

: CT MR 1

3 2 . 3 .

MR : CT MR CT

: 25 0.5 1 ml/kg 1 .
 CT (n=12), 1 (n=14), 3 (n=10), 1 (n=15), 2 (n= 10), 4
 (n=9), 6 (n=5), 8 (n=6), 10 (n=4), 12 (n=2), 14 (n=3), 16 (n=2)
 . MR
 (n=12), 1 (n=9), 3 (n=9), 1 (n=15), 2 (n=9), 4 (n=11), 6 (n=5), 8
 (n=7), 10 (n=3), 14 (n=3), 16 (n=2)
 . 16 CT MR

: CT -
 2
 가 가 1 . MR T1
 가 가
 . T2

가 . CT
 ,
 CT MR

:
 (1~2) CT MR
 가

Laughlen (2). (1) 1925 (Squalene) (13), 가
 가
 가 가 (3-11). CT (4), MR

(10, 12),

1
 2
 3

1998 9 14

1998 12 15

CT MR 1 (n=14), 3 (n=10), 1 (n=15), 2 (n=10), 4 (n=9), 6 (n=5), 8 (n=6), 10 (n=4), 12 (n=2), 14 (n=3), 16 (n=2) . MR (n=12), 1 (n=9), 3 (n=9), 1 (n=15), 2 (n=9), 4 (n=11), 6 (n=5), 8 (n=7), 10 (n=3), 14 (n=3) 16 (n=2) . CT MR Ketamine HCl 2 mg/kg Xylazine HCl 0.15 ml/kg

2.5-3kg 25

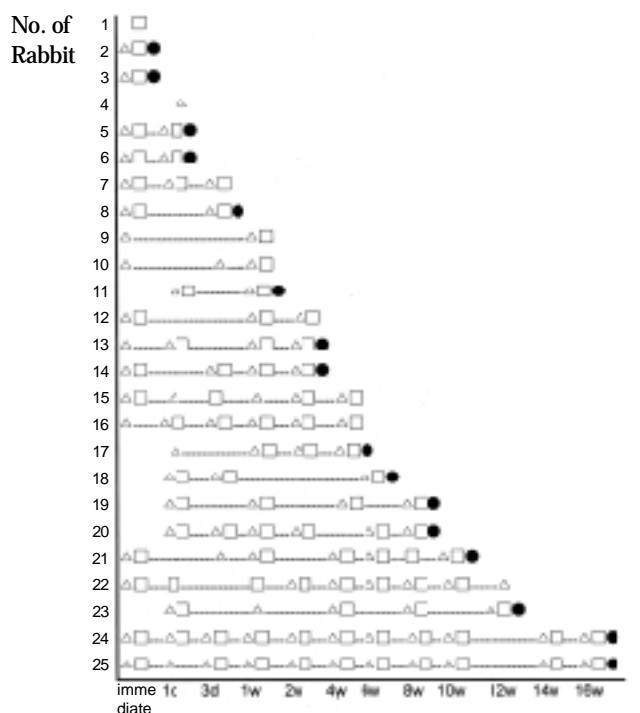
mg/kg Ketamine HCl() 2 1 , 4 , 8 , 16 2 , 3 , 1 , 2 , 6 , 10 ml/kg Xylazine HCl(rompun,) 0.15 , 12 1 16

(guide wire) CT MR Table 1

(株),) 25 6 1 ml/kg , 19 CT CT scan Somatom Plus 40(Siemens, Erlangen, Germany) CT 3 mm , pitch 1 1mm 3mm

CT attenuation MR sig- (ultrahigh-spatial-frequency algorithm) 5 CT CT (lung win- d= day or days w= week or weeks d = CT =MR = sacrifice for pathologic examination

Table 1. Summary of study protocol.



Time interval after endobronchial injection of shark liver oil
d = day or days w = week or weeks
□ = CT ● = MR △ = sacrifice for pathologic examination

450 HU 35 HU CT (ground-glass attenuation), (consolidation), (nodular or linear opacities), (mass-like opacity)

MR 1.5 Tesla Magnetom 63 SP (Siemens, Erlangen, Germany) 4 mm, 4.8 mm, matrix 256 × 184 256 × 144, (excitation) 4 , 14 cm T1 TR = 500 msec, TE = 15 msec , T2 TR = 6000 msec, TE = 90 msec (fat suppression technique) (short tau inversion recovery) T1

T1 , T2 ,
T1 , T2 ,
T2 ,
T2 ,
MR
CT MR
가 가 CT MR
가
10%
hematoxyline & eosin(H & E)
oil red O
24-48
Masson's trichrome

(alveolar
macrophage in alveoli or alveolar walls),
(free oil masses in parenchyma),
(cuboidal metaplasia of alveolar epithelial
cells),
(alveolar
septal widening and inflammatory cell infiltration)

(24)
(+;1/4 , ++;1/4-1/2, +++; 1/2-3/4, +++++;3/4
)

2 가

25 CT MR
23 25 2

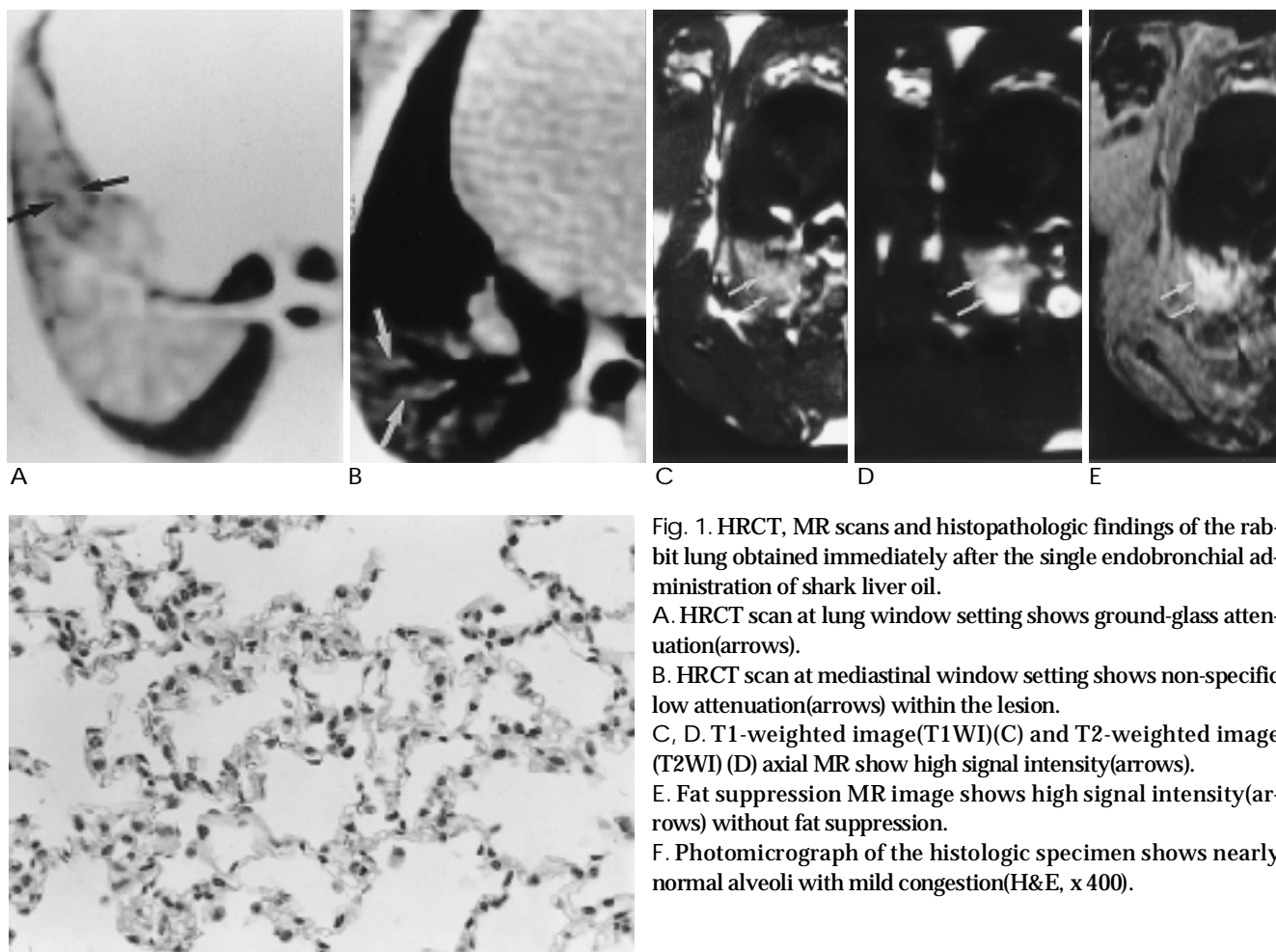


Fig. 1. HRCT, MR scans and histopathologic findings of the rabbit lung obtained immediately after the single endobronchial administration of shark liver oil.

A. HRCT scan at lung window setting shows ground-glass attenuation(arrows).

B. HRCT scan at mediastinal window setting shows non-specific low attenuation(arrows) within the lesion.

C, D. T1-weighted image(T1WI)(C) and T2-weighted image(T2WI) (D) axial MR show high signal intensity(arrows).

E. Fat suppression MR image shows high signal intensity(arrows) without fat suppression.

F. Photomicrograph of the histologic specimen shows nearly normal alveoli with mild congestion(H&E, x 400).

(, 1 , 8 , 16) CT
MR Fig. 1-4 .

CT
-180HU
CT
(Table 2), 17
5 , 4 9 1
, 8 , 12 , 14 1
3 , 1
가 가 , 1-2 가
, 3 (n=4) 10 (n=1), 4
(n=7) 가
(Table 3) , 1 , 3
65%(11/17), 87%(13/14), 70%(7/10)

1 44%(7/15)
, 2
20%(2/10) 12

Table 2. HRCT Findings(Lung window setting) of Exogenous Lipoid Pneumonia in Rabbits(n= 25)

	Ground-glass attenuation	Consolidation	Nodular linear opacity	Mass-like opacity
Immediate(n= 17)	5	12		
1d (n= 14)		14		
3 d (n= 10)		10		
1wk (n= 15)		15		
2wk (n= 10)		10		
4wk (n= 9)		8	1	
6wk (n= 5)		5		
8wk (n= 6)		5		1
10 wk (n= 4)		4		
12 wk (n= 2)		1		1
14 wk (n= 3)		2		1
16 wk (n= 2)		2		

d : day or days wk : week or weeks

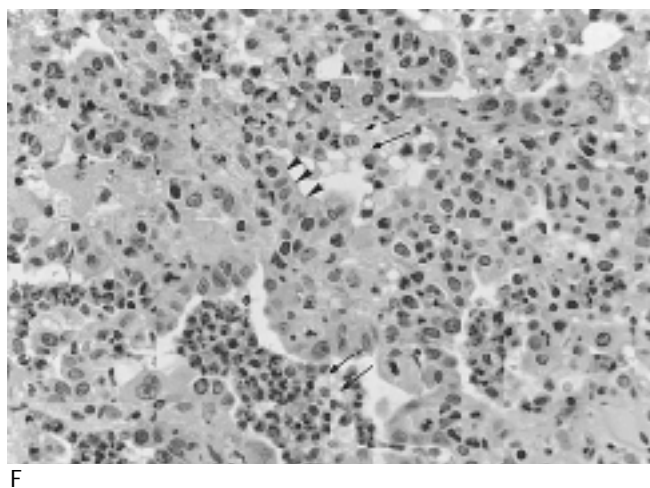
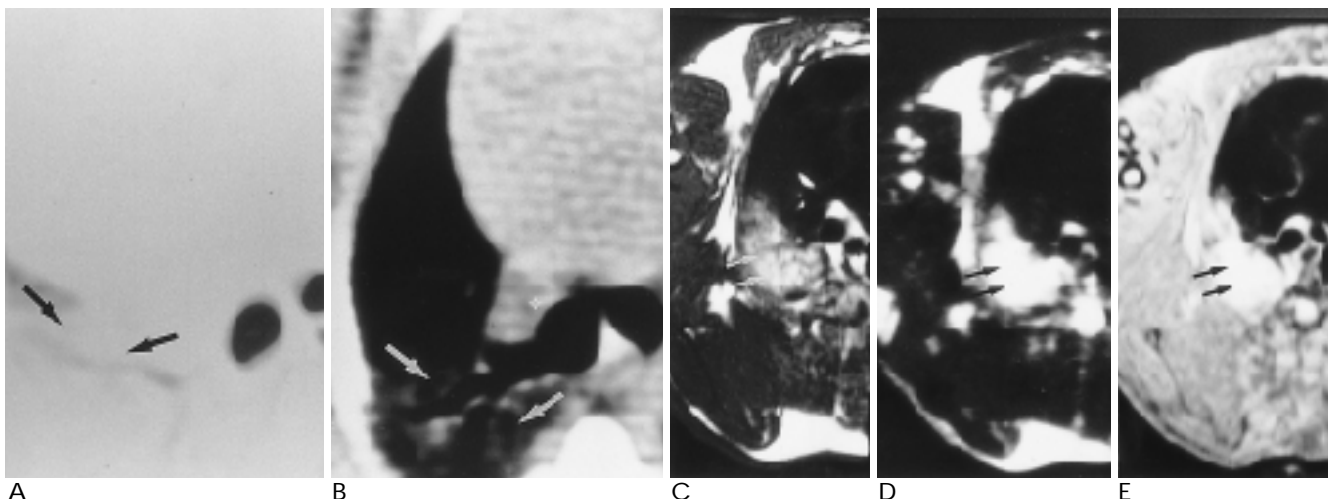


Fig. 2. HRCT, MR scans, and histopathologic finding of the lung with shark liver oil-induced lipoid pneumonia obtained one week after the administration.

A. HRCT scan(lung window setting) shows consolidation with air-bronchogram(arrows) and more increased extent of the lesion as compared with previous films.

B. HRCT scan(mediastinal window setting) shows fat density(-140 HU, arrows) similar to that of subcutaneous fat.

C, D, E. T1WI(C) shows slightly decreased high signal intensity (arrows), T2WI(D) shows high signal intensity(arrows), however, there is no definite fat suppression(E).

F. Photomicrograph shows lipid-laden alveolar macrophages(arrows) within alveoli and alveolar walls(H&E, x 400). The field of lung infiltrated by oil is maximized 1 week after the administration and then decreased thereafter. The cuboidal metaplasia of alveolar lining epithelial cells and alveolar septal widening with inflammatory cell infiltration(arrowheads) are well demonstrated.

가

MR

MR

T1 T2

MR

Table 3. HRCT Findings(Mediastinal window setting) of Exogenous Lipoid Pneumonia in Rabbits(n= 25)

Density	Presence of fat(%)	Non-specific low attenuation	No low attenuation
Immediate(n= 17)	11(65%)	3	3
1d (n= 14)	13(87%)	1	
3d (n= 10)	7(70%)	2	1
1wk (n= 15)	7(44%)	7	1
2wk (n= 10)	2(20%)	7	1
4wk (n= 9)		7	2
6wk (n= 5)		4	1
8wk (n= 6)		4	2
10wk (n= 4)		3	1
12wk (n= 2)		1	1
14wk (n= 3)		2	1
16wk (n= 2)		1	1

Table 4. MR Findings of Exogenous Lipoid Pneumonia in Rabbits(n= 25)

	T1H T2H	T1I T2I	fat T2H	T2I	suppression
Immediate (n= 12)	5	0	1	6	3
1d (n= 9)	4	0	3	2	-
3d (n= 9)	4	0	4	1	-
1wk (n= 15)	5	2	6	2	-
2wk (n= 9)	4	0	4	1	-
4wk (n= 11)	5	0	5	1	-
6wk (n= 5)	2	0	2	1	-
8wk (n= 7)	4	0	2	1	-
10wk (n= 3)	1	0	1	1	-
14wk (n= 3)		0	3	1	-
16wk (n= 2)		0	2	1	-

T1 high signal intensity(H) >>> muscle, < fat
T1 intermediate signal intensity(I) > muscle, <<< fat
T2 high signal intensity(H) = water, fluid
T2 intermediate signal intensity(I) > muscle, <<< water

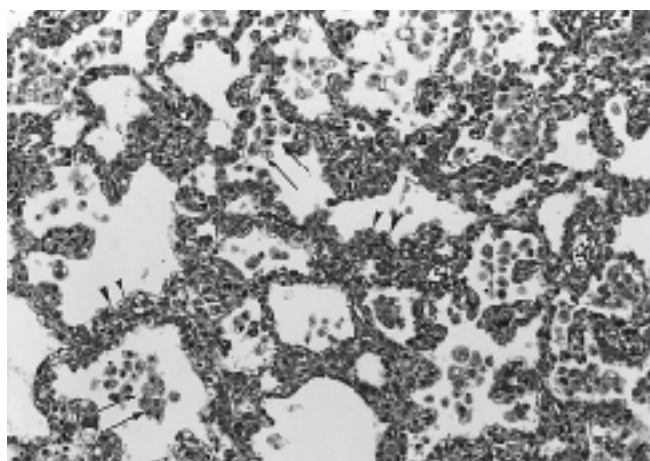
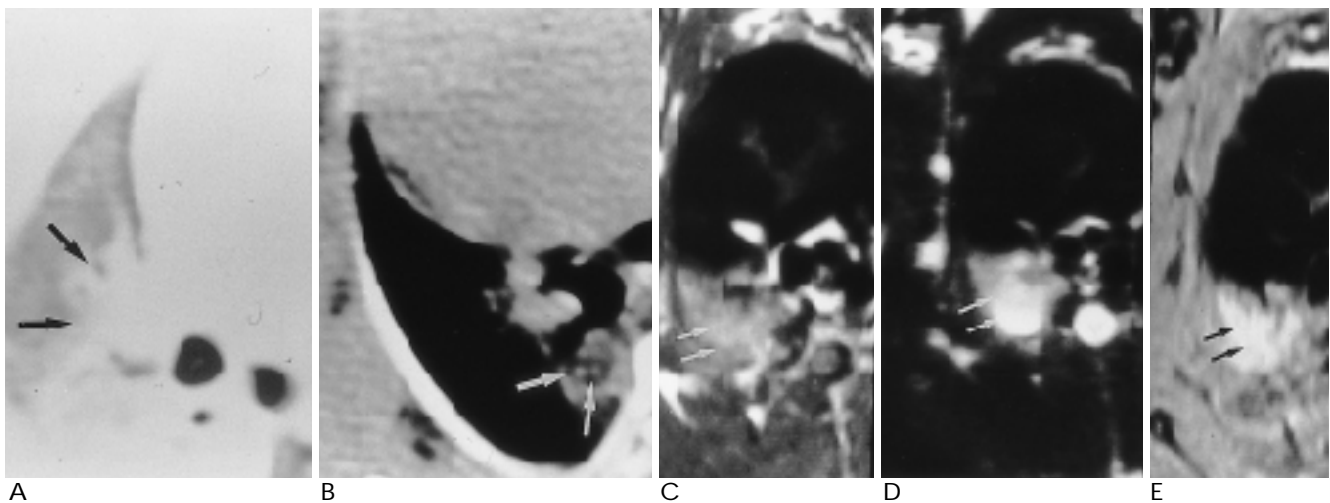


Fig. 3. HRCT, MR scans, and histopathologic finding of the lung with shark liver oil-induced lipoid pneumonia obtained eight weeks after the administration.

A. HRCT scan(lung window setting) shows more decreased extent of the consolidation(arrows).

B. HRCT scan(mediastinal window setting) shows non-specific low attenuation(arrows).

C, D, E. T1WI(C) shows intermediate signal intensity(arrow), T2WI(D) shows high signal intensity(arrows) and there is no fat suppression(E).

F. The lipid-laden alveolar macrophages(arrows), the cuboidal metaplasia of alveolar epithelial cells, alveolar septal widening with inflammatory cell infiltration(arrowheads) are more decreased in number, degree, and extent(Masson's trichrome stain, x 200).

가 T1 T1 T1 3 (n=1) 가

(Table 4). T2 , 10 T1

1 T1 6 2

T2 3

MR

, T1 가

16

Table 5

(n=2) 가 6 1

10 (n=1)

1 (n=2)

12 (n=1), 16 (n=2) 10

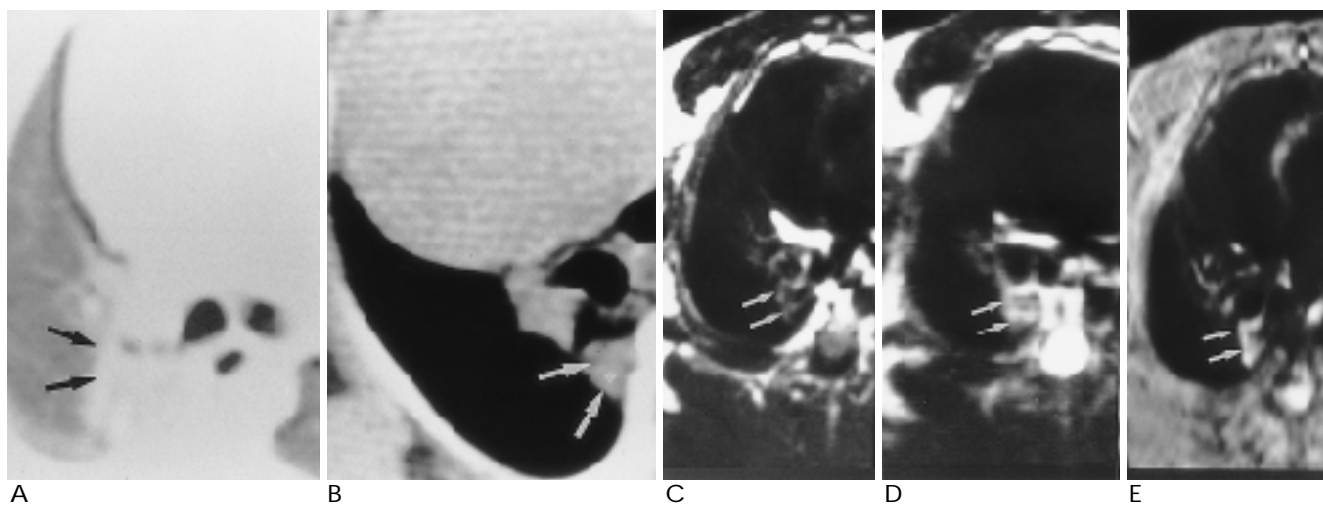


Fig. 4. HRCT, MR scans, and histopathologic findings of the lung with shark liver oil-induced lipoid pneumonia obtained sixteen weeks after the administration.

A. HRCT scan(lung window setting) shows more decreased extent of the consolidation(arrows).

B. HRCT scan(mediastinal window setting) shows no low attenuation(arrows).

C, D, E. T1WI(C) shows intermediate signal intensity(arrows), T2WI(D) shows high signal intensity(arrows) with markedly decreased extent of the lesion and there is no fat suppression(E).

F. The lipid-laden alveolar macrophages(arrows) remain within alveoli.

The cuboidal metaplasia of alveolar epithelial cells, alveolar septal widening with cell infiltration(arrowheads) are more decreased in the degree and extent(H&E, x 200).

가

4 1 8
 , 3 , 1 , 2 , 4 1

25 9 가
 1 2 2 , 4 2 , 2 , 3 1 , 1 (1).
 1925 Laughlen

(2).

CT, MR

CT

(mineral oil)

가

(14).

1 16

가

가

1 8, 12, 14

(1, 15, 16).

CT

가

가

1 65~87% , T1 (16, 17).

MR

2

가

3 1

(11).

Table 5. Pathologic Features of Exogenous Lipoid Pneumonia in Rabbits(n= 16)

No		Lipid-laden AM	Free oil mass	Cuboidal metaplasia of AE	Av septal widening & cell infiltration
1	Immediate	-	+	-	-
2	Immediate	-	+	-	-
3	1d	++++	+	++	++
4	1d	++++	+	++	+++
5	3d	++++	oil space	++++	++++
6	1wk	++++	oil space	++	+++
7	2wk	++++	oil space	++	+++
8	4wk	+++	oil space	-	++
9	4wk	+++	+	++++	++
10	6wk	++++	-	-	+++
11	8wk	+++	-	-	+
12	8wk	+	+	+	-
13	10wk	+	-	+	+
14	12wk	+	-	-	+
15	16wk	+	-	+	+
16	16wk	++	-	-	+

AM= alveolar macrophages, AE= alveolar epithelial cells, Av= alveolar or alveoli

*Grading : + < 1/4 of lung field

++ 1/4-1/2

+++ 1/2-3/4

++++ > 3/4

1 ml 1
T1 T2
(1)
가
(10, 12)가 T1
CT 가 -150 -60 HU
(4, 8, 18, 19)가
CT HU
(18). MR
가
CT가
(12, 20, 21). (11) MR T1
(-35 -75 HU)
가 가 T1
가 CT T1
가
CT
가
2
MR
(intracellular)
(extracellular) MR
(free)
(4) CT 6 MR 가
3 , 1 가 CT
2 , 가
(11) T1
9 CT , T1 가
8 , 가
가 4 , (23) 가 1
(interlobular septa) 가 6 CT
17 5 16 8 CT
가 20 CT
(23) CT
가
가
가
2 (22) CT MR
가 1 4
kg 0.5
700

가 가 가

HRCT 1 가 8 , 12 , 14 CT 가 가

가 1 kg 0.5 1 ml

. Leung (24) 가 1

29 CT 3 , 13 가 가

, 13

CT 7 1 , 1

, 5

Leung (24)

, HRCT 가,

(11)

(hyaline membrane)

3 (diffuse alveolar damage)

CT

가 . ,

2

가 .

HRCT

(2),

HRCT

(11)

2 , 2

가 .

(25)

CT -

2

가 가 1

가 (24)

MR T1 T2

가 T1 T1

T2

가 .

CT

가 가

1 1 가

- CT MR
- 가
- CT MR
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An Experimental Study of Exogenous Lipoid Pneumonia : Sequential Changes in High-Resolution CT and MR Findings¹

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Purpose : To evaluate sequential changes in high-resolution CT(HRCT) and MR findings of exogenous lipoid pneumonia in rabbits and to compare the radiologic and histopathologic findings.

Materials & Methods : A single endobronchial administration of shark liver oil(0.5 or 1 ml/kg of body weight) was given to 25 rabbits. HRCT scans were obtained immediately(n= 17), at 1 day(n= 14), 3 days(n= 10), 1 week(n= 15), 2 weeks(n= 10), 4 weeks(n= 9), 6 weeks(n= 5), 8 weeks(n= 6), 10 weeks(n= 4), 12 weeks(n= 2), 14 weeks(n= 3), and 16 weeks(n= 2) after administration. Changes in distribution, extent, and attenuation were assessed on HRCT scans. MR scans were obtained immediately(n= 12), at 1 day(n= 9), 3 days(n= 9), 1 week(n= 15), 2 weeks(n= 9), 4 weeks(n= 11), 6 weeks(n= 5), 8 weeks(n= 7), 10 weeks(n= 3), 14 weeks(n= 3), and at 16 weeks(n= 2) after administration. Changes in distribution, extent, and signal intensity were assessed on MR scans. In 16 rabbits, CT and MR findings were compared with histopathologic findings obtained in the same plane.

Results : HRCT findings included consolidation with air-bronchogram, ground-glass attenuation and fat attenuation within the lesion at earlier stages(immediate-2 weeks). The extent of lesions was greatest at 1 week, and was then seen to gradually decrease on follow-up CT scans. T1-weighted MR images(T1WI) showed high or intermediate signal intensity(SI) at earlier stages and intermediate SI at later stages, while T2-weighted MR images(T2WI) showed high SI at both earlier and later stages. Histopathologic correlation showed that ground-glass attenuation and consolidation on HRCT reflected intraalveolar lipid-laden macrophages, cuboidal metaplasia of alveolar epithelial cells, and alveolar septal widening with inflammatory cell infiltration. Maximal infiltration of oil in the lung correlated closely with the peak low-attenuation seen on CT scans and the high signal intensity seen on T1WI.

Conclusion : Shark liver oil-induced exogenous lipoid pneumonia in rabbits is reliably diagnosed by HRCT and MR during earlier stages(1-2 weeks). The absence of fat at later stages cannot exclude for certain a diagnosis of exogenous lipoid pneumonia.

Index words : Animals

Lung, CT

Lung, MR

Lung, aspiration

Pneumonitis, aspiration

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