Spinal sarcoma treatment

Treatments for primary spinal sarcomas involve a multi-modality approach consisting of surgery, radiation therapy and chemotherapy.

Metallic implants have been correlated to local control failure for spinal sarcoma and chordoma patients due to the uncertainty of implant delineation from computed tomography (CT). Such uncertainty can compromise the proton Monte Carlo technique dose calculation (MCDC) accuracy. A component method is proposed to determine the dimension and volume of the implants from CT images.

The proposed component method leverages the knowledge of surgical implants from medical supply vendors to predefine accurate contours for each implant component, including tulips, screw bodies, lockers, and rods. A retrospective patient study was conducted to demonstrate the feasibility of the method. The reference implant materials and samples were collected from patient medical records and vendors, Medtronic and NuVasive. Additional CT images with extensive features, such as extended Hounsfield units and various reconstruction diameters, were used to quantify the uncertainty of implant contours.

For in vivo patient implant estimation, the reference and the component method differences were 0.35, 0.17, and 0.04 cm3 for tulips, screw bodies, and rods, respectively. The discrepancies by a conventional threshold method were 5.46, 0.76, and 0.05 cm3 , respectively. The mischaracterization of implant materials and dimensions can underdose the clinical target volume coverage by 20 cm3 for a patient with eight lumbar implants. The tulip dominates the dosimetry uncertainty as it can be made from titanium or cobalt-chromium alloys by different vendors.

A component method was developed and demonstrated using phantom and patient studies with implants. The proposed method provides more accurate implant characterization for proton MCDC and can potentially enhance the treatment quality for proton therapy. The current proof-of-concept study is limited to the implant characterization for lumbar spine. Future investigations could be extended to cervical spine and dental implants for head-and-neck patients where tight margins are required to spare organs at risk [1)].

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Chang CW, Charyyev S, Harms J, Slopsema R, Wolf J, Refai D, Yoon T, McDonald MW, Bradley JD, Leng S, Zhou J, Yang X, Lin L. A component method to delineate surgical spine implants for proton Monte Carlo dose calculation. J Appl Clin Med Phys. 2022 Oct 9:e13800. doi: 10.1002/acm2.13800. Epub ahead of print. PMID: 36210177.