Ion therapy of prostate cancer: daily rectal dose reduction by application of spacer gel.

Abstract:
Ion beam therapy represents a promising approach to treat prostate cancer, mainly due to its high conformity and radiobiological effectiveness. However, the presence of prostate motion, patient positioning and range uncertainties may deteriorate target dose and increase exposure of organs at risk. Spacer gel injected between prostate and rectum may increase the safety of prostate cancer (PC) radiation therapy by separating the rectum from the target dose field. The dosimetric impact of the application of spacer gel for scanned carbon ion therapy of PC has been analyzed at Heidelberg Ion-Beam Therapy Center (HIT). The robustness of ion therapy treatment plans was investigated by comparison of two data sets of patients treated with and without spacer gel. A research treatment planning system for ion therapy was used for treatment plan optimization and calculation of daily dose distributions on 2 to 9 Computed Tomography (CT) studies available for each of the 19 patients. Planning and daily dose distributions were analyzed with respect to target coverage, maximal dose to the rectum (excluding 1 ml of the greatest dose; Dmax-1 ml) and the rectal volume receiving dose greater than 90% of prescribed target dose (V90Rectum), respectively. The application of spacer gel did substantially diminish rectum dose. Dmax-1 ml on the treatment planning CT was on average reduced...
from 100.0 ± 1.0% to 90.2 ± 4.8%, when spacer gel was applied. The robustness analysis performed with daily CT studies demonstrated for all analyzed patient cases that application of spacer gel results in a decrease of the daily V90Rectum index, which calculated over all patient cases and CT studies was 10.2 ± 10.4 [ml] and 1.1 ± 2.1 [ml] for patients without and with spacer gel, respectively. The dosimetric benefit of increasing the distance between prostate and rectum using spacer gel for PC treatment with carbon ion beams has been quantified. Application of spacer gel substantially reduced rectal exposure to high treatment dose and, therefore, can reduce the hazard of rectal toxicity in ion beam therapy of PC. The results of this study enable modifications of the PC ion therapy protocol such as dose escalation or hypofractionation.

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