

Treating Spinal Bone Metastasis with Image-Guided, High-Dose Radiation

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INTRODUCTION

Spinal and paraspinal malignancies are common problems in oncology, and the majority of them are metastases. Traditionally, these metastatic tumors have been treated—with surgery, radiation, chemotherapy, or a combination of treatments—in order to relieve pain. Surgical resection has been the preferred method of treatment for many of these tumors, even for many patients with no findings of spinal column instability, because the spinal cord limits the amount of radiation that can be safely delivered to these lesions. This case study presents the noninvasive treatment of a solitary T2 bone metastasis with image-guided, high-dose radiation.

CASE REPORT

A 54-year-old white female with a history of papillary thyroid carcinoma, nonavid for iodine-131, showed an increase in thyroglobulin from 16 IUs to 293 IUs 18 months after her thyroidectomy, which was performed in January 2003. An MRI and biopsy confirmed the presence of a solitary bone metastasis at T2 (figure 1). It was an expansile lesion in the posterior aspect of the T2 vertebral body with early ventral epidural disease.

A multidisciplinary tumor board recommended minimally invasive, high-dose, image-guided radiation rather than surgical resection. The patient reported moderate pain, but showed no significant signs of mechanical instability of the spine. Aggressive radiation treatment was deemed appropriate because the T2 lesion was the only active metastasis. While this patient also had a history of Crohn's disease, this was not considered a factor in the treatment decision because of the tumor location.

This patient was enrolled in an IRB study for image-guided, single-fraction spine radiation and treated in November 2004.

Treatment

The IRB study protocol called for a radiation dose of 2,100 cGy to the 100-percent isodose line, to be given in a single fraction using 6 MV photons. The treatment was delivered with a dynamic multileaf intensity modulation technique (IMRT). With this technique, the radiation dose was limited to less than 1,200 cGy at the surface of the spinal cord.

The conformal treatment was planned using a proprietary 3D planning system developed at the Memorial Sloan-Kettering Cancer Center. The plan for this patient involved nine fields around a single isocenter, as shown in figure 2. Figure 3 shows the dose volume histogram for the plan. The gross tumor volume was contoured. The clinical target volume included the entire vertebral body. The planning target volume was a 3-millimeter expansion of the clinical target volume.

Accurate targeting of each field was accomplished using a Varian Clinac® 2100EX linear accelerator with gantry-mounted on-board imaging technology from Varian. At each beam angle, patient position relative to the planned position was verified by kV radiographic anatomic image matching as well as cone-beam CT image verification. Cone-beam CT provides a 3D image that gives a clear indication of possible translation and rotational setup errors. Patient position was also monitored using internally developed in-bunker stereoscopic infrared cameras. A variation from planned position greater than 2 millimeters would typically require stopping treatment and adjusting position; in this case, there was no such variation, so repositioning and reverification were not necessary.

Figure 1. The pretreatment axial T2 MRI, showing solitary metastasis

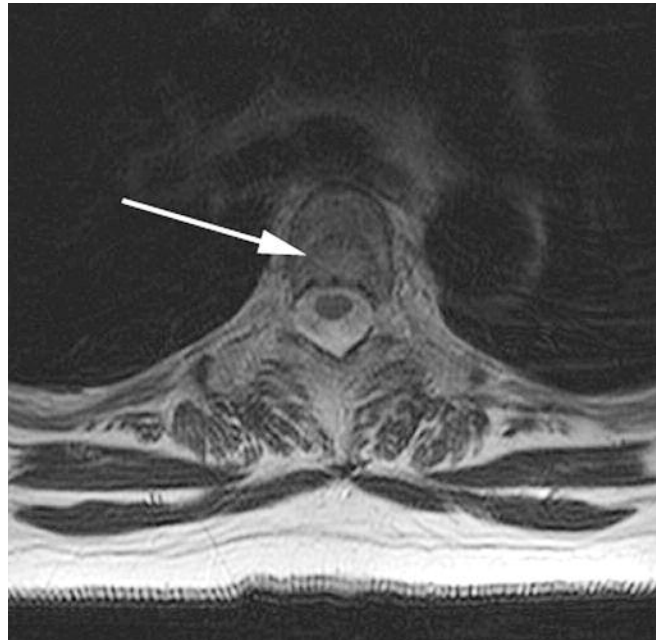


Figure 2. The nine-field isocentric IMRT plan, with dose prescribed to the 100-percent isodose line

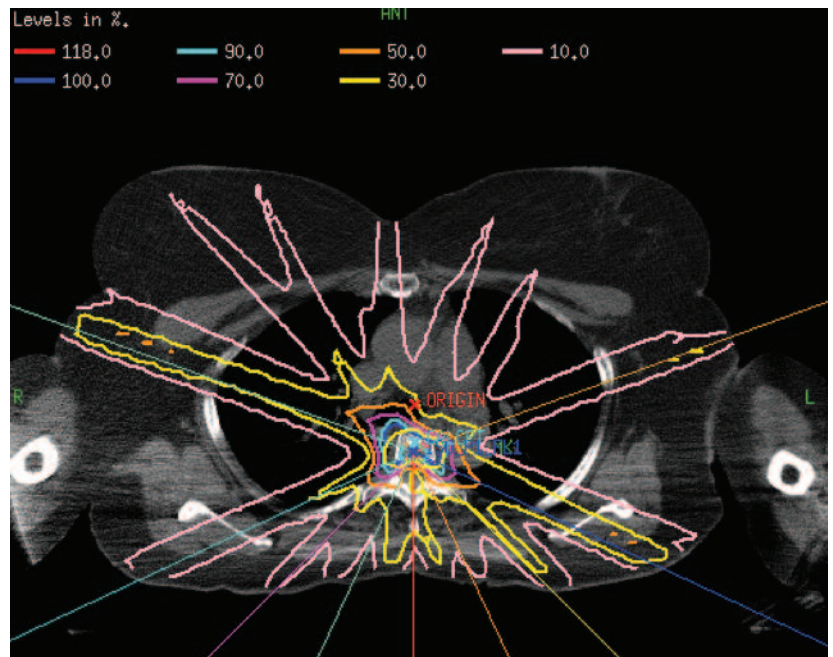


Figure 3. The dose volume histogram of the IMRT treatment plan

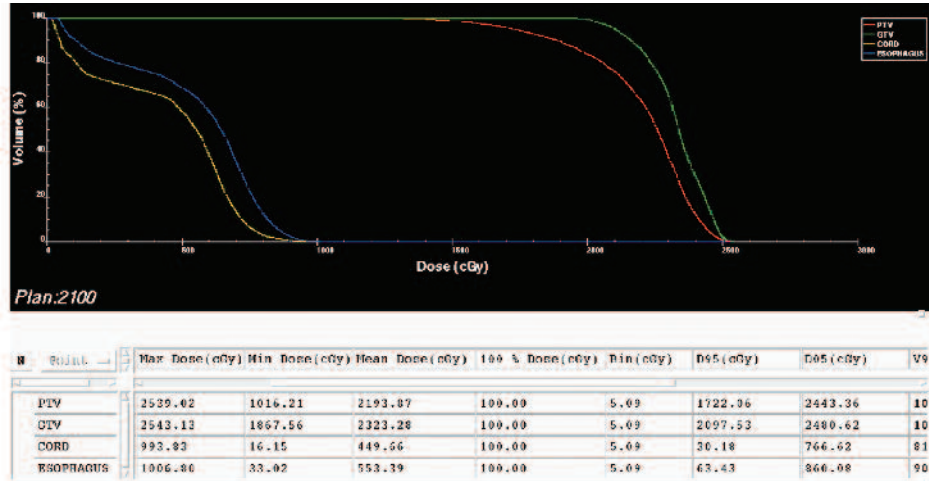
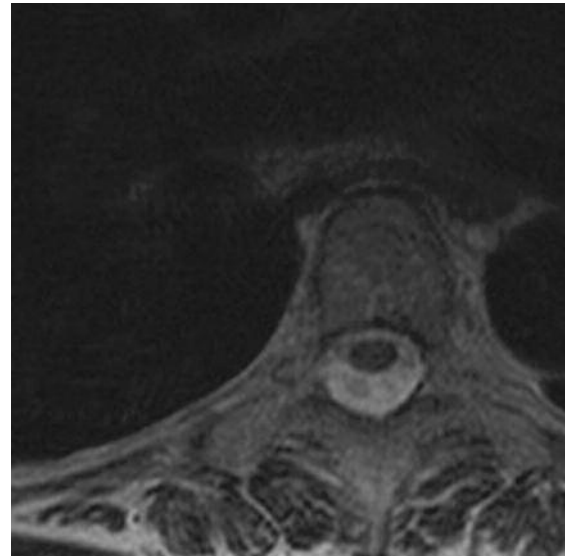


Figure 4. An axial T2 MRI taken six months post-treatment



Results

This patient is followed routinely every four months. In the three years since treatment, she has shown no evidence of active cancer. Her back pain resolved, and she discontinued all pain medication. Her thyroglobulin levels returned to normal. MRIs have shown no development of new metastases, and the treated lesion has remained controlled (figure 4). She experienced no effects of radiation toxicity except for a mild and temporary esophagitis that required no treatment.

These results are typical for the 20 patients treated under the initial IRB study and for the more than 200 patients subsequently receiving high-dose, image-guided IMRT spinal treatment.

CONCLUSIONS

Paraspinal metastatic tumors, many of which do not respond well to conventional radiation, can be treated safely and effectively with escalated radiation doses, which require image-guided technology. Studies show that a high-dose, image-guided approach is more effective at relieving pain and also improves outcomes. It offers patients without findings of spinal column instability a safer, less invasive alternative to surgery. As a result, image guidance has changed the way spinal metastases are treated at the Memorial Sloan-Kettering Cancer Center. Improved radiation therapies are giving patients who previously had no options new choices for controlling metastases and improving the quality of life.

References

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