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Beam Arrangement as a Method to Reduce Dose to An Implanted Cardiac Device for Cranial Stereotactic Radiotherapy Patients

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INTRODUCTION

To determine the dose to an ICD (implanted cardiac device) during stereotactic radiotherapy and if beam arrangement is a viable method to reduce the dose. This study is innovative because it quantifies the effect beam placement could have on the instantaneous dose on an ICD which could lead to oversensing and failure of the device.

METHOD

A treatment plan was created for a stereotactic radiotherapy patient with an ICD for a meningioma in the posterior parasagittal region of the brain. The beams were strategically placed to avoid the left side of the patient's body in order to spare dose to the ICD. The arcs were set with the following table angles, 180°, 250°, 220°. The manufacturer recommended keeping the total dose to the device below 500 cGy and to limit the dose rate to <1 cGy/min to avoid oversensing. The plan was then delivered to an anthropomorphic phantom (Rando) with optically stimulated luminescent dosimeters (OSLD) in the place of the ICD. To determine the degree of dose reduction with beam arrangement, OSLDs were also placed on the opposite side to determine the amount of sparing. Four OSLDs were placed on each side and the time taken to deliver the treatment was recorded. The positioning of the OSLDs relative to the ICD was verified with AP and lateral radiographs.

RESULTS

Figures 1 and 2 show the scout image of the patient with the ICD and a KV image with the ICD recreated with wire on the anthropomorphic phantom. Figure 3 shows the anthropomorphic phantom table setup with four OSLDs on each side. Figure 4 shows the beam placement for the treatment plan. We assume the right side received higher doses due to the exit path of the beam onto the right side of the patient body. The OSLDs on the side of the ICD showed a maximum point dose of 0.65 cGy or 3.25 cGy for all five fractions. The treatment time was 98 seconds (total of 490 seconds) of exposure and therefore the instantaneous dose rate was <0.4 cGy/min. The contralateral OSLDs however showed a maximum point dose of 3.62 cGy or 18.1 cGy for all five fractions resulting in an instantaneous dose of 2.2 cGy/min.

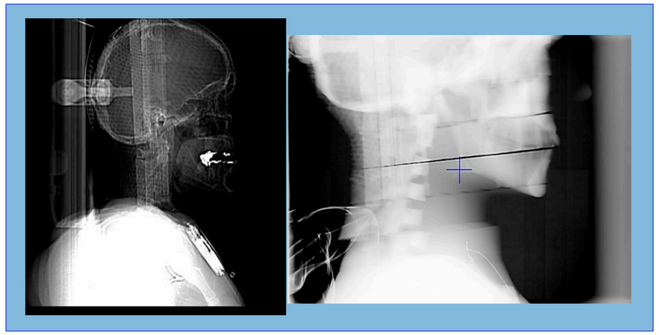

Figure 1. Sagittal views of ICD on the scout image and KV image of anthropomorphic phantom.

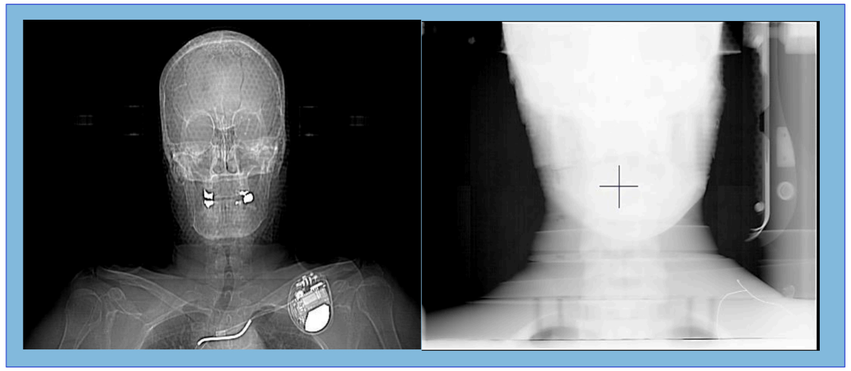

Figure 2. Coronal views of ICD on the scout image and KV image of anthropomorphic phantom.

Figure 3. OSLD placement on anthropomorphic phantom.

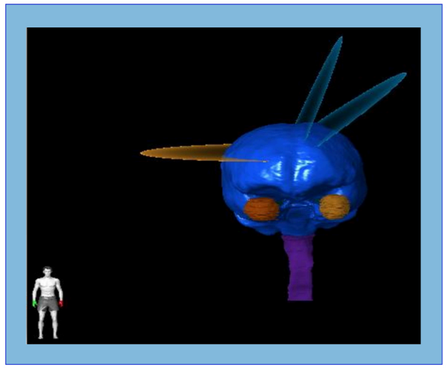

Figure 4. Arc placement with exit dose avoiding the left side of the patient.

CONCLUSIONS

The beam arrangement led to an allowable dose rate for the ICD. The contralateral however showed a dose rate higher than the manufacturer recommended. Therefore, beam arrangement can be used to spare an ICD in terms of dose and dose rate and should be something that is considered when treating a patient with an ICD.

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