (n = 6) and CT (n = 6) were performed within 1 day to 2 months of oil aspiration (median, 15 days).

Serial chest roentgenograms, which were available for all six patients, were obtained weekly for 1 month after the initial diagnosis and then once every 3 months for a total follow-up period of 2 years. In patients with multiple follow-up studies, the last study available was evaluated.

Results

Most symptoms occurred within 1 day after aspiration. Chest pain, cough, fever, and hemoptysis were the chief complaints (Table). Physical examination and laboratory data revealed no significant abnormalities. However, in one patient, the pulmonary function test showed a minor restrictive pattern.

During the follow-up period, patients received oral antibiotics for 1 or 2 weeks. However, antibiotic treatment was discontinued for one patient because there was no definite evidence of pneumonia from clinical and laboratory studies, and chest roentgenograms persistently showed parenchymal abnormalities. Therefore, of the six patients treated, improvement was seen in five. Lobectomy was performed in one patient.

Initial chest roentgenograms showed areas of bilateral

Table. Comparison of symptomatology, treatment regimen, and parenchymal abnormalities on initial computerized tomography (CT) scans and follow-up roentgenograms

Age	Profession	Oil aspirated	Symptoms	Specimen	Treatment	Initial CT	Crazy paving	Follow-up roentgenograms
80	Chef	Salad	Chest tightness	None	Antibiotic and steroid	Ground glass	No	Partial resolution after 1 month
32	Chef	Salad	Non-productive cough	Lobectomy	Lobectomy	Mass	No	Lobectomy without parenchymal lesions
37	Chef	Salad	Chest pain and fever	Lavage	Antibiotic and steroid	Ground glass	Yes	Partial resolution after 1 month
67	Fisherman	Diesel	Chest pain, fever and hemoptysis	None	Antibiotic and steroid	Ground glass	Yes	Complete resolution after 1 month
43	Taxi driver	Diesel	Chest pain	Lavage	None	Ground glass	Yes	Partial resolution after 1 month
38	Fisherman	Diesel	Chest pain and fever	None	Antibiotic and steroid	Ground glass	Yes	Partial resolution after 1 month

ground-glass opacities (n = 2), unilateral ground-glass opacities (n = 3), and a mass-like lesion. Initial high-resolution CT scans demonstrated bilateral areas of ground-glass attenuation (n = 2), unilateral ground-glass attenuation (n = 3), crazy paving (n = 4), and a unilateral pulmonary mass. The abnormalities were distributed in a bilateral multilobar (n = 2), unilateral multilobar (n = 3), and unilateral unilobar (n = 1) pattern. The most common lobar distribution was the right middle lobe, followed by the right lower lobe, the left lower lobe, and the lingular lobe.

Follow-up chest roentgenograms (n = 6) showed complete disappearance of the parenchymal lesions in only one patient. In this patient, the parenchymal abnormalities had been seen in only one lung (right) on the initial chest roentgenogram. In the patient who underwent right lower lobectomy, the follow-up chest roentgenogram showed disappearance of the tumor-like lesion in the right lower lobe. The remaining four patients had a partial decrease in the extent of the lesions.

In two of four patients with partial improvement, parenchymal abnormalities disappeared completely in some zones and decreased in extent in other zones. In the other two patients, there was an overall decrease in the extent of abnormalities in previously noted areas of abnormalities.

Discussion

Exogenous lipoid pneumonia is an uncommon pulmonary disorder resulting from aspiration or inhalation of mineral, vegetable, or animal oil into the peripheral lung. Disease severity depends on the amount and kind of lipid [14]. Animal fat causes a severe inflammatory reaction because it is hydrolyzed by the pulmonary lipases, producing fibrosis, granulomas, and *in situ* hemorrhage. Mineral oil generally causes a less severe foreign-body reaction, whereas vegetable oil may produce only a minor inflammatory process with giant cell formation and caseous necrosis or no reaction at all.

Predisposing factors, such as structural abnormalities of the pharynx or esophagus (achalasia, esophageal diverticulum, hiatal hernia), neuromuscular disorders, neonatal or older age, are frequently associated with this condition.

The clinical picture ranges from minimal symptoms to death. Toxicities can take the form of pneumonitis, central nervous system toxicity with weakness, confusion, or coma, cardiomyopathy, renal toxicity, and hepatosplenomegaly [15]. In our series, there were no relevant systemic toxicities, only pulmonary involvement. This was probably because of the aspiration route of entry.

Characteristic microscopic features are the numerous lipid-laden macrophages that fill and distend the alveolar walls and interstitium, and which are associated with accumulation of lipid material, inflammatory cellular infiltration, and interstitial fibrosis [16].

Chest roentgenographic findings of lipoid pneumonia are non-specific [17]. Abnormalities include areas of ground-glass opacity, consolidation, and poorly defined nodules. The most common distribution of parenchymal abnormalities is in the right middle lobe, followed by both lower lobes.

CT is considered the imaging technique of choice to diagnose lipoid pneumonia [18]. One patient, a 32-year-old male chef, was admitted with an initial CT showing a tumor-like lesion in the right lower lobe. He had a history of aspiration of salad oil. Neither sputum cytology nor a lung specimen showed any malignant cells. Since there was a possibility of bronchogenic carcinoma, the patient underwent right lower lobectomy. The histologic features of the resected specimen were those of lipoid pneumonia; no cancer cells were detected. The lobectomy might seem to have been an unnecessary surgical procedure, but this was a rare case of pulmonary mass mimicking bronchogenic carcinoma (Figure 1).

The crazy-paving pattern, consistent with well-defined areas of ground-glass attenuation with superimposed septal thickening, has been described as a characteristic feature of lipoid pneumonia, in which the alveoli are filled with a proteinaceous material positive for the periodic acid-Schiff stain and rich in lipids [19]. To our knowledge, the crazy-paving pattern has been reported as a finding of pulmonary alveolar proteinosis and mucinous bronchoalveolar cell carcinoma [20]. This pattern was found in four of our patients with exogenous lipoid pneumonia, including a 37-year-old female chef (Figure 2).

Other differential diagnoses include diseases that present findings of ground-glass attenuation and poorly defined nodules, such as *Pneumocystis carinii* pneumonia [21]. However, a clinical history of oil inhalation or ingestion, when associated with these radiographic findings, may suggest a diagnosis of lipoid pneumonia. Although exogenous lipoid pneumonia may be related to excessive use of oil-based nose drops, in most cases, exogenous lipoid pneumonia is a result of mineral oil given orally for medicinal purposes. Aspiration is the most common mechanism, although exogenous lipoid pneumonia has been reported as a result of mineral oil embolization after rectal administration and from excessive use of lip balm [22,23].

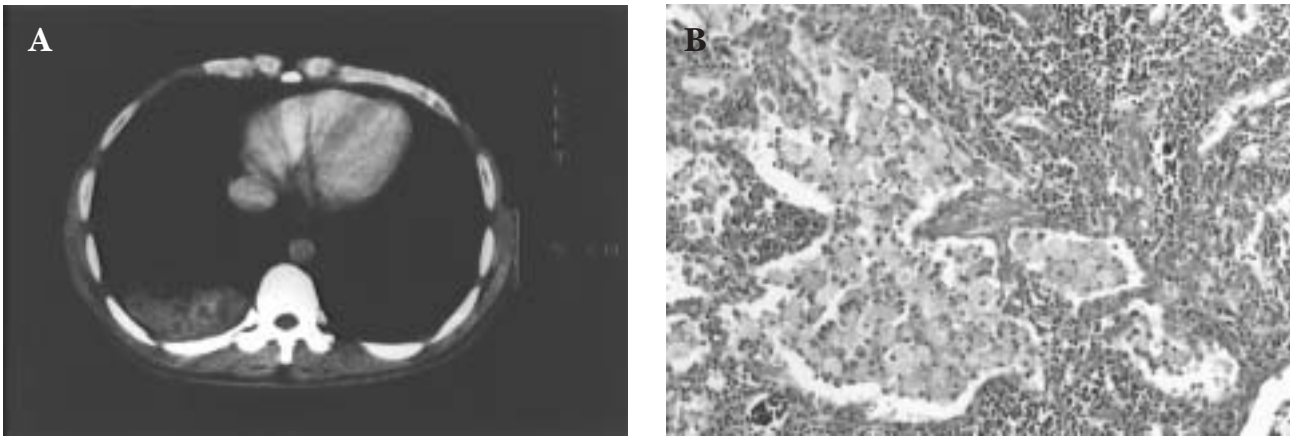

Figure 1. *Vegetable oil-induced extrinsic lipoid pneumonia in a 32-year-old man. (A) Chest computerized tomography (CT) scan showing a lobulated, heterogeneous tumor shadow in the right lower lobe (CT No.: 58 HU). (B) High-magnification view of the pathologic specimen obtained from the right lower lobe shows mainly inflammatory cell infiltration in the alveolar walls and interstitium, with some intra-alveolar and interstitial foamy macrophages.*

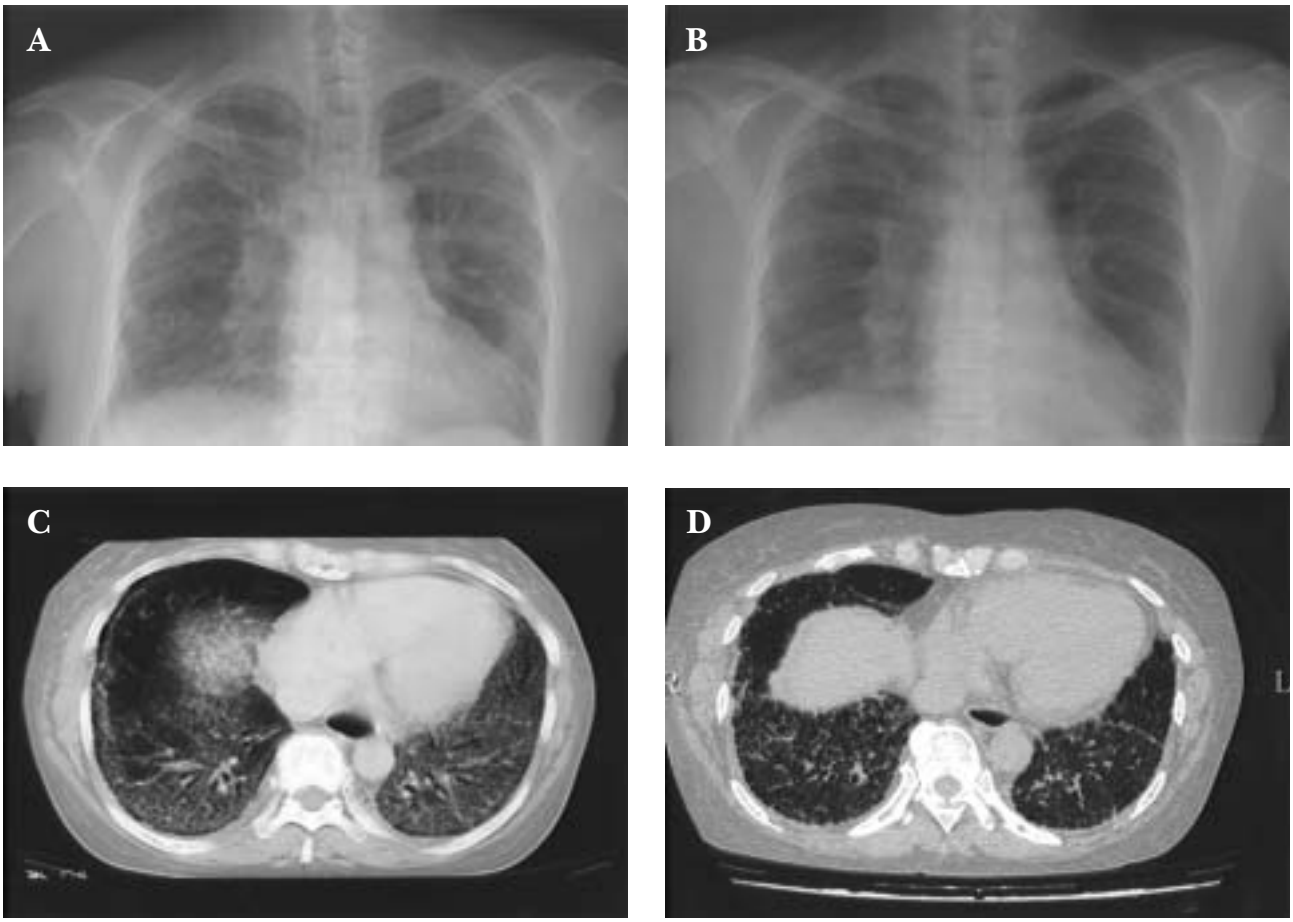

Figure 2. *Vegetable oil-induced extrinsic lipoid pneumonia in a 37-year-old woman. (A) Chest roentgenogram shows areas of ground-glass opacity in both lower lung fields. (B) Follow-up chest roentgenogram 8 months later shows a slightly decreased extent of ground-glass opacity in both lower lung fields. (C) High-resolution (1.0 mm collimation) computerized tomography (CT) scan obtained at the ventricular level reveals areas of ground-glass attenuation with intralobular septal thickening (crazy-paving appearance). (D) High-resolution (1.0 mm collimation) CT scan obtained at the same level 8 months later shows significant improvement in ground-glass opacity lesions in both lower lobes.*

Diagnosis is sometimes difficult and our study is limited by the fact that the work was retrospective and not all cases were confirmed histopathologically. However, a history of oil inhalation was present in all patients and the radiographic studies, especially high-resolution CT, excluded the possibility of infection or other inflammatory diseases.

Annobil et al reported radiographic resolution on follow-up roentgenograms in 20 cases of lipoid pneumonia [24]. They demonstrated complete radiologic resolution between 6 weeks and 6 months. In our follow-up study (n = 6), complete disappearance of parenchymal abnormalities was seen on only one patient's chest roentgenogram 1 month after the initial study. Partial resolution was seen in the remaining patients after 1 month.

Open-lung biopsy has been used as a diagnostic method, but carries the disadvantage of being a much more invasive procedure [25].

In conclusion, oil-induced lipoid pneumonia presents non-specific findings on chest roentgenography, with mixed findings of ground-glass opacity, consolidation, and poorly defined nodules. These lesions are commonly located in the right middle and both lower lobes. On high-resolution CT, lesions appear most commonly as areas of consolidation, ground-glass attenuation mixed with crazy paving pattern, and poorly defined nodules mainly distributed in the right middle lobe and both lower lobes. Finally, the diagnosis of lipoid pneumonia with a solitary pulmonary mass mimicking bronchogenic carcinoma should be considered to avoid unnecessary surgical intervention.

REFERENCES

1. Laughlen GF. Studies on pneumonia following naso-pharyngeal injections of oil. *Am J Pathol* 1925;1:407–15.
2. Pinkerton H. Oils and fats: their entrance into and fate in the lungs of infants and children—a clinical and pathologic report. *Am J Dis Child* 1927;33:259–85.
3. Pinkerton H. The reaction to oils and fats in the lung. *Arch Pathol* 1928;5:380–401.
4. Graef I. Pulmonary changes due to the aspiration of lipids and mineral oil. *Am J Pathol* 1935;11:862–8.
5. Ikeda K. Oil aspiration pneumonia (lipoid pneumonia): clinical, pathologic and experimental considerations. *Am J Dis Child* 1935;49:985–1006.
6. Ikeda K. Lipoid pneumonia of the adult type (paraffinoma of the lung): report of five cases. *Arch Pathol* 1937;23:470–92.
7. Paterson JLH. An experimental study of pneumonia following the aspiration of oily substances: lipoid cell pneumonia. *J Pathol Bacteriol* 1938;46:151–64.
8. Volk BW, Nathanson L, Losner S, et al. Incidence of lipoid pneumonia in a survey of 389 chronically ill patients. *Am J Med* 1951;10:316–24.
9. Jampolis RW, McDonald JR, Clagett OT. Mineral oil granuloma of the lung: an evaluation of methods for identification of mineral oil in tissue. *Int Abstr Surg* 1953;97:105–19.
10. Miller A, Bader RA, Bader ME, et al. Mineral oil pneumonia. *Ann Intern Med* 1962;57:627–34.
11. Silverman JF, Turner RC, West RL, et al. Bronchoalveolar lavage in the diagnosis of lipoid pneumonia. *Diagn Cytopathol* 1989;5:3–8.
12. Kang FY, Grenier P, Laurent F, Muller NL. Interlobular septal thickening: patterns at high-resolution computed tomography. *J Thorac Imaging* 1996;11:260–4.
13. Lee CH, Chiang YC, Lan RS, et al. Aspiration pneumonia following diesel oil siphonage—analysis of 12 cases. *Chang Gung Med J* 1988;11:180–4.
14. Lauque D, Dongay G, Levade T, et al. Bronchoalveolar lavage in liquid paraffin pneumonitis. *Chest* 1990;98:1149–55.
15. Wheeler PS, Stitik FP, Hutchins GM, et al. Diagnosis of lipoid pneumonia by computed tomography. *JAMA* 1982;245:65–6.
16. Kennedy J, Costello P, Balikian JP, Herman PG. Exogenous lipoid pneumonia. *AJR Am J Roentgenol* 1981;136:1145–9.
17. Lee JS, Gong GU, Lim TH. Squalene aspiration pneumonia: thin section CT and histopathologic findings. *J Kor Radiol Soc* 1998;38:453–8.
18. Joshi RR, Cholakeril JV. Computed tomography in lipoid pneumonia. *J Comput Assist Tomogr* 1985;9:211–3.
19. Frequent T, Gimenez A, Bordes R, Castella J. The crazy-paving pattern in exogenous lipoid pneumonia: CT-pathologic correlation. *AJR Am J Roentgenol* 1988;170:315–7.
20. Godwin JD, Muller NL, Takasugi GE. Pulmonary alveolar proteinosis: CT findings. *Radiology* 1988;169:609–13.
21. Klein JS, Warnock M, Webb WR, Gamsu G. Cavitating and non-cavitating granulomas in AIDS patients with Pneumocystis pneumonitis. *AJR Am J Roentgenol* 1989;152:753–4.
22. Rabah R, Evans RW, Younis EJ. Mineral oil embolization and lipoid pneumonia in an infant treated for Hirschsprung's disease. *Pediatr Pathol* 1987;7:447–55.
23. Becton DL, Lowe JE, Faletta JM. Lipoid pneumonia in an adole-scent girl secondary to use of lip balm. *J Pediatr* 1984;105: 421–3.
24. Annobil SH, Ogunbiyi AL, Benjamin B. Chest radiographic findings in childhood lipoid pneumonia following aspiration of animal fat. *Eur J Radiol* 1993;16:217–20.
25. Fan LL, Graham LR. Radiological case of the month. Lipoid pneumonia from mineral oil aspiration. *Arch Pediatr Adolesc Med* 1994;148:205–6.