Gadolinium-enhanced 3D T1-contrast inversion recovery fast spin-echo imaging on 3T MR system can reduce ambiguous findings in detection of small brain metastases

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Purpose

In evaluation of brain metastases using Gadolinium (Gd)-enhanced magnetic resonance (MR) imaging, elimination of small pseudo-lesions originating from contrast-enhancing vascular structures is crucial for determining accurate numbers of metastases (ref. 1-5). Gd-enhanced inversion recovery fast spin-echo (IR-FSE) imaging does not usually demonstrate contrast enhancement of small vessels with slow flow due to the flow-void phenomenon (ref. 1, 3, 6, 7).

We assessed whether adding Gd-enhanced 3D IR-FSE imaging to Gd-enhanced 2D SE type imaging on a 3T MR system improves diagnostic confidence in the evaluation of brain metastases.

Methods and Materials

Patients: The MR images of five patients with brain metastases of lung cancer (2 women and 3 men; age range, 54-68 years) at onset and after stereotactic radiosurgery (2-9 months follow-up period) were retrospectively evaluated.

MR imaging: All images were acquired with a 3T MR system. The following imaging parameters were used after administration of contrast material: repetition time 450-480 ms, echo time 10 ms, and 3-mm section thickness for 2D SE imaging (Fig. 1a); repetition time 2000 ms, echo time 98 ms, inversion time 780 ms, an echo train length of 43, acquisition volume size 0.96 x 0.96 x 1.20 mm, and imaging time 6 min 34 sec for 3D IR-FSE imaging (Fig. 1b). Gd-enhanced 3D IR-FSE imaging can clearly depict the anatomical location of enhancing lesions due to the high degree of contrast between gray matter and white matter (ref. 7, 8).

Image interpretation: A candidate lesion for metastasis at onset, which included a pseudo-lesion originating from a contrast-enhancing vessel, was defined as an intraparenchymal round or oval enhancement area less than 5 mm in diameter. Two neuroradiologists interpreted the Gd-enhanced 2D SE images and rated the candidate lesions within the cerebral hemispheres using a five-point confidence rating scale (grade 1 = definitely not metastasis; grade 2 = probably not metastasis; grade 3 = indeterminate; grade 4 = probably metastasis; grade 5 = definitely metastasis) by consensus (interpretation 1). After interpretation 1, the Gd-enhanced 3D IR-FSE images (reconstructed to images with 3-mm section thickness matched to the section thickness of the axial 2D SE images) were interpreted. The candidate lesions picked up in interpretation 1 were re-rated (interpretation 2) (ref. 1). Diagnostic confirmation was based on follow-up MR imaging. When a lesion showed no change, a reduction in size,
or disappeared on follow-up Gd-enhanced 2D SE imaging, it was considered a non-metastatic lesion.

**Statistical analysis:** A Wilcoxon matched-pairs signed-rank test was used to analyze whether the grades of the confidence rating scale were improved by the additional information obtained from interpretation 2. P < .01 was considered statistically significant.

**Images for this section:**

![Images showing brain imaging](image_url)

**Fig. 1:** A 54-year-old patient with brain metastases of lung cancer. The signal from enhancing vessels shown on Gd-enhanced 2D SE image (a) is well suppressed on Gd-enhanced 3D IR-FSE image (b). Central gray matter is clearly depicted on the 3D IR-FSE image that provides excellent contrast between gray matter and white matter.
Results

Eighty-six candidate lesions were detected in interpretation 1. 72 lesions were rated into grades 2 - 4 and 67 lesions of this group were re-rated into grade 1 [n = 62; 32 lesions from grade 2, 22 lesions from grade 3, 8 lesions from grade 4], grade 2 (n = 2, 2 lesions from grade 3), or grade 5 [n = 3, one lesion each from grade 2, grade 3, and grade 4] in interpretation 2 (Table 1). The 8 lesions that were re-rated from grade 4 to grade 1 were potentially false-positive findings. The ambiguous findings were attributed to enhancing vessels themselves and ghosts from these vessels (Fig. 2, 3). The difference in the number of grades between interpretation 1 and 2 was statistically significant. Diagnostic confidence was improved by the additional information obtained from interpretation 2.

Images for this section:

Confidence Rating of 67 Re-rated Lesions

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Table 1
Fig. 2: A 68-year-old patient with brain metastases of lung cancer. Gd-enhanced 2D SE image (a) shows a candidate lesion with contrast enhancement in the right occipital lobe (arrow). Gd-enhanced 3D IR-FSE image (b) and follow-up 2D SE image (c) acquired after stereotactic radiosurgery show no abnormal enhancement in the corresponding area. The lesion is considered to be ghost enhancement representing a phase-shift artifact from a vessel (straight sinus). The 3D IR-FSE image shows small nodular enhancing lesions rated as grade 5 after the sessions (arrow-heads in b).
Fig. 3: A 63-year-old patient with brain metastases of lung cancer. Gd-enhanced 2D SE image (a) shows candidate lesions with contrast enhancement (arrows in a). Gd-enhanced 3D IR-FSE image (b) show no abnormal enhancement in the corresponding area. The lesions are considered to be a ghost enhancement representing a phase-shift artifact from the anterior cerebral arteries because follow-up 2D SE image (c) acquired after stereotactic radiosurgery shows contrast enhancement in the different locations from the corresponding areas.
Conclusion

In evaluating brain metastases, Gd-enhanced 3D IR-FSE imaging in combination with Gd-enhanced 2D SE imaging can reduce ambiguous findings, including potential false-positive findings.

References


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