

# Clinical Effectiveness of Boron Neutron Capture Therapy for a Recurrent Malignant Peripheral Nerve Sheath Tumor in the Mediastinum

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A 70-year-old woman underwent extirpation of a malignant peripheral nerve sheath tumor,  $4.5 \times 2.0$  cm in size, in the right supraclavicular fossa. Locoregional recurrence was found 10 months after operation (Figure 1). Although one course of systemic chemotherapy using cisplatin ( $80 \text{ mg/m}^2$  at day 1) and vinorelbine ( $25 \text{ mg/m}^2$  at days 1 and 8) was given, the recurrent tumor progressed. Because conventional radiotherapy is not effective for malignant peripheral nerve sheath tumor, boron neutron capture therapy (BNCT) was considered based on the subcutaneous mediastinal location. After institutional review board approval and securing the patient's written informed consent, accumulation of p-boronophenylalanine (BPA) in the tumor was confirmed using  $^{18}\text{F}$ -BPA positron emission tomography. Using simulation environment for radiation applications software program, fast neutron and  $\gamma$ -ray physical doses, compound biologic effectiveness- and relative biologic effectiveness-weighted doses, were calculated.

The patient underwent two courses of BNCT with an interval of 3 weeks. BPA-fructose was administered intravenously at a dose of 500 mg/kg just before irradiation. For the first course, the epithermal neutron irradiation was performed for 105 minutes. The dose distribution in the tumor ranged from 13.7 to 22.3 Gy-Eq and was 6.0 Gy-Eq to the skin. For the second course, the irradiation time was shortened to 51 minutes, because of the higher epithermal neutron flux. The dose delivered to the tumor ranged from 6.0 to 24.3 Gy-Eq and was 9.7 Gy-Eq to the skin.

Chest computed tomography scan 1 year after BNCT showed that the tumor size decreased from  $6.2 \times 4.0$  cm to  $4.6 \times 3.2$  cm in size (25% reduction), and stable disease was

maintained for 24 months (Figure 2). Positron emission tomography-computed tomography 18 months after BNCT showed no uptake of  $^{18}\text{F}$ -fluorodeoxy glucose in the residual mass, suggesting no viability (Figure 3). Neuralgia of the right arm improved. Although temporary dysphagia because of an oral mucosa disorder was observed as a side effect, the patient's general quality of life was preserved. There is no evidence of recurrence 2 years after BNCT.

## DISCUSSION

When  $^{10}\text{B}$  absorbs thermal neutrons,  $\alpha$  and  $^7\text{Li}$  particles are generated.<sup>1</sup> BNCT selectively injures the tumor cells containing  $^{10}\text{B}$ ; it was suitable in this case with tumor invasion into the neighboring great vessels. Because the peak of thermal neutron flux is 3 cm beneath the tissue surface, its clinical applications have been limited to malignant melanomas and brain tumors. Kato et al.<sup>2</sup> reported its efficacy for head and neck malignancies. The indication was extended to metastatic liver tumor,<sup>3</sup> malignant mesothelioma,<sup>4</sup> and glioblastoma.<sup>5</sup> This is the first case of mediastinal tumor treated with BNCT.

The effect of BNCT is critically dependent on selective accumulation of  $^{10}\text{B}$  compounds. The tumor/normal tissue ratio of the  $^{10}\text{B}$  uptake was 2 in this case, while a ratio greater than 2.5 is preferable for selective treatment. BNCT might be a treatment option for subcutaneous mediastinal tumors, which is resistant to conventional irradiation.

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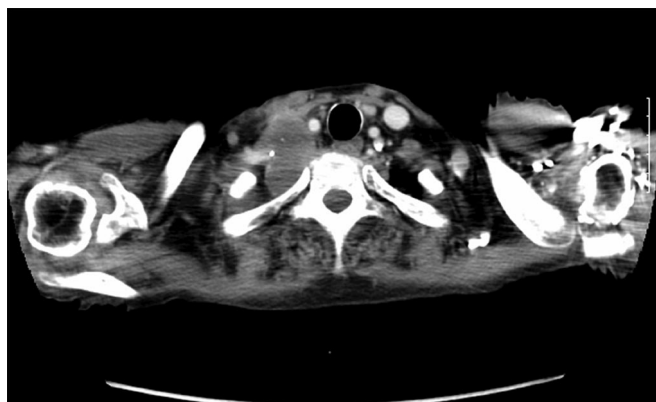
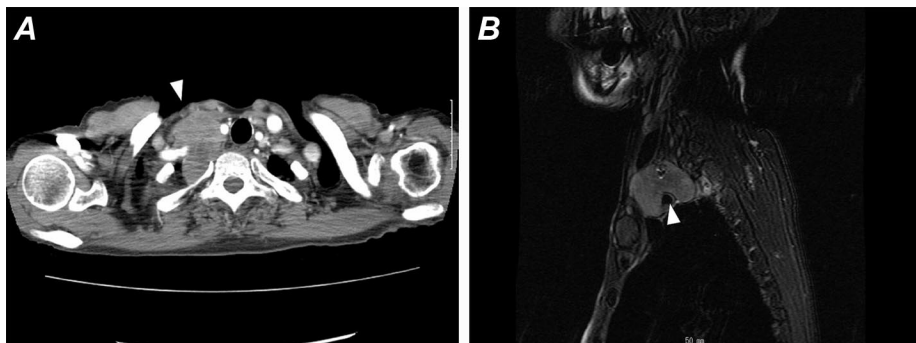
Disclosure: The authors declare no conflicts of interest.

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ISSN: 1556-0864/10/0512-2037

**FIGURE 1.** Chest computed tomography (CT) scan and magnetic resonance imaging (MRI) showing the recurrent lesion. *A*, Postoperative recurrence,  $4.5 \times 2.0$  cm in size, is seen in the right subclavicular region (arrow head) in the follow-up CT scan 10 months after operation. *B*, Tumor invasion into the right subclavicular artery and brachiocephalic vein is seen (arrow head) in the sagittal view of MRI.



**FIGURE 2.** Chest computed tomography scan 1 year after boron neutron capture therapy shows shrinkage of the recurrent lesion after chemotherapy from  $6.2 \times 4.0$  cm to  $4.6 \times 3.2$  cm in size (25% reduction).

**FIGURE 3.** FDG-positron emission tomography (PET) shows the remarkable effect of boron neutron capture therapy (BNCT). *A*, PET-computed tomography (CT) before BNCT shows significant tumor uptake. *B*, Although a residual mass is seen, the FDG uptake is reduced to the background level 18 months after BNCT.

