Salvage carbon ion radiotherapy for recurrent solitary fibrous tumor: A case report and literature review

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Abstract

Background: Malignant solitary fibrous tumor (MSFT) arising from the spinal cord is extremely rare and poorly understood mesenchymal neoplasms: only a few MSFT in the spinal canal has been described. We describe the clinical course of the patient with MSFT arising from the thoracic spinal cord. Case report: We describe the clinical course of the patient and the radiological and pathological findings of the tumor. The tumor had been resected by microscopic posterior approach and video-assisted thoracic surgery, but local recurrence was observed by MRI at 1-year follow-up period. No metastatic lesion was confirmed. Then, carbon ion radiotherapy (CIRT) was administered to the recurrent lesion. Local suppression has been observed for 40 months after irradiation. Conclusion: Dumbbell-shaped MSFT arising from thoracic spinal cord is a highly unusual presentation. CIRT might be effective for treatment of recurrent tumors.

Keywords

carbon ion radiotherapy, dumbbell-shaped tumor, malignant solitary fibrous tumor

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Introduction

Solitary fibrous tumors (SFTs) of the meninges were first described in 1996.¹ Approximately, 60 cases of SFT have been reported in the central nervous system (CNS). Moreover, malignant solitary fibrous tumors (MSFTs) in CNS are extremely rare. To date, there has been only a few reports of an MSFT arising from the spinal cord.²,³ We already reported the interim progress of an extremely uncommon case of MSFT arising from the thoracic spinal root.⁴ We described here clinical outcome of additional carbon ion radiotherapy (CIRT) using carbon ion with a review of the relevant literature.

Case report

A 49-year-old woman presented with a history of 1 year of chest pain. Plain chest X-ray showed a pulmonary hilar lesion. A magnetic resonance imaging showed an intradural extramedullary tumor with dumbbell shape affecting the right thoracic spine with largest diameter of 60 mm (Figure 1). A CT scan revealed the sixth vertebral body

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scalloped by the tumor. We resected the dumbbell-shaped lesion by one-stage posteroanterior combined approach. Initially, posterior approach through midline incision was made microscopically. Then, laminectomy on the sixth and seventh vertebrae was performed. Intraoperative observation brings out the elastic hard and hemorrhagic epidural tumor with capsule adhered with nerve root. We resected the piece of tumor and ordered the rapid pathological diagnosis by frozen section which reported the tumor was soft tissue tumor other than neurogenic tumor. We euthanized the nerve root and pushed the tumor out of the spinal canal from the foramen. Thereafter, lateral approach was made by video-assisted thoracic surgery technique. The tumor was adhered with pleura and intercostal artery/vein. After releasing adhesion, the tumor was totally resected (Figure 2). At histopathological examination of the tumor specimen, spindle cells proliferated with staghorn-like-shaped vessels and necrosis. These tumor cells showed high cellularity and high mitotic activity (8 mitoses per 10 high-power fields) without pleomorphism (Figure 3). Immunohistochemically, the tumor cells exhibited diffusely positive for CD34 (Figure 4), STAT6 (Figure 5), vimentin and bcl-2 accompanied with a local expression of S-100 protein (Figure 6) and CD99. With these findings, the final diagnosis was MSFT of the spinal cord based on the World Health Organization’s Classification of soft tissue tumors.5,6

One year after surgery, local recurrence was observed by MRI follow-up (Figure 7). CT scan does not confirmed the presence of metastatic site. We planned curable resection of recurrent site at first; however, we finally judged complete resection might be difficult due to the problem of organs at risk (OARs). Although only a few studies are available with CIRT on the spinal lesions, we considered that CIRT was the promising options for recurrent and metastatic MSFT, often with poor prognosis in case of conventional adjuvant chemoradiotherapy. Therefore, CIRT was initiated upon the recurrence lesion. CIRT was performed using scanning irradiation method. The dose

![Figure 1. Sagittal and axial view of magnetic resonance imaging showing the dumbbell-shaped mass with signals of iso-intensity on T1 and low-intensity on T2WI in the level of the sixth thorax.](image-url)
constraint for spinal cord is $D_{\text{max}} < 45 \text{ Gy(RBE)}$ in the setting of the National Institute of Radiological Sciences, Chiba, Japan. In this case, $D_{\text{max}}$ to spinal cord was 35.4 Gy(RBE). The moving distance of the tumor during breathing was calculated to adjust planning target volume (PTV) (Figure 8). Respiratory-gated irradiation was employed. Irradiation was performed once a day, 4 days
per week, in a total of 16 fractions over 4 weeks. The patient was finally received a total dose of 64.0 Gy(RBE). After CIRT, the tumor size has been decreasing time by time. Tumor size of recurrent site has decreased gradually, and no metastatic site has been observed at 19 months after CIRT (Figure 9).

Discussion

The present case report describes a patient with recurrent MSFT arising from thoracic nerve root mimicking neural tumors for its dumbbell shape: we already reported interim progress of this case.4 The main interest in the current case is considered to be the adaptability of CIRT for spinal cord tumor which remains unclear in the point of intrafocal kinetics. Even though it is encompassed with pros and cons, it is possible that CIRT may be of choice for suppression of recurrent MSFT.

SFTs, which were first reported in 1931 as pleural-based lesions, have been thought to occur on serosal surfaces. SFT may affect wide generation (median age, 50 years), with equal distribution both in men and women.7 Symptoms are not specific and related to the location of the tumor. Histopathologically, SFT is highly variable in appearance, depending on the relative proportions of cells and fibrous stroma.5,6 Although, SFTs have recently been reported at various sites, SFTs arising from the spinal cord are extremely rare.2 These lesions have been reported to arise within the intramedullary (58%), intradural–extra-medullary (24%), and extradural (18%) compartments.8 The most frequent site of spinal cord SFT is the thoracic spine (56.3%), followed by the cervical spine (31.2%).8 Therefore, differential diagnosis of SFT arising in the spinal cord should be widely varied from schwannoma, meningioma, to hemangioblastoma.9,10 Usual MRI findings included hypointensity on T1- and T2-weighted imaging, reflecting fibrous tissue11; however, in our case, hypointensity on T1 and intermixed hypointensity and hyperintensity on T2-weighted imaging were noted. However, both Clinical and radiological differentiation are often difficult. Most cases with SFT are histologically benign; however, some percentage possesses irregularity. MSFTs are statistically rare, accounting for 10% of pleural tumors, approximately; its frequency among extrapleural lesions is considered to be less than that number.8

In a large number of cases, dumbbell tumor may be pathologically benign: the previous paper reported 97.2% of adult patients with dumbbell tumor were diagnosed as benign pathology such as schwannoma and neurofibroma.12 SFT is considered to be rare as a cause of dumbbell tumor: only 16 cases were reported before, and 4 of 16 were malignant, to our knowledge.8,9,13,14

As for our case, we consider it is quite difficult to differentiate MSFT from other more common dumbbell-shaped tumor such as schwannoma by clinical presentation. And imaging findings might be of little help. We would like to emphasize that MSFT, although quite rare, should be considered in the differential diagnosis of dumbbell-shaped tumor.

As mentioned before, most cases with SFT are considered to have benign histological features and can be treated by gross total resection or subtotal resection with adjuvant therapy, whereas the treatment of MSFT in spinal cord has not been well established because of the rarity of the disease: it is sometimes difficult to achieve, but the gross total resection of the tumor is supposed to be effective.15 However, recurrence rate of MSFT in CNS even after gross total resection may be considered very high and estimated as 75% (three of four cases) reported in the literature including this case.14 Prognosis of relapsed MSFT is considered very poor, because salvage surgery may be usually impracticable to perform gross total resection due to their proximity to the OARs.

Figure 5. Tumor cells showed diffusely positive for STAT6.

Figure 6. Tumor cells focally and weakly expressed S-100 protein.
in addition to adverse effect caused by prior surgery. Moreover, MSFT has histologically chemoradio-resistant nature which yields poor outcome in local disease control and overall survival for patients with unresectable relapsed MSFT. Our patient was treated with CIRT after careful informed consent. Although the relapsed tumor lesions successfully reduced after treatment so far, CIRT hasn’t been standard option for salvage against recurrent MSFT. Nowadays, CIRT has been accepted as the definitive therapy for unresectable and even radioresistant tumors.\textsuperscript{16} The physical characteristics of CIRT yields highly localized dose distribution which was critical entity in this case due to OARs tangential to the tumor.\textsuperscript{17} Furthermore, carbon ion provides higher linear energy transfer than photon or proton which contributes greater relative biological effectiveness.\textsuperscript{18,19} These features are considered as critical advantages in the management of radioresistant tumor. Recently, there is also limited evidence supporting effectiveness of CIRT in the setting of salvage treatment in recurrent sarcoma where 12-month local progression-free rates and overall survival rates have been reported as 74.6\% and 86.5\%, respectively.\textsuperscript{20} Although further studies are needed to define the best targets for CIRT, this is the first case of MSFT treated by CIRT with suppression of the site. In the light of the result, if preoperative diagnosis of MSFT were possible by biopsy, CIRT might be well of consideration for the treatment.

We have to also inform the limitation of the report. First, this is the first case report about CIRT on recurrent MFST. The tumors have been locally controlled after CIRT so far, though long-term effectiveness remains unclear. Second, safety of CIRT on spinal cord has to be examined. The patients did not experience neurological deficiency after treatment in this case; however, the effect of CIRT in the normal spinal cord tissue should be revealed. Structural atrophy or vessel wall thickening may appear as a side effect of radiotherapy on CNS.\textsuperscript{21} Despite these limitation, we consider HPBT may provide better outcome in the patient with recurrent MSFT which is highly challenging entity.

Figure 7. Representative image of recurrence site on magnetic resonance imaging.
Figure 8. Representative image of treatment plan of carbon ion radiotherapy.

Figure 9. Representative image of recurrence site on magnetic resonance imaging at 19 months after carbon ion radiotherapy.
Conclusion
We described a case with dumbbell-shaped MSFT arising from thoracic nerve root. Despite surgical resection by video-assisted thoracic surgery and posterior approach, the tumor recurred 1 year later. Salvage CIRT was made, which successfully suppressed the recurrent lesion.

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