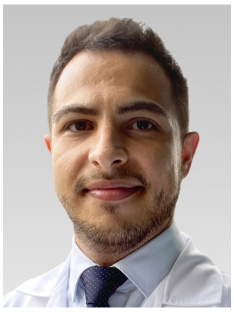
MR/Clinical Case Study

Radiotherapy Treatment Planning of a T-Spine Lesion Using a Canon Galan 3T MR-Simulator and a Canon Celesteion CT-Simulator



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Introduction

Prostate cancer, a prevalent malignancy among men, originates in the prostate gland-a crucial part of the male reproductive system. While often slow-growing and confined to the prostate initially, prostate cancer can become aggressive and metastasize, posing a significant threat. Metastasis involves the spread of cancer cells beyond the prostate to distant organs or tissues, commonly affecting the bones, lymph nodes, or other organs.

Typically, Magnetic Resonance Imaging (MRI) sequences along with Positron Emission Tomography (PET) imaging is used to help identify prostate lesions. Additionally, PET scans, bone scans, along with MRI offer improved sensitivity for detecting both bone and soft tissue metastases.

For treatment purposes, MRI's detailed images offer precise tumor localization, size assessment, and evaluation of proximity to critical structures. Moreover, MRI serves as a non-invasive method for monitoring the tumor's response to treatment, allowing for adjustments and ensuring optimal care for patients throughout their cancer journey. In this report, we have provided one case study from a patient treated for prostate metastasis in the spine who underwent a Canon Galan 3T MR-Simulator scan and a Canon Celesteion CT-Simulator. Typical MRI sequences used in our institute for spine lesions are an axial 3D T1 fat-saturated (FS) sequence, an axial 3D T2, and a sagittal short tau inversion recovery (STIR) scan. The details of the MRI sequences are provided in Table 1.

	AX 3D T1 FS	AX 3D T2	SAG STIR
Scanning sequence	Spin Echo (SE)	SE	[SE, inversion recovery (IR)]
MR acquisition type	3D	3D	2D
Slice thickness (mm)	3	3	3
TR (ms)	408	2000	5380
TE (ms)	19	115	68
Echo numbers	1	1	1
Spacing between slices (mm)	1.5	1.5	3.6
Number of phase encoding steps	72	72	510
Echo Train Length (ETL)	12	59	17
Flip angle (degree)	90	90	90
Pixel spacing (mm)	[0.56, 0.56]	[0.51, 0.51]	[0.63, 0.63]

Table 1: Details of the MRI sequences used for a spine scan on a Canon Galan 3T MR-Simulator.

Case 1

History: A patient in his late seventies with a known history of stage IVB prostate cancer was found to have diffuse metastatic disease. PET scan showed a T2 lesion in the spine.

Imaging Findings: The SAG STIR MR images showed enhancement of signal in thoracic vertebrae T2 consistent with PET images. The patient's MRI, PET, and CT scans are shown in Figure 1. CT data was unable to identify the target.

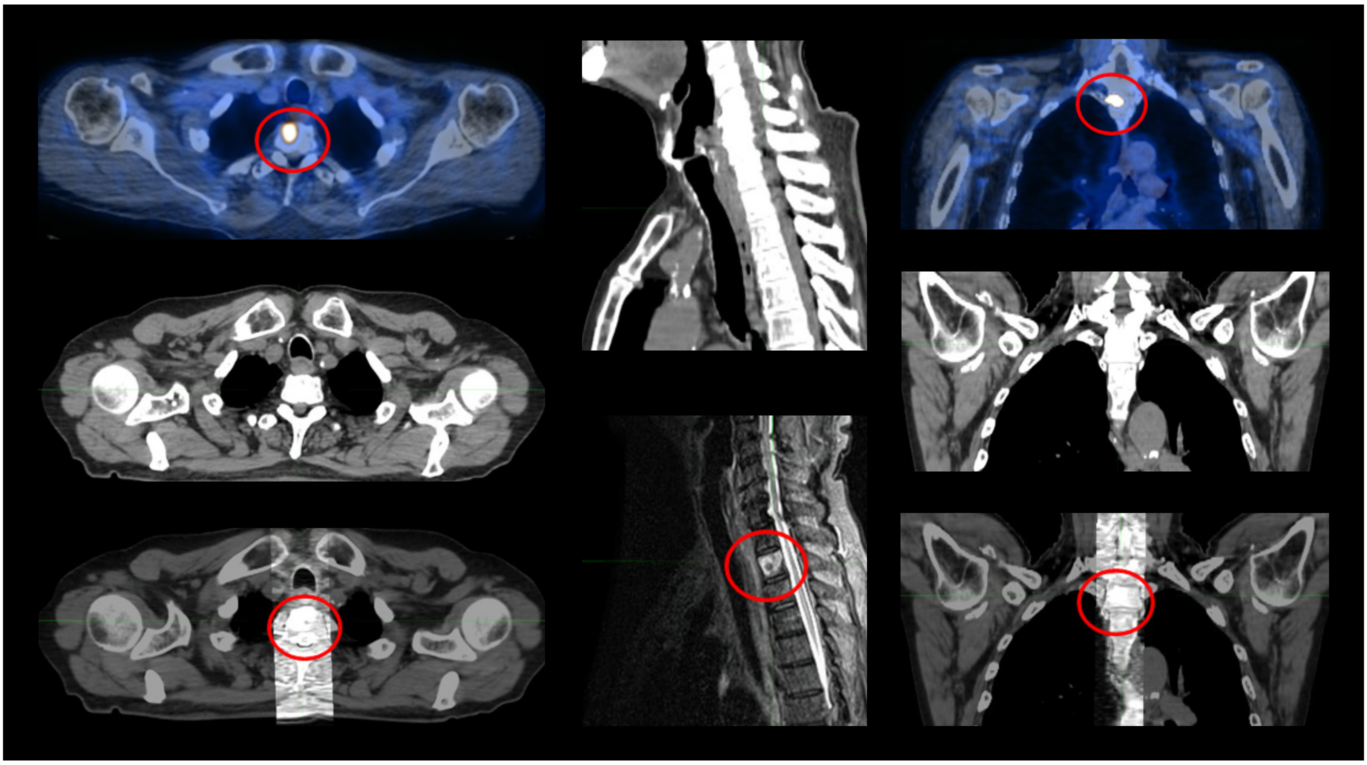

Figure 1: PET, CT, and fusion of SAG STIR MR with CT images are shown from the top to the bottom row. The target is shown within the red circle. CT is unable to identify the lesion.

Treatment: The primary goal of treatment is palliative, with the approach being primary radiotherapy (RT) utilizing the stereotactic body radiotherapy (SBRT) technique for 27 Gy delivered in 3 fractions. About two-thirds of the patients with metastatic bone pain will experience some relief from RT, and one-third will experience complete pain relief.

For treatment planning, CT-Simulation was employed as the primary modality, while MR-Simulation was utilized as the secondary modality for contouring the target and organs at risk. This approach was necessary because CT lacks the ability to provide superb soft-tissue contrast. Figure 2 shows the CT and MRI images, as well as the fusion of the two modalities to leverage the complementary information from MRI during treatment planning. Additionally, Figure 2 displays the dosimetry plan, the planning target volume (PTV), and organs at risk (e.g., spinal cord).

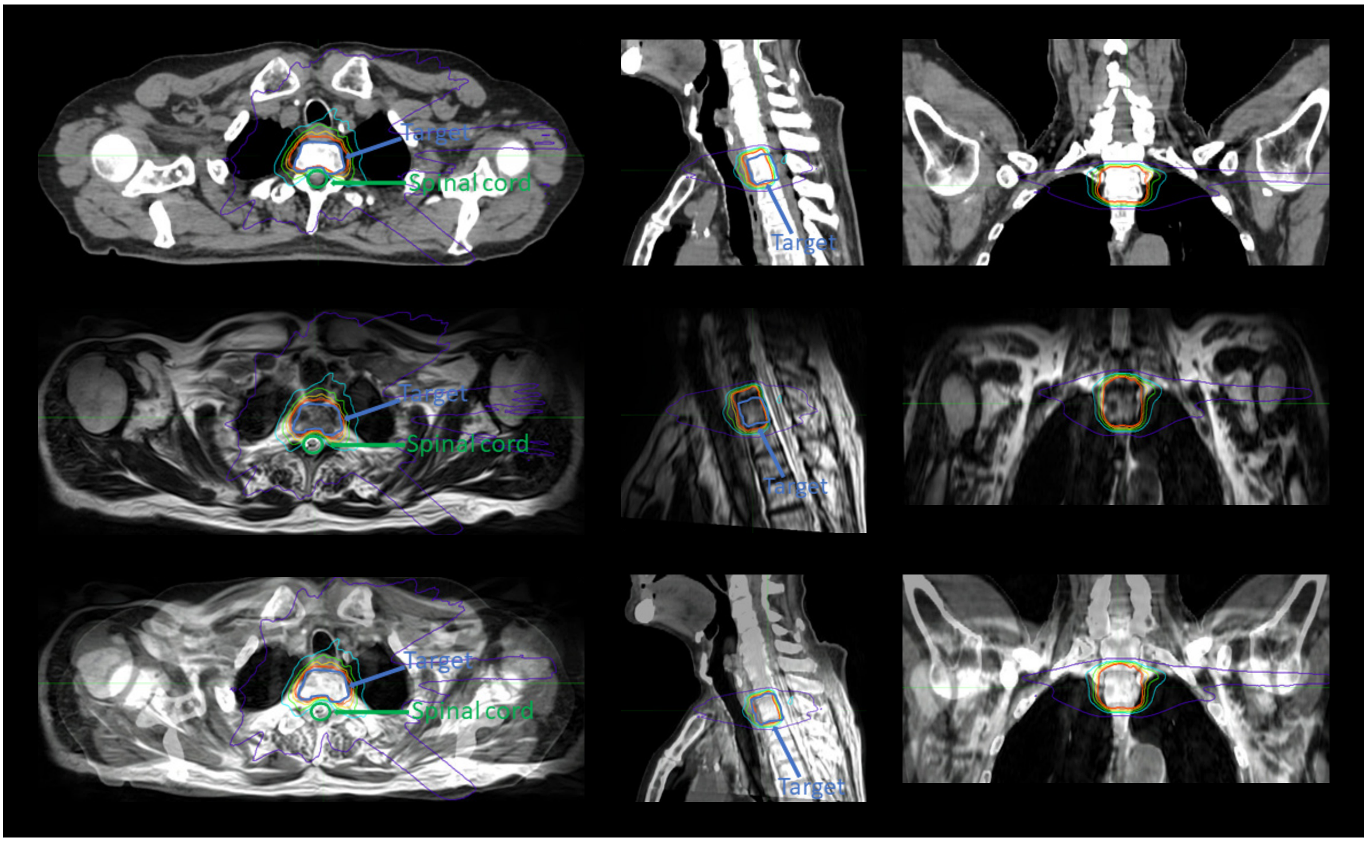

Figure 2: The dosimetry map on MRI, CT images, and the fusion of two modalities in three axes. The target and spinal cord are shown with arrows.

Conclusion

CT alone falls short in capturing crucial information essential for delineating targets and organs at risk in cancer patients, especially in those with metastatic disease. In contrast, the incorporation of Canon 3T Galan MR Simulation offers clinicians heightened accuracy and precision. It facilitates more refined segmentation of tumors and organs at risk, contributing to the protection of critical organs during treatment, thereby reducing toxicity and improving tumor targeting. Additionally, utilizing a flat tabletop setup in both CT and MR scans replicates operating room conditions, effectively reducing motion artifacts and registration uncertainties. The integration of Canon 3T Galan MR Simulation into the process not only conserves valuable time that would otherwise be spent contouring low-contrast CT images but also allows for the optimization of treatment delivery and patient care.

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