Updates in MRI characterization of the thymus in myasthenic patients

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Purpose

- The aim of this prospective study is to assess the importance of MRI examination in characterizing thymic lodge in myasthenic patients, especially for differentiating thymic hyperplasia from tumors of the thymus gland, considering that chemical-shift MR imaging with Dual-Echo In-phase/Opposed-phase sequences depicts no decrease in signal intensity of thymic tumors, unlike the decreased in signal intensity of thymic hyperplasia, because thymic tumors do not have a lipidic component included.

Methods and Materials

In the past year, a total of 11 myasthenic patients (4 male, 7 female; age range, 26-65 years), have been investigated by MRI centered at the thymic lodge in the Department of Radiology and Medical Imaging of Fundeni Clinical Institute, Bucharest, Romania.

Patients population. The patients were assigned to two groups: a hyperplasia group consisting of five patients with hyperplastic thymus and a tumor group consisting of six patients with thymoma. We obtain pathologic proof of the diagnosis for all patients in this study.

The mean ages of the patients in the hyperplasia and tumor groups were 31 years ± 5.83 and 52.67 years ± 9.07, respectively. Patients in the hyperplasia group were significantly younger than those in the tumor group ($P = 0.0014$).

MRI technique All MR imaging was performed using a 1.5-T unit (General Electric Medical Systems Genesis Signa). A phased-array coil (Torsopa; GE Medical Systems) was used. In all patients, imaging was performed in the transverse plane.

Chemical-shift images were obtained by using both in-phase and opposed-phase T1-weighted gradient-echo sequences in all subjects. These images were acquired using fast multiplanar spoiled gradient-echo sequences in a single breath-hold of 30-35 sec. TE for the in-phase images was 4.6 msec and for the opposed-phase images, 2.1 msec. Both in-phase and opposed-phase imaging was performed with the following parameters: TR, 155; flip angle, 90°; matrix, 256 × 192; NEX,1; field of view, 40 cm; section thickness, 6 mm with a 1 mm intersection gap; and bandwidth, ± 62.50 kHz. We also performed T1- and T2-weighted FSE RT and fSPGR BH, with and without fat suppression.

MR Image Analysis: Characterization of shape, size, contour and structure of the thymus gland is similar to CT examinations. The current study was focused on the analysis of thymic gland signal intensity and chemical shift ratio (CSR).

The lesion was considered as homogeneous if it was composed of one signal intensity. If the lesion had heterogeneous signal intensity, we used the dominant signal intensity.

The signal intensity of the thymus gland was compared with that of the chest-wall muscle. (1)

For quantitative evaluation we measured the signal intensities of the thymus gland and the chest-wall muscle on both in-phase and opposed-phase images.

Signal intensity measurements of the thymus and the chest-wall muscle were then obtained using standard region-of-interest (ROI) electronic cursors, manually positioned at a slice level of the maximum axial surface of the thymus (area, 0.5-1.5 cm^2 for the thymus gland, respectively 1.1-2.5 cm^2 for the chest-wall muscle).

The chemical shift ratio (CSR), which was determined by comparing the signal intensity of the thymus gland (tSI) with that of the chest-wall muscle (mSI) on both in phase (in) and opposed-phase (op) images, was calculated by using the following equation (1,2): CSR = (tSIop/mSIop)/(tSIin/mSIin). Fig. 1 on page 3

Images for this section:

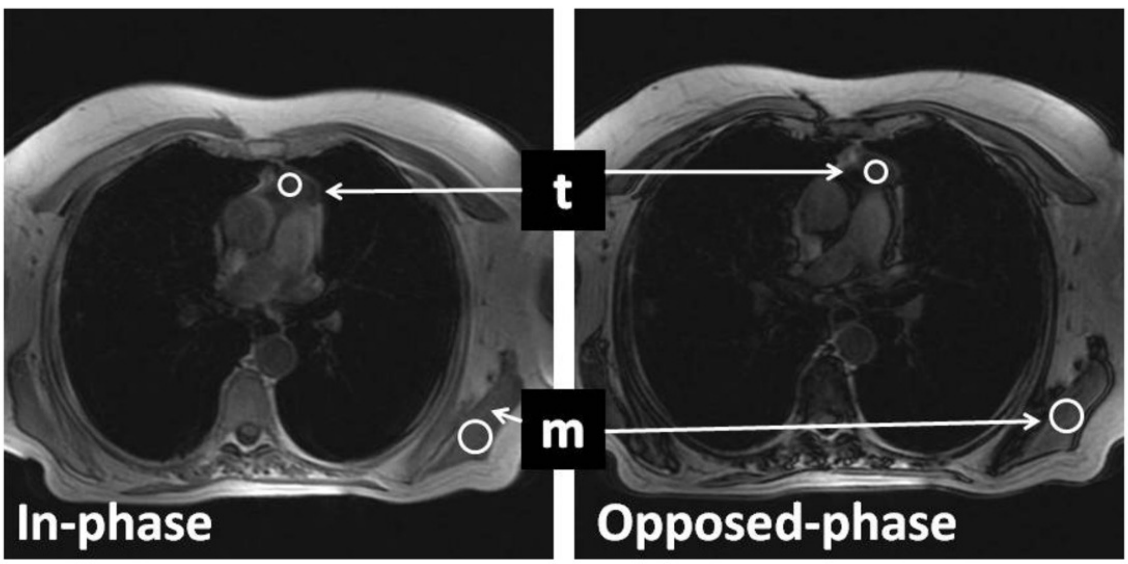

Fig. 1: Signal intensity measurements of the thymus (t) and the chest-wall muscle (m) is obtained using standard region-of-interest (ROI) electronic cursors, manually positioned. The chemical shift ratio (CSR), which was determined by comparing the signal intensity of the thymus gland (tSI) with that of the chest-wall muscle (mSI) on both in phase (in) and opposed-phase (op) images, was calculated by using the following equation (1,5): CSR = (tSIop/mSIop)/(tSIin/mSIin).

Results

Results:

- In the ***hyperplasia group***, the thymus gland showed diffuse enlargement without lobulation, and a homogeneous decrease in the signal intensity of the thymus gland on the opposed-phase image relative to the in-phase image in all patients. Fig. 2 on page 5 Fig. 3 on page 6

- In the ***tumor group***, the thymus gland was round or had an irregular shape with no signal intensity loss in the thymus gland on the opposed-phase image relative to the in-phase image in any patients. Fig. 4 on page 6 Fig. 5 on page 7

The CSR values are expressed as means ± standard deviations for the two groups. To test between group differences (the hyperplasia group and the tumor group), the t test for unequal variance (Welch t test) was performed. The mean CSR was 0,4964 ± 0,1841 in the hyperplasia group and 1,0398 ± 0,0244 in the tumor group. Statistically significant differences were seen between the hyperplasia and tumor groups (P=0,0028); there was no overlap in range. Fig. 6 on page 7

Discussion:

- The thymus achieves its maximal weight between 12 and 19 years; between 20 and 60 years, regression in size occurs, together with replacement by adipose (3).
- Therefore, the normal thymus contains various amounts of fat tissue, depending on age. The percentage of the total weight of the thymus that is fat tissue is nearly 20% in the first decade of life and increases during the second decade, reaching 40% late in the second decade (2, 4).
- Moore et al reported that no distinct difference in the extent of fat replacement in the thymus was observed on CT between groups with normal thymic histology and those with microscopic hyperplasia in patients with myasthenia gravis (MG) (2, 5).
- Chemical shift MR imaging is much more sensitive than other fat-suppressed MR sequences for detecting microscopic fat within tissue because it relies on the unique difference in resonance frequency between protons in water and those in triglyceride molecules (1, 6, 7). This technique is widely used to diagnose lipid-containing lesions (lipoma, dermoid, teratoma, adrenal adenoma, focal fat within the liver, fatty liver and angiomiolipoma) (7).
- Sometimes, thymoma may show diffuse thymic enlargement at CT, and this can be incorrectly diagnosed as a hyperplastic thymus; in addition, hyperplastic thymus may appear at CT as a soft-tissue mass mimicking thymoma (1). It can be challenging to differentiate hyperplastic thymus from thymoma on the basis of morphologic assessment alone, especially in patients with MG (1, 8, 9).

- Lymphoid thymic hyperplasia is most commonly associated with MG, being seen in up to 65% of cases (10). In patients with thymoma the MG is present or appears in 30-50% of the cases (11).
Currently the thymus is surgically resected in patients with MG because at least an improvement of clinical symptoms due to MG can be obtained, even if there is no associated thymoma (11). Minimal invasive surgical techniques are not recommended in patients with thymic malignancies with high risk of local recurrence (1).
- *Chemical shift MR imaging* can help differentiate between hyperplastic thymus and thymoma according to our study, based on the assessment of the CSR. CSR allows us to perform a quantitative assessment and for this purpose the signal intensity of the thymus gland was compared with that of the chest-wall muscle on both in-phase and opposed-phase images.
- All patients in the hyperplasia group showed an homogeneous decrease in the signal intensity of the thymus gland on the opposed-phase image relative to the in-phase image. None of the patients in the tumor group showed a decrease in signal intensity of the thymus gland at chemical shift MR imaging. In addition, the mean CSR in the hyperplasia group was considerably lower than that in the tumor group, and there was no overlap in range.
- In the literature we found recent data proving the usefulness of chemical shift MR imaging to identify normal and hyperplastic thymus by proving that normal fat infiltration and to differentiate thymic hyperplasia from tumors of the thymus gland in patients with different pathological entities.
- Our study included only patients with myasthenia gravis. An important limit of this study is the small number of patients. It is necessary a larger number of patients to clarify the utility of chemical shift MR imaging for differentiating thymic hyperplasia from tumors of the thymus gland, in myasthenic patients.

Images for this section:

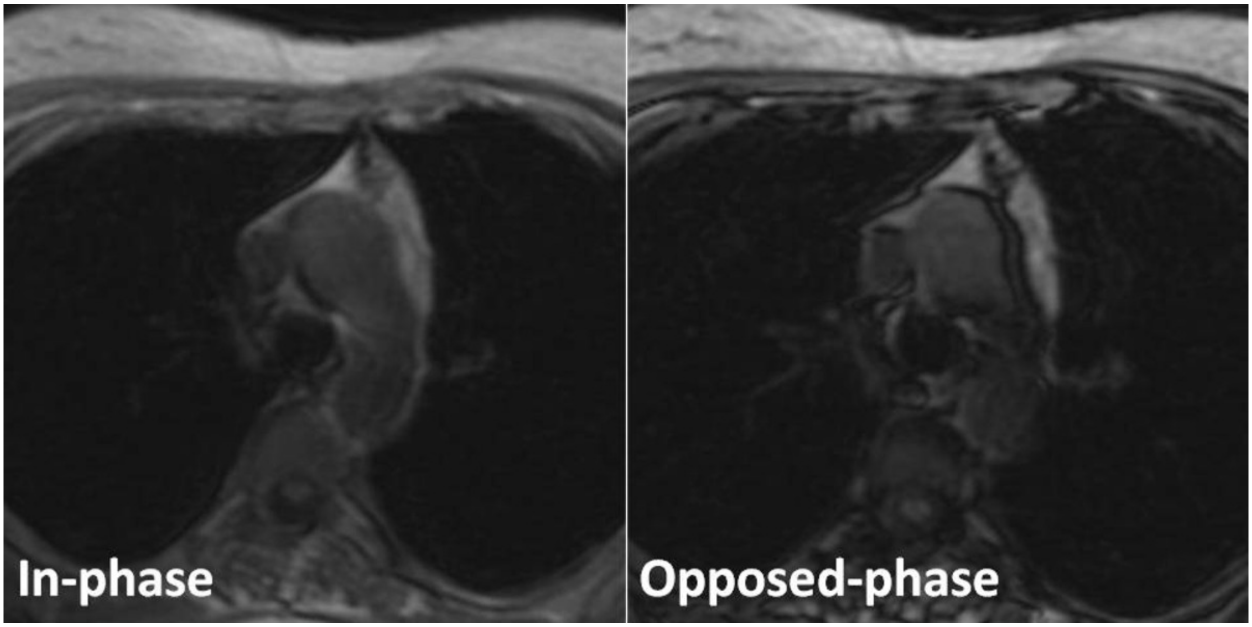

Fig. 2: Thymic hyperplasia in a 40-year-old woman with myasthenia gravis. Transverse in-phase (155/4.6) and opposed-phase (155/2.1) gradient-echo T1-weighted MR images demonstrate an apparent decrease in signal intensity of the thymus gland on the opposed-phase image relative to the in-phase image. The CSR is 0.761.

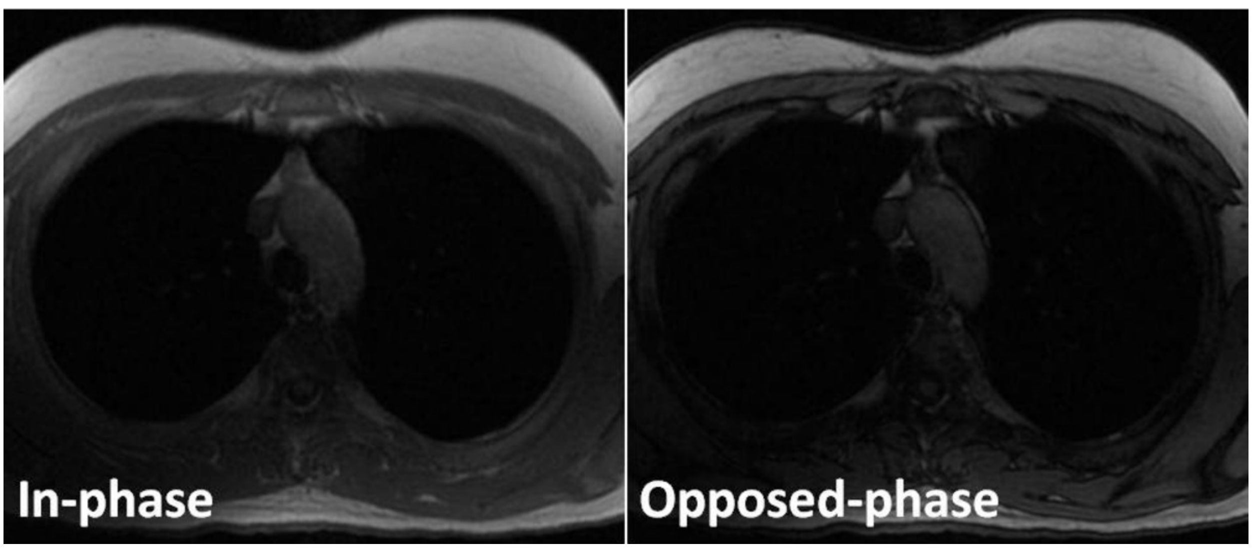

Fig. 3: Thymic hyperplasia in a 26-year-old men with myasthenia gravis. Transverse in-phase (155/4.6) and opposed-phase (155/2.1) gradient-echo T1-weighted MR images demonstrate an apparent decrease in signal intensity of the thymus gland on the opposed-phase image relative to the in-phase image. The CSR is 0.331.

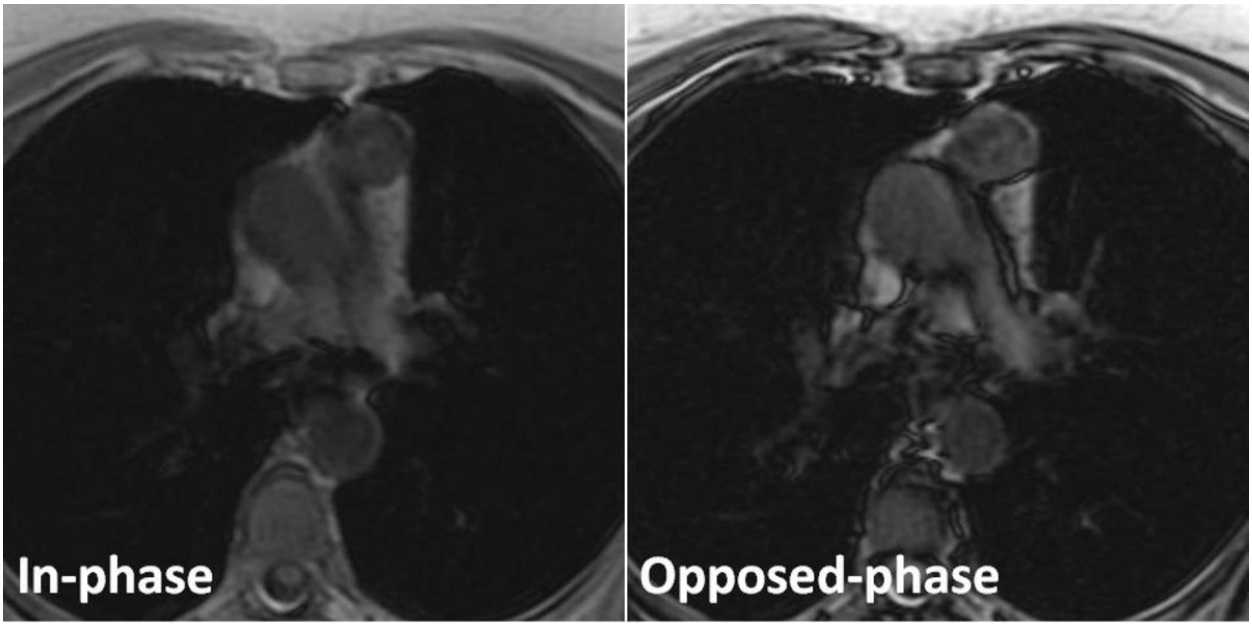

Fig. 4: Thymoma in a 65-year-old woman with myasthenia gravis. Transverse in-phase (155/4.6) and opposed-phase (155/2.1) gradient-echo T1-weighted MR images demonstrate no change in signal intensity of the lesion on the opposed-phase image relative to the in-phase image. The CSR is 1.010.

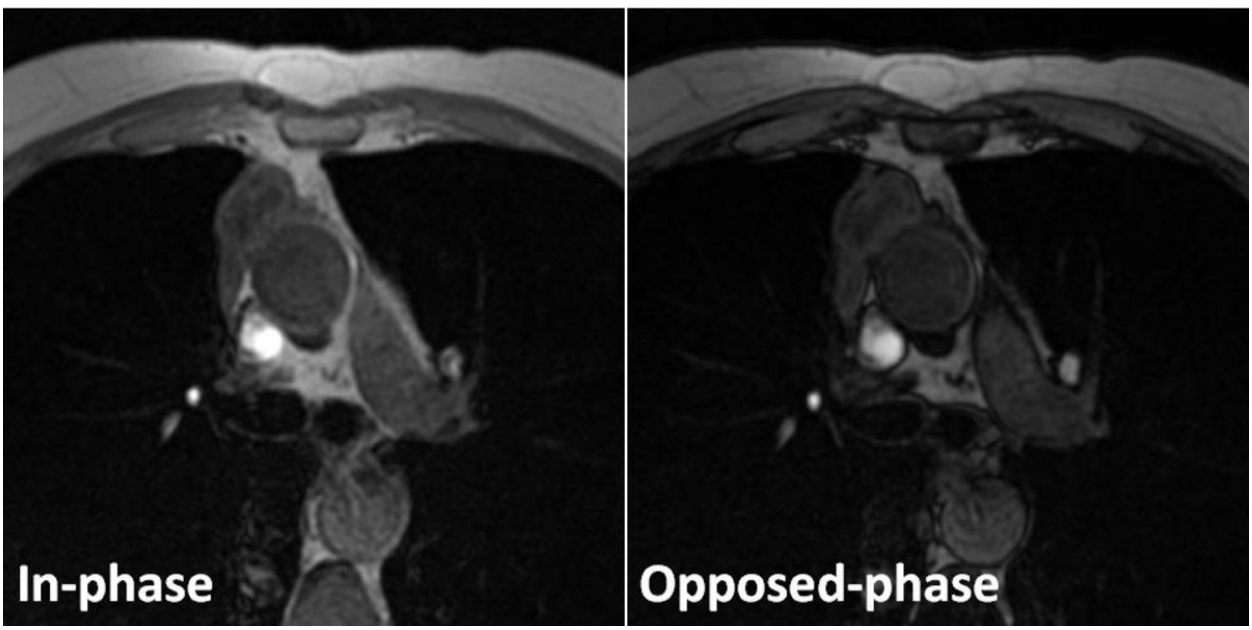

Fig. 5: Thymoma in a 52-year-old men with myasthenia gravis. Transverse in-phase (155/4.6) and opposed-phase (155/2.1) gradient-echo T1-weighted MR images demonstrate no change in signal intensity of the lesion on the opposed-phase image relative to the in-phase image. The CSR is 1.050.

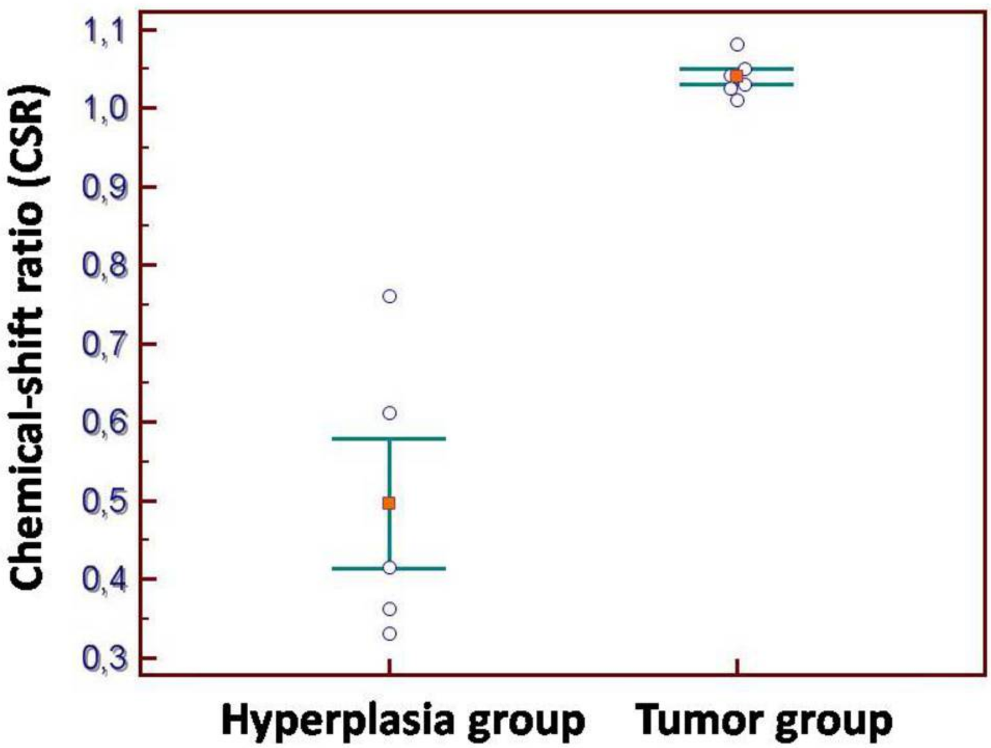

Fig. 6: The CSR values are expressed as means ± standard deviations for the two groups. The mean CSR was 0,4964 ± 0,1841 in the hyperplasia group and 1,0398 ± 0,0244 in the tumor group. Statistically significant differences were seen between the hyperplasia and tumor groups (P=0,0028); there was no overlap in range.

Conclusion

- Occasionally, in the first and second decades of life, when the thymus gland has not been completely replaced by fat tissue, the CT attenuation values and signal intensities on MR imaging of a normal or pathological thymus can overlap.
- Using qualitative comparison and calculating the chemical-shift ratio between in-phase and opposed-phase gradient-echo images, particularly in patients with myasthenia gravis, it is possible to differentiate the hyperplastic thymus from tumors of the thymus gland.

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