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Title: Quantification of Transmission and Backscatter Factors as a Function of Distance to Inhomogeneity Interface for Three Types of Surgical Implant Plates

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Purpose:

Carbon fiber materials have been increasingly used clinically, mainly in orthopedics, as an alternative to metallic implants because of their minimal artifacts on CT and MRI images. This study characterizes the transmission and backscatter property of carbon fiber plates (CarboFix Orthopedics, Herzeliya, Israel) with measurements for radiation therapy applications, and compares them to traditional Stainless Steel (SS) and Titanium (Ti) metal materials.

Methods:

For the transmission measurements, 1-mm-thick test plate was placed upstream from a plane parallel Markus chamber, separated by various thicknesses of polystyrene plates in 0.5 cm increments between 0 and 5 cm.
With this setup, we quantified the radiation transmission as a function of distance to the inhomogeneity interface. The LINAC source to detector distance was maintained at 100 cm and 200 MU was delivered for each measurement. Two 3-cm solid water phantoms were placed at the top and bottom to provide build up. All the measurements were performed for 6 MV and 18 MV photons. The backscatter measurements had the identical setup, except that the test plate was downstream of the chamber from radiation.
Results: The carbon fiber plates did not introduce any measureable inhomogeneity effect on the transmission and backscatter factor because of its low atomic number. In contrast, traditional metal implant materials caused up to 15% dose difference at upstream and 25% backscatter at downstream from radiation. Such differences decrease as the distance to the inhomogeneity interface increases and become unmeasurable at distance of 3 cm and 1 cm for upstream and downstream, respectively.

Conclusion:

A new type of carbon fiber implant plate was evaluated and found to have minimal inhomogeneity effect in MV radiation beams. Patients would benefit from a carbon based implant over metal for radiation
therapy due to their minimal backscatter and imaging artifacts.