

Triolein Oleic Acid CT

1

2 3

: Triolein Oleic Acid CT

: 16 8 Triolein 0.2 mL (I), 8 Oleic Acid
0.2 mL (II) 30 , 4 , 24 , 48 , 72 CT
30 , 24 , 48 , 72
: I 24 CT 2 - 3 mm 가
100% (n=8/8)가 가
75% (n=6/8) . 4 CT 100% (n=7/7)
, 24 CT
가 48 CT 100% (n=6/6) 가
. 72 CT 가
: Triolein Oleic Acid CT 가
, Triolein Oleic acid
. CT

(1 - 3). 24 72 24 72 (lipase)
(latent time) , 가
(petechia) 3가 가
(triad)가
가 (4 - 7). 48 가
CT
Triolein (8, 9). 가 Oleic Acid 가
가 Oleic Acid Triolein Triolein 가
CT
Triolein Oleic Acid
CT

1
2
3

: Triolein Oleic Acid CT

(), (, , , , ,)
, ,)
, (liver)

1.8 kg 2.2 kg

(2.0 kg) 16

CT

. Triolein Oleic Acid 99.9%
. 1 8 , 0.2 mL Triolein (1,2,3 - tri(cis - 9 -
octadecanoyl)glycerol, Sigma, St. Louis, MO, U.S.A., Triolein
1 mL = 0.8988g, Triolein)
30 . 2 8 , Oleic
Acid (cis - 9 - octadecanoic acid, Sigma, St. Louis, MO,
U.S.A., Oleic Acid 1 cc=0.891 g, Oleic Acid)
0.2 mL .

Triolein Oleic Acid 30 , 24 , 48 ,
72 CT

(ketamine hydro -
chloride; , , , ketamine 1 mL=50 mg)
(xylazine hydrochloride; Bayer Korea, , , mL
xylocaine 1 mL= 23.32 mg) 0.3 mL/Kg

CT
(succinyl choline; , ,) 50 mg 0.5

가

10%

(ceftezole sodium, , ,) 20
mg/Kg 2 12

2

CT

CT

(axial

scan)

CT

Hematoxylin - Eosin

Triolein Oleic Acid
30 , 4 , 24 , 48 , 72 CT
. CT (prone position)

. Hispeed i/Pro (GE,
milwaukee, U.S.A.) 140 KVP, 170 mA,
3 mm, (pitch) 1.2/1, (field of view) 10
cm x 10 cm 0.8

, (coagulation necrosis), (intra -
vascular thrombosis), (hyaline membra - ine),
(PMN infiltration), (fibro - blast)
, , (mild, moderate, severe)

(window width) 1100 HU, (window level)
- 350 HU

40

가

100

CT

, 30%

, 30 - 70%

, 70%

CT

CT

CT

가

(pattern), , (extent)

가 3 - 4 mm
(Fig. 1).
10 - 30% . 72 CT (n=5/5)
CT
1 CT (Table 1) 30 (n=8/8) 4 2 CT (Table 2) 30 CT 25%
(n=7/7) CT 24 CT 86% (n=2/8)
(n=6/7) 14% (n=1/7) 가
2 - 3 mm 가
10% . 48 CT 83.3% (n=5/6) 가 10 - 30%/10%
24 CT 75% (n=6/8) , 가 (n=8/8) , ,
. 25% (n=2/8)

Table 1. CT Findings in Rabbit Lungs Embolized by Intravenous Injection of 0.2 mL Triolein (group I)

Hours		0.5	4	24	48	72
CT findings	N	8	8	7	6	5
Ground glass opacities		0 (0)	0 (0)	1 (14)	1 (17)	0 (0)
Consolidation		0 (0)	0 (0)	0 (0)	1 (17)	0 (0)
Nodule		0 (0)	0 (0)	1 (14)	1 (17)	0 (0)

Note. Hours: Time duration between triolein injection and CT scan.

N: number of rabbit

(): percentage

Table 2. CT Findings in Rabbit Lungs Embolized by Intravenous Injection of 0.2 mL Oleic Acid (group II)

Hours		0.5	4	24	48	72
CT findings	N	8	8	7	6	5
Ground glass opacities		8 (100)	8 (100)	7 (100)	0 (0)	0 (0)
Consolidation		6 (75)	8 (100)	7 (100)	6 (100)	5 (100)

Note. Hours: Time duration between oleic acid injection and CT scan.

N: number of rabbit

(): percentage

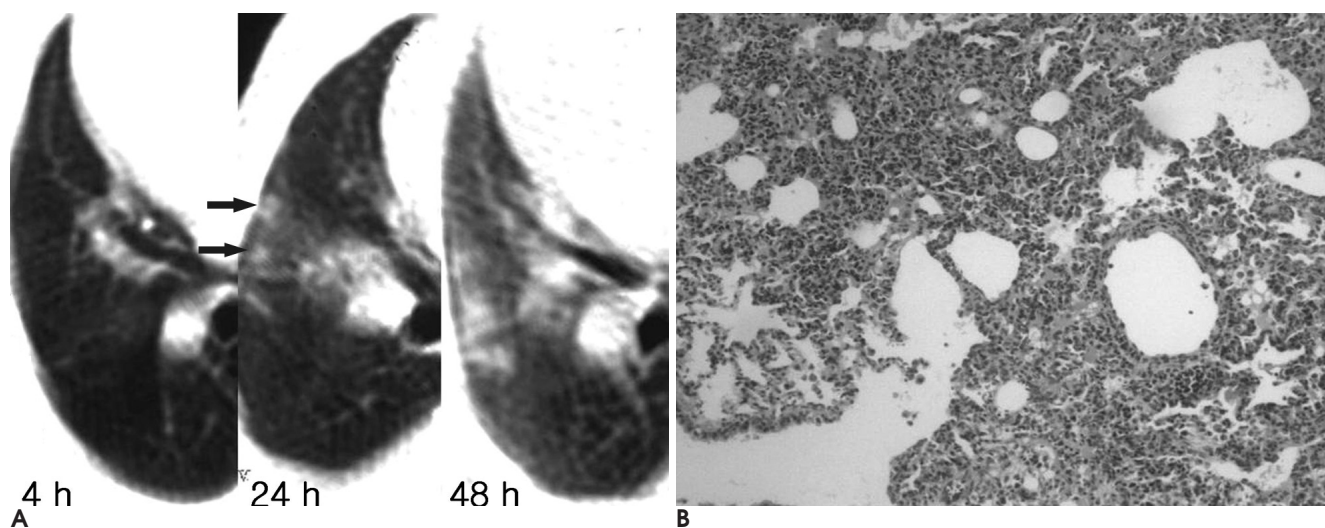


Fig. 1. The CT scans and pathology of the rabbit embolized by an intravenous injection of 0.2 mL Triolein (Group I).

A. Peripheral predominant ground glass opacities and small nodules (arrows) are observed on the 24 hour CT scan and these findings are aggravated at 48 hours.

B. The pathologic findings noted at 48 hours are mainly intraalveolar edema (H & E, $\times 100$).

Triolein Oleic Acid CT

75% (n=8/8) , 가

25% (n=2/8) , , 24 가

2 (12.5%) 10% , 6

10 (62.5%) 10 - 30%, 2 4 (25%)

30 - 50% . 4 CT 30 CT

2 (n=7/7) 1 2 (Table 3)

4 8 1 4 3

(56%) 가 , 3 6 (44%)

10 - 30% 가 30 - 50% . 24 CT

(n=7/7) 가

. 4 8 (56%) 가 4

30 - 50% 10 - 30% (Fig. 3) 3

6 (44%) 가 . 48 CT

(n=6/6)

24 가 . 72 CT 6 12 (n=5/5)

가

가

CT

30 , 24 , 72 1 3 CT

. 48 CT

2 30 CT

. 24

가 . 48

72 CT

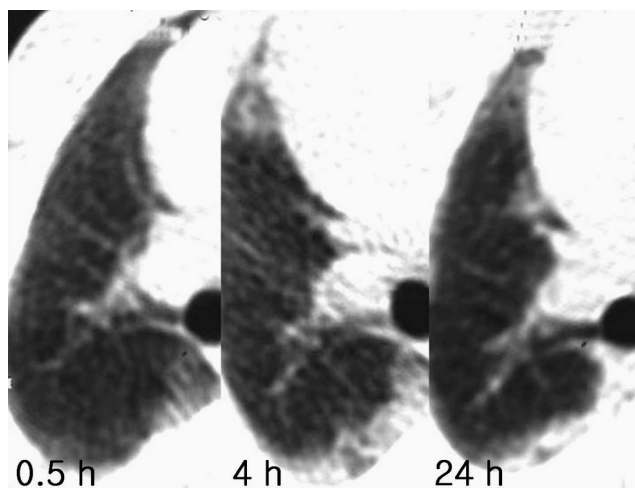


Fig. 3. The CT findings of a group II rabbit: At 0.5 hours after 0.2 mL oleic acid injection, the CT scan shows peripheral ill-defined opacities in the right lung. At 4 hours, the CT scans show ground glass opacities and consolidations with an increased extent. At 24 hours, the extent of the consolidation is decreased and the margin of the consolidation is sharper.



A
Fig. 2. CT scan and pathology of the rabbit taken at 0.5 hours after 0.2 mL oleic acid injection (group II).
A. The CT scan shows ill-defined multiple peripheral wedge shaped ground glass opacities with a mild right lung predominance.
B. The pathology shows interstitial edema and congestion with minimal intraalveolar edema (H and E, $\times 200$).

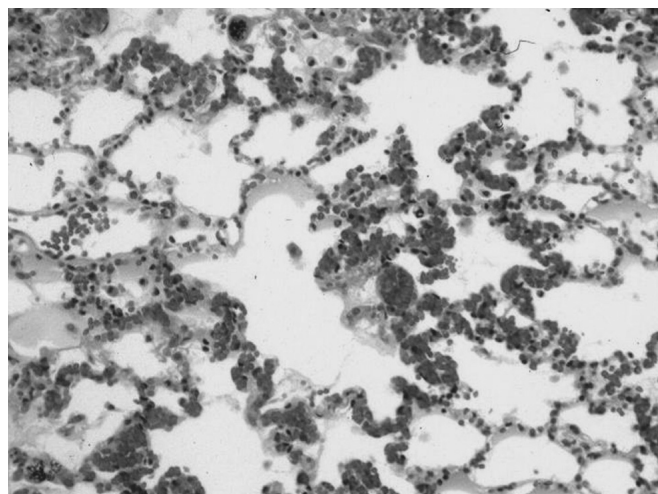


Table 3. Pathologic Findings in Rabbit Lungs Embolized by Intravenous Injection of 0.2 mL Triolein (group I) and 0.2 mL Oleic Acid (group II)

Pathologic findings	Groups		Group I				Group II			
	Hours		0.5	24	48	72	0.5	24	48	72
Interstitial congestion			1	1	1	1	3	-	-	-
Interstitial edema			-	-	1	-	2	-	-	-
Alveolar edema			-	-	2	-	1	2	3	2
Alveolar hemorrhage			-	-	-	-	-	2	2	2
Coagulation necrosis			-	-	-	-	-	2	3	3
Intraalveolar macrophage			-	-	-	-	-	1	2	3
PMN infiltration			-	-	-	-	-	2	2	2
Hyaline membrane			-	-	-	-	-	-	-	1
Fibroblast proliferation			-	-	-	-	-	-	1	3

Note. hours: Time duration between triolein or oleic acid injection and sacrifice

1: mild, 2: moderate, 3: severe

가 (12). 가 가
(biochemical theory)
(catecholamine) 가 1
(chylomicron) 10 - 40
가
(isolated long bone (13, 14).
fracture) 0.5 - 3.5% (pelvic bone 4 , 24 48
fracture) (multiple fracture) 5 - 10%
(lipase) 가
(soft tissue trauma), (9).
(intramedullary nailing)
(liposuction), ,
(1 - 3). 가
Triolein (5).
가 0.5 mL/kg (15), Baker Triolein (1
mL/kg) Oleic Acid (0.07 mL/kg)
(lung compliance),
(arterial oxygen saturation),
(8). Baker Oleic Acid
Triolein
(10). Alastair
(intramedullary nailing) Triolein 1 30 CT 4 CT
(transesophageal echocardiogram) 가 24 CT
(nailing) Oleic Acid
가 (mechanical theory) CT
(11). 가 ($p < 0.01$, Chi - Square
, 10 - 30%),
(fat embolism)
1% 가 (biochemical theory) 가 .

: Triolein Oleic Acid CT
 Triolein CT 24 CT 가
 , ,
 . 100% Oleic CT
 Acid Triolein CT
 Triolein 0.3 mL Christian
 8 Oleic Acid
 . Triolein (19).
 가 가 Oleic Acid 8
 . (fat embolism) Oleic
 Acid 가
 (pulmonary fat embolism syndrome) 8
 , Maruyama
 (20)
 Oleic Acid 가
 Triolein
 가가
 Oleic Acid 25%
 Oleic Acid (decubitus)
 가
 , (anterior neck), (anterior chest),
 Arakawa 6
 5 CT 10 mm
 CT
 (21). Katerina 9 7
 가 . 2
 50% (centrilobular nodule) 2 CT (22).
 가 Hyeneman
 가 CT
 Swan ganz
 가 (16, 17). (23).
 (bronchoalveolar lavage, BAL) Oleic Acid
 (BAL fluid) 가 30%
 2%
 (18).
 (24)
 12
 . Swan ganz catheter CT 12
 가
 CT 89%
 . CT 100% 가 (25).
 , ,
 .
 Triolein 1 (1/8, 12.5%)
 Oleic Acid (100%)
 가
 Oleic Acid 0.2 mL 30 CT
 Oleic Acid CT 가
 , CT

- Oleic Acid CT
- CT CT
- CT Triolein Oleic Acid 가
- CT 가
- Triolein Oleic Acid CT
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 24. 가 가
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Comparison of the CT and Pathologic Findings of Pulmonary Fat Embolism Induced by Triolein and Oleic Acid in Rabbits¹

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Purpose: The aim of this study was to evaluate the CT findings of pulmonary fat embolism syndrome that was induced by triolein and oleic acid, along with its pathologic correlation.

Materials and Methods: 16 rabbits were included in this study. The rabbits in group I ($n=8$) were embolized with 0.2 mL triolein and the rabbits of group II ($n=8$) were embolized with 0.2 mL oleic acid through ear veins. HRCT scans were done prior to embolization and at 0.5, 4, 24, 48 and 72 hours post-embolization. The pathologic correlations were determined at 0.5, 24, 48 and 72 hours.

Results: At 24 hours, one group I rabbit showed abnormal CT findings that were composed of several 2 - 3 mm nodules and multiple ill-defined peripheral ground glass opacities. The pathologic finding of this rabbit at 48 hours was mainly intraalveolar edema. All the group II rabbits ($n=8/8$) showed ill-defined bilateral and peripheral ground glass opacities with ($n=6/8$) or without consolidations ($n=2/8$) on the 0.5 hour CT. All the rabbits ($n=7/7$) showed that the new ground glass opacities and ground glass opacities noted on the 0.5 hour CT were changed into consolidation. The margins of the ground glass opacities and consolidations were more sharpened on the 24 hours CT. All 6 rabbits ($n=6/6$) showed consolidations without ground glass opacities and the margins of the consolidations were more sharpened on the 48 hours CT. There was no significant interval change on the 72 hours CT. The pathologic findings of ground glass opacities were interstitial edema or mild intraalveolar edema. The pathologic findings of consolidation were intraalveolar edema, hemorrhage and coagulation necrosis.

Conclusion: The CT findings after fat embolization using triolein and oleic acid were ill-defined peripheral ground glass opacities with/without consolidations. These findings occurred in only one triolein group with the time lag, but these findings were immediately and extensively seen in all group II rabbits. These CT findings may be important for making a diagnosis of pulmonary fat embolism syndrome.

Index words : Embolism, fat
Embolism, pulmonary
Lung, CT

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