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ASSESSMENT OF DOSIMETRIC IMPACT OF CARBON FIBER STABILIZATION DEVICES FOR POSTOPERATIVE PARTICLE THERAPY

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Introduction: Carbon fiber reinforced (CFR)-PEEK metal free devices (CarboFix Orthopedics) have been recently introduced for surgical implant fixation in case of spinal tumors, which are generally good candidates for particle therapy (PT). The purpose of this study was to investigate and compare uncertainties related to the use of titanium and CFR-PEEK screws in terms of image quality and artifacts, contouring and dose calculation accuracy for both protons and carbon ion beams.

Materials and methods: CT artifacts in the presence of titanium and CFR-PEEK screws and resultant contouring inaccuracy were evaluated. Water equivalent path lengths (WEPL) of both implants were measured and implemented in our treatment planning system (TPS) for material density assignment. Plans were optimized with and without density correction for both proton and carbon ions. The impact of CT artifacts and contouring uncertainties on dosimetric calculation accuracy was evaluated in comparison with Monte Carlo (MC) calculation. The effect of wrong material assignment was analyzed for two clinical cases evaluating the dose deviation to the target and organs at risks (OARs).

Results: HU artifacts on CT images in case of CFR-PEEK implants are negligible, while titanium screw made it difficult to correctly contour both target and OARs. A good agreement in dose distribution between TPS and MC simulation was found for CFR-PEEK screws, while in case of titanium significant differences in high-Z region were observed. Inaccurate material assignment did not significantly vary the clinical case 3D dose distribution for CFR-PEEK implants (<1%), while in the presence of titanium screws local dose deviations up to 20% can be found when HU uncertainties are not correctly managed.

Conclusions: CFR-PEEK devices have clinical advantages for PT of patients with orthopedic implants leading to less image alteration, less contouring uncertainties and significantly higher dosimetric accuracy than commonly-used titanium devices.

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