J. Tokyo Med. Univ., **73**(2) : 137-143, 2015

Utility of chemical shift-MRI for anterior mediastinal mature teratoma

Ryuhei MASUNO[1)], Soichi AKATA[1)], Jinho PARK[1)], Jun MATUBAYASHI[2)], Norihiko IKEDA[3)], Kazuhiro SAITO[1)] and Koichi TOKUUYE[1)]

[1)]Department of Radiology, Tokyo Medical University (R.M., S.A., J.P., K.T. and K.S),
[2)]Department Pathology, Tokyo Medical University (J.M.)
[3)]Department of Surgery, Tokyo Medical University (N.I.).

Abstract

Chemical shift-magnetic resonance imaging (CS-MRI) can detect microscopic fat that cannot be detected by computed tomography (CT) or conventional MRI. The purpose of this study was to investigate whether anterior mediastinal mature teratomas could be identified by CS-MRI. Findings obtained by CT, conventional MRI, and CS-MRI on a total of 29 anterior mediastinal cystic masses resected from 28 patients (9 mature teratomas, 20 other cysts) between November 2005 and August 2012 at the Tokyo Medical University hospital were analyzed retrospectively. All MRI was performed using a 1.5-T system. All patients underwent axial breath-hold dual-echo sequence. The repetition time was 120-138 msec, while echo time was 2.38 (opposed-phase) and 4.76 (in-phase) msec. The signal-intensity index of CS-MRI was obtained for each mass and statistically significant differences determined between two groups (mature teratomas and other cysts). Teratoma was confirmed by a change in signal on CS-MRI in two cases. On the other hand, no change in signal was observed in other types of lesion or the remaining teratomas. The Mann-Whitney U-test revealed a statistically significant difference between the two groups (mature teratomas and other cysts, $P = 0.039 < 0.05$). If the anterior mediastinal cystic mass has a signal-intensity index of greater than 20% on CS-MRI, a mature teratoma should be diagnosed, even when CT and conventional MRI findings are indeterminate.

Introduction

Although most teratomas are benign, malignant transformation does sometimes occur. Both benign and malignant teratomas may grow and rupture or fistulize with adjacent structures in the mediastinum, or with the lung, pleura or pericardium[1)]. Most mature cystic teratomas show significantly low density in computed tomography (CT) as they usually contain fat. On magnetic resonance imaging (MRI), mature cystic teratomas are seen with high signal intensities in both T1-weighed and T2-weighted images[2)3)]. However, it may be difficult to detect the fat component in some teratomas by CT or conventional MRI. Furthermore, Moeller et al.[4)] reported that almost 30% of teratomas do not exhibit fat on CT or MRI.

Chemical shift-MRI (CS-MRI) can be used to detect microscopic fat that cannot be detected by CT or conventional MRI. Therefore, we evaluated whether anterior mediastinal mature teratomas could be identified by CS-MRI.

Materials and Methods

Findings obtained by CT, conventional MRI, and CS-MRI on a total of 29 anterior mediastinal cystic masses resected from 28 patients (9 mature teratomas, 20 other cysts) between November 2005 and August 2012 at the Tokyo Medical University hospital were analyzed retro-

Received November, 18, 2014, Accepted January 14, 2015
Key words : chemical shift imaging, MRI, mature teratoma, mediastinal tumor
Corresponding author : Ryuhei Masuno, Department of Pathology, Tokyo Medical University, 6-7-1 Nishi-shinjuku, Shinjuku-ku, Tokyo 160-0023 Japan
TEL : +81-3-3342-6111 Ext. 5818 FAX : +81-3-3348-6314 E-mail : weiscruits@yahoo.co.jp

spectively. All lesions were confirmed pathologically. Four tumors clearly containing fat based on CT and conventional MRI were excluded. Therefore, a total of 25 cases (5 mature teratomas and 20 other cysts) were included in the analysis. All MRI was performed using a 1.5-T system. All patients underwent axial breath-hold dual-echo sequence. The repetition time range was 120-138 msec, while echo time was 2.38 (opposed-phase) and 4.76 (in-phase) msec. The signal-intensity index (SII) on CS-MRI was obtained for each mass. The SII was calculated as follows : $[(SI_{in}-SI_{opp}) / (SI_{in})] \times 100$, where SI_{in} is the tumor signal intensity on in-phase images and SI_{opp} is the tumor signal intensity on opposed-phase images. Mature teratomas were diagnosed when the mass had an SII of greater than 20%. The Mann-Whitney U-test was used to determine the statistical significance of differences in SII values between the two groups (mature teratomas and other cysts). A *P*-value of less than 0.05 was considered to indicate a statistically significant difference.

Results

Two of the 5 teratomas showed high SII values, indicating true positive. The 20 other cysts were all true negative. The specificities and positive predictive value for diagnosing a mature teratoma using SII were 100%. Furthermore, the negative predictive value was 87%. These values are very significant (Table 1). The Mann-Whitney U-test revealed a significant difference between the two groups (mature teratomas and other cysts, $P=0.039<0.05$). Figures 1 and 2 show that a change in signal by a chemical shift was confirmed in two of the teratomas. A slight reduction in signal was observed in one case, and a clear reduction in another. On the other hand, no change in signal was observed in the other types of tumor (Figure 3) or in the remaining teratomas (Figure 4).

Discussion

Primary germ cell tumors (GCT) of the mediastinum are relatively rare and represent approximately 10%-15% of mediastinal tumors[1]. Mediastinal GCTs are generally found in adolescents and young adults. Approximately 80% of such lesions are benign, and most of these benign lesions represent teratomas[5]. Fat or calcification is characteristic of teratoma, but differentiation becomes difficult when they cannot be identified.

Chemical shift-MRI is much more sensitive than other fat-suppressed MR sequences in detecting microscopic fat within tissue because it relies on unique differences in resonance frequency between protons in water and those in triglyceride molecules[6]. Chemical shift-MRI has already been advocated as a method to establish the diagnosis of adrenal adenoma, which contains various amounts of fat tissue, and to identify thymic tissue and hyperplastic thymus in early adulthood[7]. However, the usefulness of CS-MRI for diagnosis of teratomas has not yet been reported. Therefore, we investigated whether CS-MRI was useful in the diagnosis of teratomas. Since we demonstrated a statistically significant difference between two groups of mature teratomas and other cysts, we concluded that CS-MRI was useful in diagnosing teratomas. In this series of cases, two of the teratomas produced a change in signal in chemical shift images. However, no fat component was clearly confirmed in either case. Reaction may occur to foreign matter such as hair or horn-like material, or even fat leaked from neutrophils. Although thymoma and teratoma, which do not exhibit any change in signal in chemical shift imaging, also exhibit foreign matter reaction, this does not necessarily indicate leakage of fat from neutrophils. Such a foreign matter reaction is more likely to occur in teratomas than in other types of tumor. Furthermore, if the tumor also contains hair or dirt, such a reaction may be stronger. Thus, differences may be observed in findings on chemical shift images.

Some teratomas may also exhibit malignant transformation, and both benign and malignant teratomas may grow and rupture or fistulize with adjacent structures in the mediastinum, or with the lung, pleura, or pericardium. Therefore, we believe that CS-MRI may be clinically useful in diagnosing cystic mature teratomas.

Conclusion

If the anterior mediastinal cystic mass has a SII of greater than 20% on CS-MRI, a mature teratoma should be diagnosed, even when CT and conventional MRI findings are indeterminate.

Table 1. Results of analysis of signal-intensity index

Sensitivity	40% (2/5)
Specificity	100% (20/20)
Positive Predictive Value	100% (2/2)
Negative Predictive Value	87% (20/23)

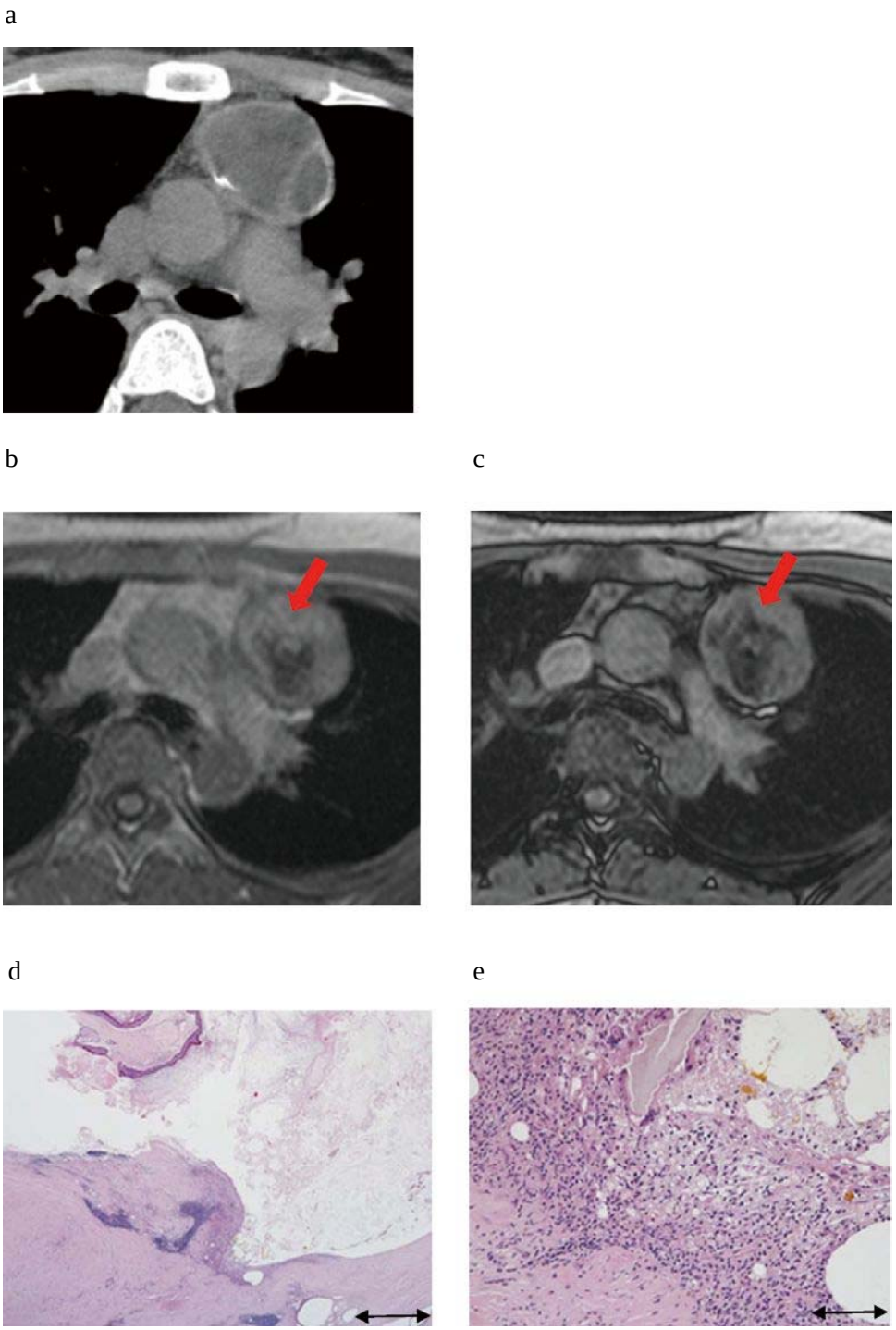


Figure 1.
Mature teratoma in 29 year-old woman.
a : CT revealed cystic tumor with capsule and septum in anterior mediastinum. There was calcification, but no fat was shown.
b : MRI in phase c : opposed phase
Signal intensity (arrow) showed a reduction during opposed phase. (SI_{in} =227, SI_{opp} =97, Signal intensity index=57.3). True Positive.
d : Low-power photomicrograph (original magnification, ×2 ; hematoxylin-eosin [H-E] stain) revealed cyst wall, skin component, sebaceous glands, and secretion. It was difficult to confirm fat component. (scale : 1,000 μm)
e : High-power photomicrograph (original magnification, ×10 ; hematoxylin-eosin [H-E] stain) revealed foam cells and polykaryocytes. (scale : 200 μm)

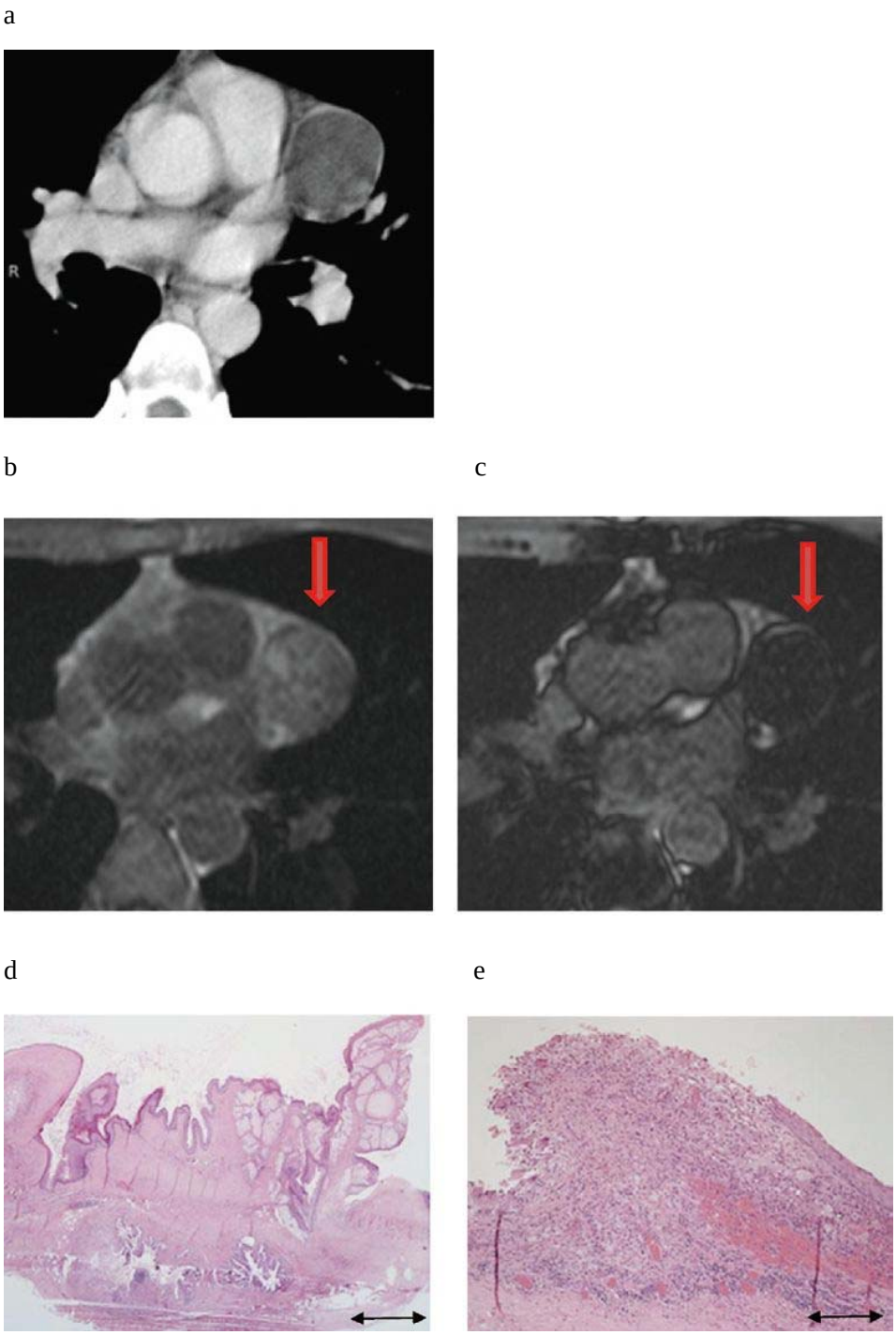


Figure 2.
Mature teratoma in 37 year-old woman.
a : CT revealed cystic tumor with capsule. Neither calcification nor fat was shown.
b : MR imaging in phase c : opposed phase
Signal intensity (arrow) showed a reduction during opposed phase. (SI_{in} =179, SI_{opp} =35, Signal intensity index =80.4). True Positive.
d : Low-power photomicrograph (original magnification, ×2 ; hematoxylin-eosin [H-E] stain) revealed that wall of tumor mainly comprised mature skin and that cysts were lined with ciliated columnar epithelium, suggesting presence of bronchi. In this case, too, it was difficult to confirm fat component in tumor. (scale : 1,000 μm)
e : High-power photomicrograph (original magnification, ×10 ; hematoxylin-eosin [H-E] stain) of part of tumor revealed peeling of skin, foam cells, and polykaryocytes, indicating that foreign body reaction had occurred. (scale : 200 μm)

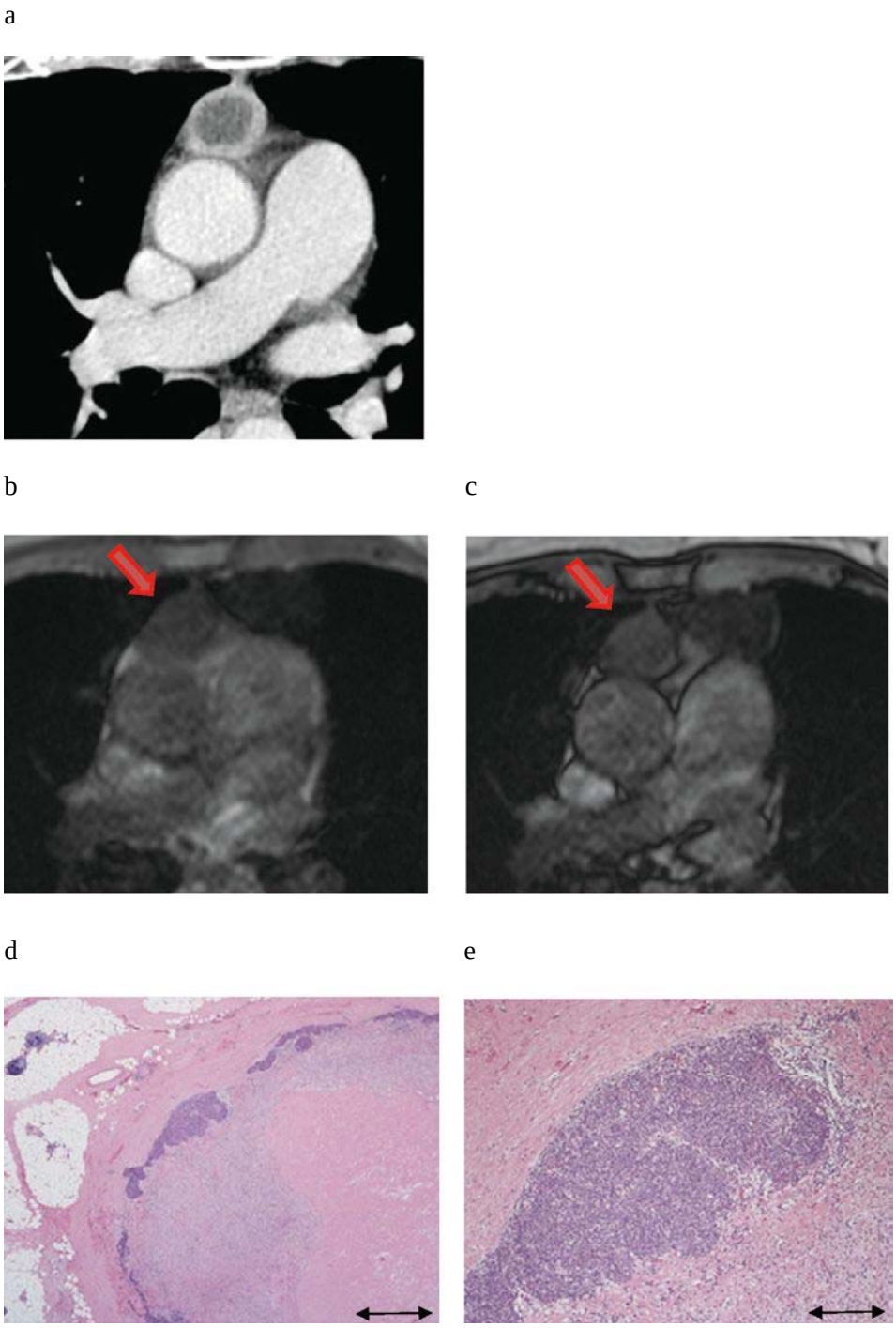
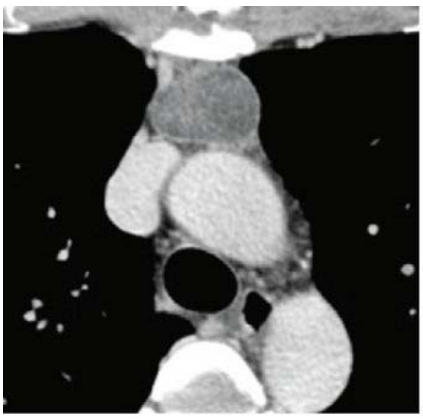


Figure 3.
Thymoma (arrow) in 58 year-old woman.
a : CT revealed cystic tumor with capsule. Neither calcification nor fat was shown.
b : MR imaging in phase c : opposed phase
In this case, decline in signal intensity of tumor during opposed phase was weak. (SI_{in} =129, SI_{opp} =133, Signal intensity index =-3.1). True Negative.
d : Low-power photomicrograph (original magnification, ×2 ; hematoxylin-eosin [H-E] stain) revealed necrosis of tumor center, around which was an accumulation of foam cells. Fat component was obscure. (scale : 1,000 μm)
e : High-power photomicrograph (original magnification, ×10 ; hematoxylin-eosin [H-E] stain) of part of tumor. Component of viable thymoma can be observed on exterior of tumor. Again, foam cells were observed around area of necrosis. (scale : 200 μm)

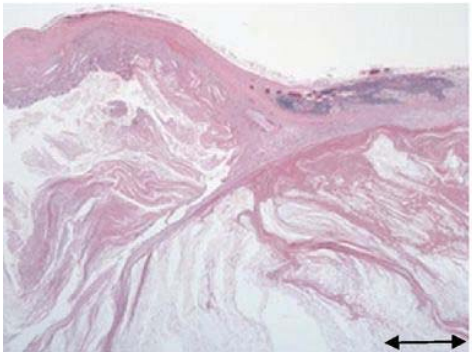
a



b

c

d



e

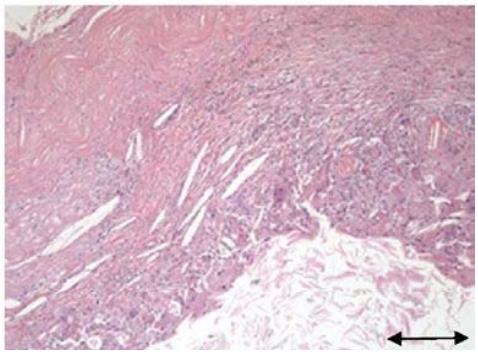


Figure 4.

Mature teratoma in 26 year-old man.

a : CT revealed cystic tumor with capsule. High density area suggested calcification. No fat was shown.

b : MR imaging in phase c : opposed phase

Also in this case, decline in signal intensity of tumor during opposed phase was weak. (SI_{in} =110, SI_{opp} =105, Signal intensity index =4.5). False Negative.

d : Low-power photomicrograph (original magnification, ×2 ; hematoxylin-eosin [H-E] stain) revealed that cyst was filled with keratin. Epithelial content was lower. (scale : 1,000 μm)

e : High-power photomicrograph (original magnification, ×10 ; hematoxylin-eosin [H-E] stain) of part of tumor. Cholesterol cleft, and around that, granulation tissue involving macrophages and accumulated giant cells were observed. (scale : 200 μm)

References

1) Takeda S, Miyoshi S, Ohta M, Minami M, Masaoka A, Matsuda H : Primary Germ Cell Tumors in the Mediastinum. CANCER **97** : 367-376, 2003
2) E. Quint L : Imaging of anterior mediastinal masses. Cancer Imaging **7** : S56-S62, 2007
3) Takagi H, Ichigo S, Murase T, Ikeda T, Imai A : Early diagnosis of malignant-transformed ovarian mature cystic teratoma : fat-suppressed MRI findings. Journal of Gynecologic Oncology **23** : 125-128, 2012
4) Ueno T, Tanaka Y, Nagata M, Tsunoda H, Anno I, Ishikawa S, Kawai K, Itai Y : Spectrum of Germ Cell Tumors : From Head to Toe. RadioGraphics **24** : 387-404, 2004
5) Moeller KH, Rosado-de-Christenson ML, Templeton PA : Mediastinal mature teratoma : imaging features. AJR **169** : 985-990, 1997
6) Inaoka T, Takahashi K, Mineta M, Yamada T, Shuke N, Okizaki A, Nagasawa K, Sugimori H, Aburano T : Thymic Hyperplasia and Thymus Gland Tumors : Differentiation with Chemical Shift MR Imaging. Radiology **243** : 869-876, 2007
7) Takahashi K, Inaoka T, Murakami N, Hirota H, Iwata K, Nagasawa K, Yamada T, ki Mineta M, Aburano T : Characterization of the Normal and Hyperplastic Thymus on Chemical-Shift MR Imaging. AJR **180** : 1265-1269, 2003

前縦隔成熟奇形腫に対する Chemical shift MRI の有用性

桝野龍平[1)] 赤田壮市[1)] 朴辰浩[1)]
松林純[2)] 池田徳彦[3)] 斎藤和博[1)]
徳植公一[1)]

[1)]東京医科大学放射線医学分野
[2)]人体病理学分野
[3)]呼吸器・甲状腺外科学分野

【要旨】 今回の研究の目的は従来の CT や MRI で脂肪や石灰化を認めない、前縦隔の嚢胞状奇形腫に対し、chemical shift-MRI（CS-MRI）を用いてわずかな脂肪成分を検出することにより診断できるか否かを検証することである。

東京医大病院にて 2005 年 11 月から 2012 年 8 月までの間に、手術された 28 例（29 病変）の前縦隔嚢胞状腫瘤のうち、CT・MRI・CS-MRI を撮影されていたものを対象とした。全例とも MRI 検査は 1.5-T system、呼吸停止下の dual-echo sequence で撮影され、繰り返し時間（TR）は 120-138 msec、エコー時間（TE）は 2.38（opposed-phase）と 4.76（in-phase）。腫瘍の CS-MRI における信号強度を測定し、成熟奇形腫とそれ以外の嚢胞とで統計学的な有意差を判定した。2 例の奇形種が CS-MRI において信号の変化が見られ、その他の奇形種および奇形種以外の病変には信号の変化は見られなかった。Mann-Whitney U-test で成熟奇形腫とそれ以外の嚢胞性病変とで統計学的有意差が確認された。（P= 0.039<0.05）前縦隔嚢胞性腫瘍で、CT や従来の MRI にて脂肪や石灰化を検出できなかったとしても、成熟奇形腫とその他の腫瘍の鑑別をするのに CS-MRI は有用である。

〈キーワード〉 chemical shift imaging、MRI、成熟奇形腫、縦隔腫瘍