

A Comparison of Three-dimensional Conformal Proton Radiotherapy, Three-dimensional Conformal Photon Radiotherapy and Intensity Modulated Radiotherapy for Retroperitoneal Sarcomas

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Purpose/Objective(s)

Due to the challenging anatomic location of retroperitoneal sarcomas, preoperative radiotherapy is often associated with gastrointestinal and renal toxicity. We conducted a dosimetric study to compare 3D conformal proton radiotherapy (3DCPT), photon IMRT, and 3D conformal photon RT (3DCRT) to predict the optimal RT technique for treating these cancers.

Materials/Methods

3DCRT, IMRT, and 3DCPT plans were created for 8 patients with retroperitoneal sarcomas referred for preoperative RT. The median tumor volume was 1,635 cm³ (range, 277 to 3476 cm³). The CTV consisted of the gross tumor plus a 2-cm margin, except when the GTV approximated the bowel where a 1.5-cm margin was used. The PTV for the photon plans was a uniform expansion of 5 mm. For the proton plans, it was nonuniform and beam-specific. The prescription dose was 50.4 Gy. Plans were normalized so that 95% of the CTV received 100% of the dose. DVH goals for the organs at risk (OARs) were as follows: spinal cord, 0.1 cm³/50 Gy; kidney, 50%/20 Gy; bowel, V40/170 cm³, V45/100 cm³, and V50/33 cm³; and liver mean dose/30 Gy and 33%/35 Gy.

Results

The CTV was covered adequately by all techniques. The median inhomogeneity coefficient ($[D5-D95]/D95$) was 0.062 for 3DCPT (range, 0.035 to 0.10), 0.066 for IMRT (range, 0.33 to 0.10), and 0.073 for 3DCRT (range, 0.56 to 0.125). The median conformity index ($CTV_{952}/[CTV \cdot V_{95}]$) was 0.69 for 3DCPT (range, 0.56 to 0.76), 0.75 for IMRT (range, 0.68 to 0.82), and 0.51 for 3DCRT (range, 0.42 to 0.64). We evaluated clinically significant DVH points based on QUANTEC (Quantitative Analysis of Normal Tissue Effects in Clinic) benchmarks for OARs. For the 3DCPT, IMRT, and 3DCRT

plans, respectively, the bowel median V15 was 16.4% (range, 8.1% to 36.9%), 52.2% (range, 15.8% to 71.4%), and 66.1% (range, 24.4% to 82.4%); the bowel median V45 was 6.3% (range, 2.0% to 13.2%), 4.7% (range, 0.8% to 28.4%), and 15.6% (range, 6.1% to 30.9%); the median ipsilateral mean kidney dose (MKD) was 22.5 CGE (range, 0 to 53.3 CGE), 34.1 Gy (range, 4.7 to 52.7 Gy), and 37.8 Gy (range, 7.5 to 53.9 Gy); the median contralateral MKD was 0 CGE (range, 0 to 1.4 CGE), 6.4 Gy (range, 0 to 17 Gy), and 11 Gy (range, 0 to 26.5 Gy); the median contralateral kidney V5 was 0% (range, 0% to 8.2%), 49.9% (range, 0% to 100%), and 99.7% (range, 0% to 100%). Despite technique, the median mean liver dose was 30 Gy and the median cord V50 was 0%.

Conclusions

IMRT and 3DCPT resulted in more conformal, homogenous plans than 3DCRT. Based on the QUANTEC benchmarks, the dosimetric advantage of proton therapy in the low-to-moderate dose regions may improve gastrointestinal and genitourinary toxicity, particularly in patients requiring unilateral nephrectomy for tumor infiltration.