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Intensity Modulated Radiation Therapy Compared with 3D Conformal Radiotherapy for Craniospinal Irradiation in Adults – Do We Gain Anything?

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Purpose

Craniospinal irradiation (CSI) remains one of the most technically challenging planning processes in radiation oncology due to its long shape especially in adults and complex target volume. In addition, CSI is associated with significant acute and late morbidities. We undertook a dosimetric analysis to determine if intensity modulated radiation therapy (IMRT) could improve target coverage while sparing normal tissue structures compared to classic 3D conformal radiation (3D-CRT) planning.

Methods

Ten adult patients treated with CSI at Thomas Jefferson University Hospital from 2008-2009 were identified retrospectively. We generated an IMRT plan for each patient and compared with 3D-CRT plans. Nine were simulated in the prone position; one patient was supine. All plans were generated using CMS XiO software. For 3D-CRT plans, opposed lateral cranial fields with collimation and couch rotation were matched to two PA spine fields extending inferiorly up to S2-S3 depending on the location of the thecal sac. For IMRT, the cranial fields were similarly planned with opposed lateral fields, and matched to two IMRT optimized spine fields, each with 5 isocentric fields. The CTV was defined as the entire spinal canal from the foramen magnum through S2-S3 similarly based on thecal sac, and extending laterally to include the nerve roots. PTV was a 5 mm circumferential expansion of the CTV. Organs at risk (OARs) were contoured for each patient including parotids, esophagus, thyroid, heart, lungs, larynx, stomach, small bowel, liver and kidneys. QA of the plan used both a diode array and a simple phantom with film. Statistical comparison was performed using two sided Student's t-test.

Results

Using IMRT, the volume that received 95% of the prescribed dose was 98% compared to 95.7% for 3D planning ($p=0.11$). IMRT resulted in a reduced maximum point dose to the PTV, 118% vs 148% for 3D-CRT ($p < 0.001$) and less volume of PTV (6.2%) that received over 107% of prescribed dose vs 59.5% for 3D-CRT ($p < 0.001$). IMRT resulted in significantly reduced (each $p < 0.05$) mean dose to the left

kidney (35% reduction), lungs (23%), esophagus (36%), liver (40%), heart (54%), small bowel (35%), and thyroid (35%). Mean dose to the right kidney, stomach and parotids were not significantly different. IMRT plans required on average 48% greater monitor units than 3D plans (5450 MU vs 3678 MU, $p < 0.001$).

Conclusion

In adult patients treated with craniospinal radiation, IMRT planning provides more homogenous target coverage while reducing dose to multiple critical organs with a trade-off of greater integral dose.