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## Case Report

# Band-like hyperintensity along the ventral surface of the brain stem on FLAIR and DWI in leptomeningeal carcinomatosis of lung adenocarcinoma <sup>☆</sup>

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## ABSTRACT

Since leptomeningeal carcinomatosis is rarely observed before diagnosis of the primary cancer, its detection is often delayed. We report the case of a 60-year-old woman who presented with lung adenocarcinoma with leptomeningeal carcinomatosis. Magnetic resonance imaging showed the characteristic abnormal hyperintensity along the ventral surface of the brain stem on fluid-attenuated inversion recovery and diffusion weighted imaging. It had no contrast uptake. Based on these findings, we were able to make an early diagnosis of leptomeningeal carcinomatosis of lung adenocarcinoma. This condition was resolved after treatment with a tyrosine kinase inhibitor.

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## Introduction

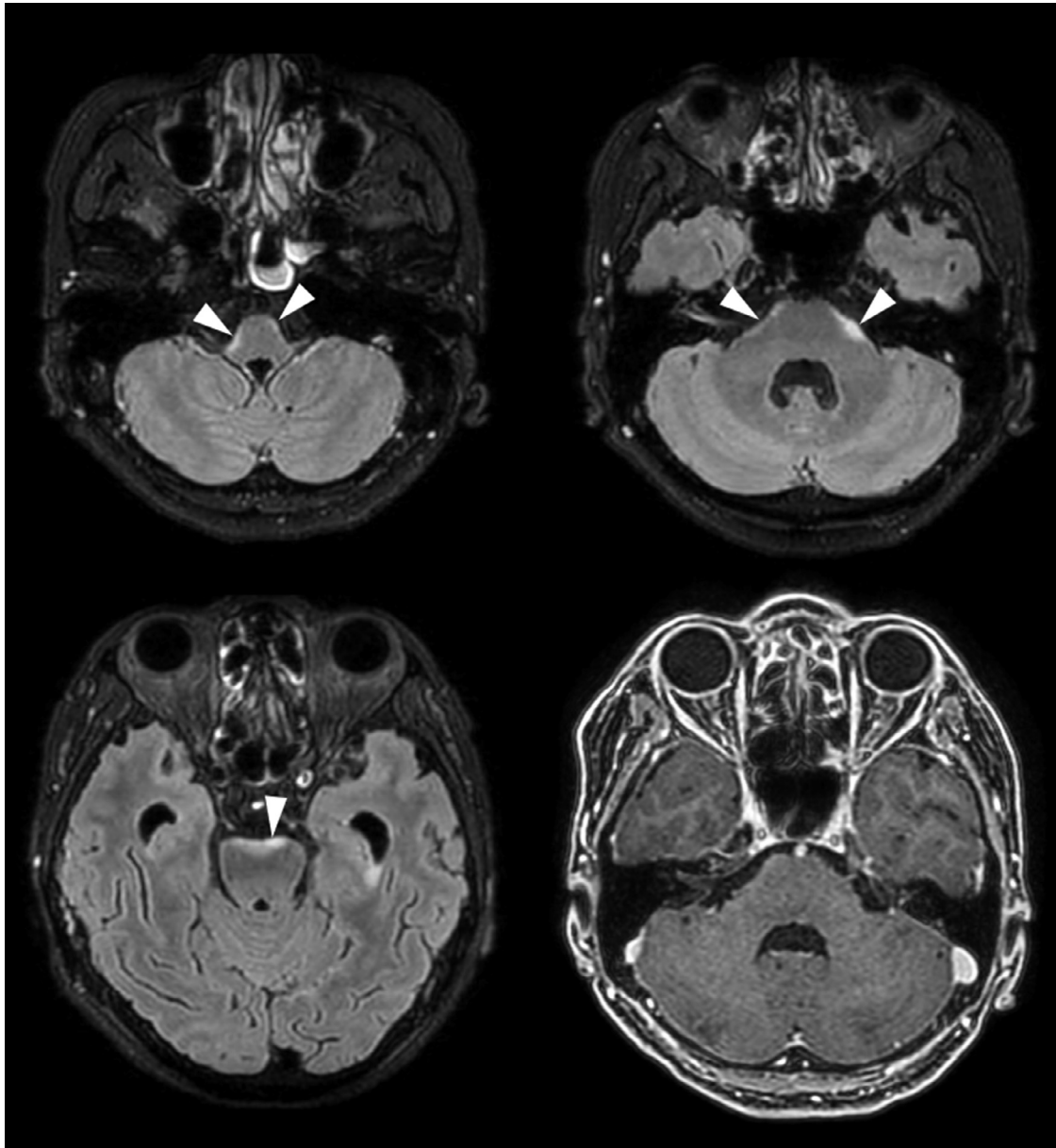
Leptomeningeal carcinomatosis is a condition with poor prognosis; however, with the development of targeted molecular drugs, early diagnosis is becoming increasingly important. Since leptomeningeal carcinomatosis is rarely observed

at the initial presentation, diagnosis is often delayed. Although leptomeningeal carcinomatosis is usually diagnosed by observing an abnormal contrast enhancement along the brain surface [1], there have been several reports of band-like abnormalities along the surface of the brain stem without contrast enhancement especially in patients with lung adenocarcinoma [2–6]. Herein, we report a case of lung adenocar-

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**Fig. 1 – Initial MRI shows band-like hyperintensity along the ventral surface of the brain stem on FLAIR (arrowheads). It did not exhibit contrast enhancement (bottom right)**

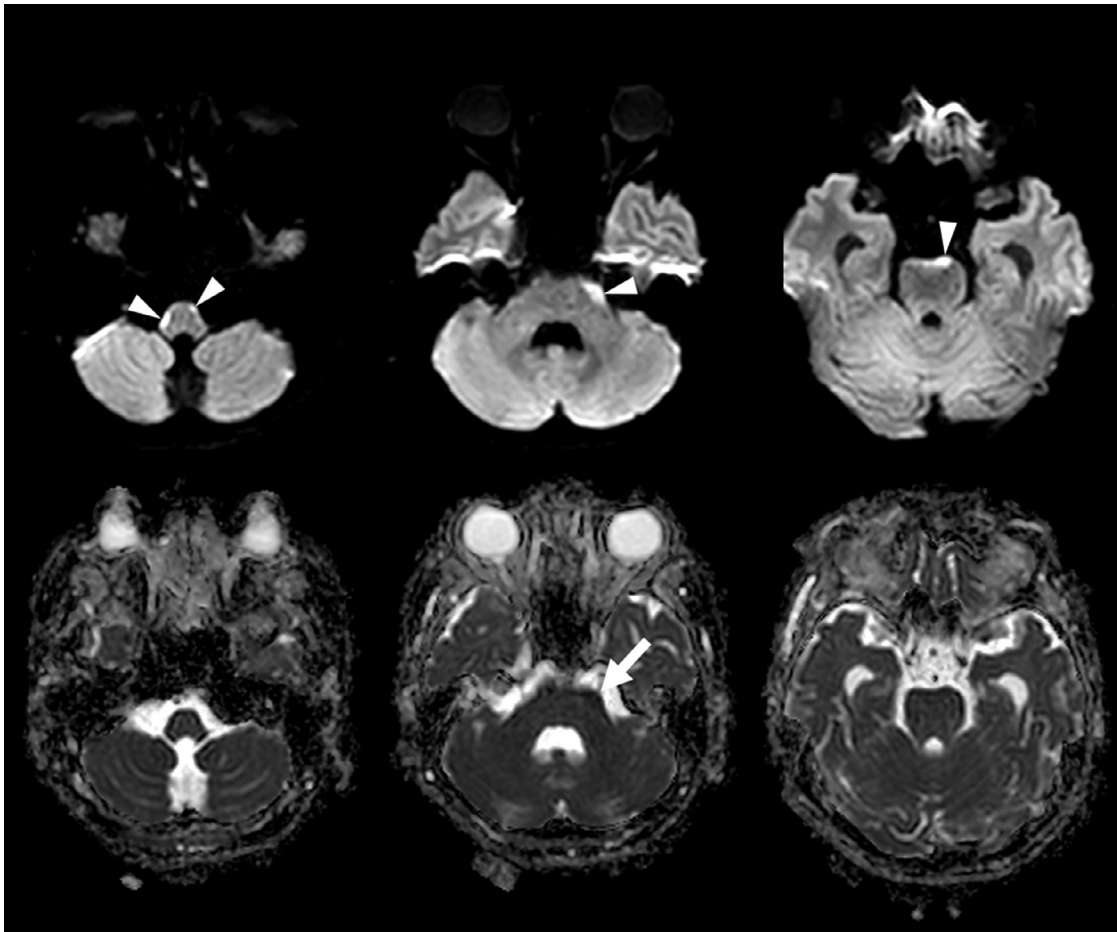
cinoma with leptomeningeal carcinomatosis at initial presentation and characteristic abnormal hyperintensity along the ventral surface of the brain stem on fluid-attenuated inversion recovery (FLAIR) and diffusion-weighted imaging (DWI).

### Case report

A 60-year-old woman was referred to our hospital by her primary care physician and presented with a headache and diplopia that had been ongoing for three months and one week, respectively. Despite conservative treatment for one

month, the symptoms did not resolve. On physical examination, the patient was afebrile, with borderline tachycardia (heart rate, 91 bpm), and hypertension (blood pressure, 179/119 mmHg). Oxygen saturation was 96 % in room air. Laboratory evaluation revealed normal blood cell counts and biochemical test results. No notable medical conditions were in her medical history.

Lumbar puncture revealed elevated intracranial pressure (320 mmH<sub>2</sub>O; normal range, 50–180 mmH<sub>2</sub>O). The cerebrospinal fluid (CSF) was colorless and transparent with a normal cell count (4 cells/mm<sup>3</sup>). Compared to normal levels, protein levels were elevated (83 mg/dL; normal range, 12–60 mg/dL), and glucose levels were decreased (34 mg/dL; normal



**Fig. 2 – The band-like lesions are also hyperintense on DWI of the initial MRI (arrowheads). ADC of the pontine lesion is low compared to the neighboring tissues (white arrow)**

range, 40–70 mg/dL). Cytology suggested malignancy, but this was inconclusive.

On MRI, FLAIR showed band-like hyperintensity along the ventral surface of the brain stem (Fig. 1). This was not enhanced using a gadolinium-based contrast agent. The band-like lesion was also hyperintense on DWI (Fig. 2). The apparent diffusion coefficient (ADC) of the lesion was low compared with that of the normal-appearing brain stem. Based on the characteristic pattern of these observations, leptomeningeal carcinomatosis from lung adenocarcinoma was suspected, and a chest computed tomography (CT) was performed.

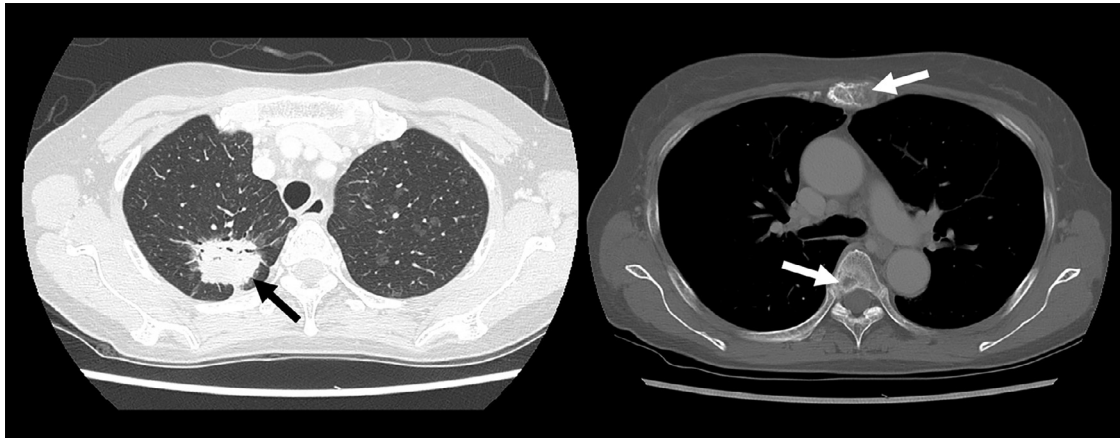
CT revealed a spiculated mass in the apex of the right lung and multiple ground-glass nodules, which is suggestive of lung cancer (Fig. 3). In addition, bone metastases were observed in the sternum and spinal bone. A transbronchial lung biopsy was performed on the spiculated mass, and adenocarcinoma was pathologically proven. An epidermal growth factor receptor (EGFR) mutation (exon21 L858R substitution) was detected. She received erlotinib, and a follow-up MRI was acquired five months after the diagnosis. On FLAIR and DWI of the follow-up MRI, the band-like hyperintensity disappeared (Fig. 4).

## Discussion

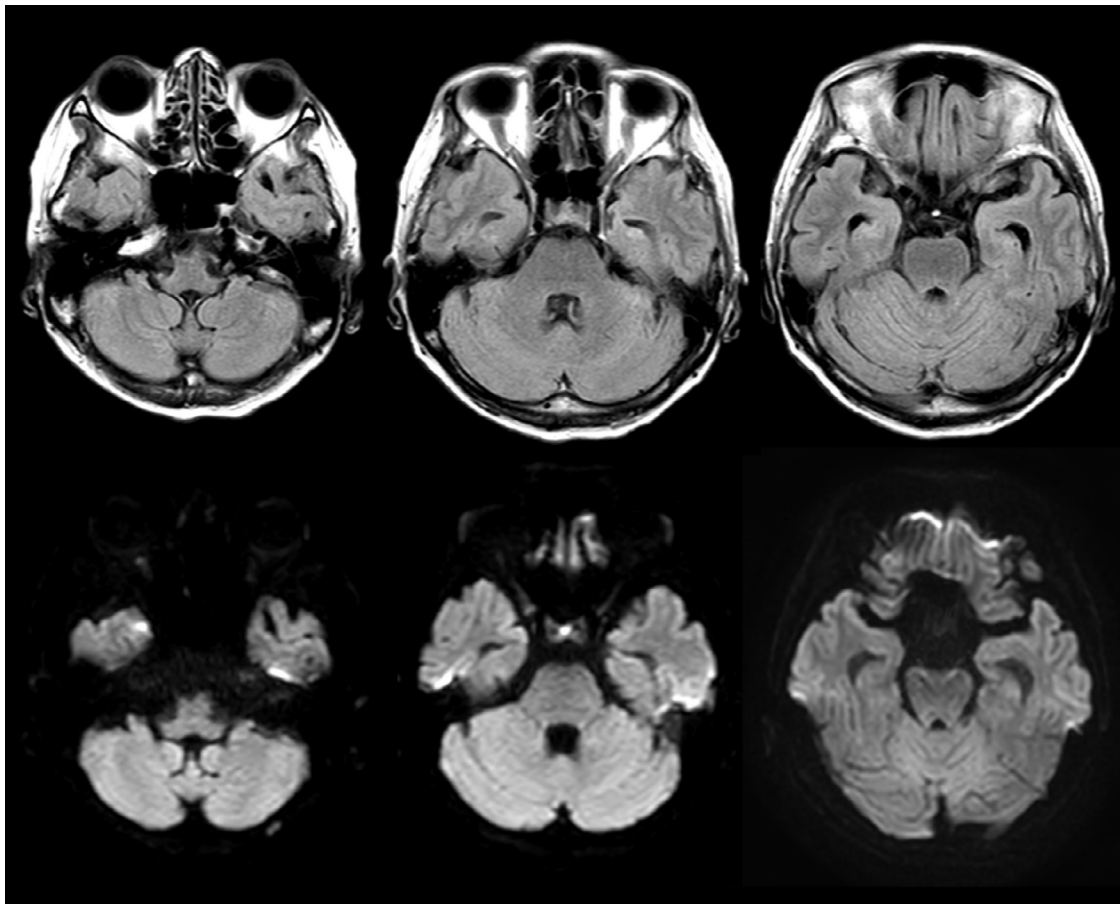
We present a case of leptomeningeal carcinomatosis where DWI and FLAIR imaging showed hyperintensity in the area along the ventral surface of the brain stem without contrast uptake. This type of lesion has been reported in patients with lung adenocarcinoma, which is often associated with positive EGFR mutations. The use of tyrosine kinase inhibitors resolved the observed abnormalities.

In a retrospective review of 142 cases of leptomeningeal carcinomatosis from solid cancers, Mitsuya et al. reported similar findings in 11 cases (7.7%) [2]. All cases were patients with lung adenocarcinoma; 10 were EGFR mutation-positive and one case had the ALK-rearrangement mutation. The researchers referred to the areas of hyperintensity as having the "bloomy rind sign." Other reports also observed the same hyperintensity in lung adenocarcinoma patients with the EGFR mutation [3–6]. Therefore, our present case is consistent with previous reports.

Band-like hyperintensity along the ventral surface of the brain stem on FLAIR and DWI is rarely an initial finding in the clinical course of lung cancer. In the largest cohort re-



**Fig. 3** – Contrast-enhanced CT shows the spiculated mass in the apex of the right lung (black arrow). Also, multiple ground glass nodules are observed. Bone window shows the osteolytic lesions, implying bone metastases (white arrows)



**Fig. 4** – On the follow-up MRI, the band-like hyperintensity was no longer observed on both FLAIR and DWI

ported by Mitsuya et al., all 11 patients had already been diagnosed with lung cancer [2]. Similarly, in a report by Cheng et al., leptomeningeal carcinomatosis was the initial finding in only 1 of 4 cases, and the band-like hyperintensity was observed [3]. When symptoms of leptomeningeal carcinomatosis are present during the initial examination, the correct diagnosis may also be delayed because lep-

tomeningeal carcinomatosis is rarely observed before diagnosis of the primary cancer and the clinical symptoms can overlap with infectious meningitis, subarachnoid hemorrhage, and other neurological conditions. In this case, we suspected leptomeningeal carcinomatosis from the beginning based on the band-like hyperintensity observed by FLAIR and DWI.

The mechanisms that result in the hyperintensity observed in FLAIR and DWI of leptomeningeal carcinomatosis remains unclear, but it may be due to tumor invasion along the surface of the brain, or microinfarction due to vascular injury by the invading tumor. In this case, the hyperintensity resolved with the use of a tyrosine kinase inhibitor (erlotinib), suggesting the involvement of tumor invasion. As the change was reversible, this eliminates the possibility of a large infarction as the cause of the abnormalities.

The reason why the band-like hyperintensity was not enhanced is also unclear. Kurihar et al. reported that contrast-enhanced brain metastases are associated with destruction of the vascular architecture, whereas lesions in the perivascular space are not enhanced [7]. Therefore, the band-like hyperintensity might result from tumor cells that spread to the perivascular space along the perforating branches without parenchymal and vascular invasion.

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## Conclusion

Here, we report a case of leptomeningeal carcinomatosis with band-like hyperintensity along the ventral surface of the brain stem visualized by FLAIR and DW. It was not enhanced. MRI findings are characteristic of leptomeningeal carcinomatosis caused by EGFR mutation-positive lung adenocarcinoma and will be useful for diagnosis. This condition was resolved following treatment with a tyrosine kinase inhibitor.

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## Patient consent

Written consent was obtained from the patient for scientific use.

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