Pancreatic Cancer

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Proton Radiotherapy for Pancreatic Cancer: A Dosimetric Comparison with Photons

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Background: Pancreatic carcinoma remains one of the most formidable challenges in oncology. Despite aggressive multimodality treatment, the survival is still very low and local failure rates remain about 60%. Proton radiotherapy offers the potential of radiation dose escalation without compromise of normal tissue tolerance. In the current study, we evaluated the feasibility of dose escalation with proton as compared with intensity-modulated radiation therapy (IMRT) or IMRT followed by proton boost.

Methods and Materials: Four patients with unresectable pancreatic cancer were included in the study. Three different planning approaches were taken: 1) IMRT alone, 2) IMRT followed by proton boost, 3) proton alone. The initial target volumes were treated to 45 Gy (cobalt Gray equivalent [CGE] for proton) at 1.8 Gy daily, followed by a boost at 1.5 Gy daily for another 22.5 Gy to the reduced volumes, for a total dose of 67.7 Gy (CGE for protons). IMRT plans were generated with Pinnacle treatment planning system. All proton plans were generated with Eclipse treatment planning system based on same target and normal tissue contours. Dose-volume data were collected for the target volume, bowel, liver, stomach, kidney, and spinal cord.

Results: Proton alone, mixed-modality, as well IMRT alone plans all provided acceptable target volume coverage and dose homogeneity. There was an advantage in limiting the dose to critical normal structures with the proton alone plans compared with the IMRT alone plans. This effect was most pronounced in low-dose volumes. For example, in one

patient, the proton alone plans reduced the dose to 1/3 of bowel from 28 Gy with IMRT to 12 Gy, and to 1/3 of liver from 31 Gy with IMRT to 18 Gy. The proton alone plans almost completely spared kidneys and spinal cord. The mixed-modality plans resulted in dose distribution in between that of the proton alone and IMRT alone plans. For example, the dose to 1/3 of bowel was 21.4 Gy, and to 1/3 of liver was 25.9 Gy. An increased integral dose to non-critical normal tissues was also observed for plans utilizing IMRT compared to proton-alone plans.

Conclusions: Proton radiation is superior to IMRT photon radiation in the treatment of pancreatic cancer. Proton radiation maintains the excellent tumor coverage while reducing the radiation dose to adjacent normal structures. The maximum benefits were achieved when proton therapy was utilized as the only modality. Proton treatment appears to be safe for dose escalation.