

Helical Tomotherapy for Palliative Radiotherapy: A Prospective Trial

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Introduction

Helical Tomotherapy (HT) combines fan beam intensity modulated radiation delivery with megavoltage CT (MVCT) imaging capability. At our institution we commissioned an HT Unit (HiArt II, Tomotherapy Inc, Madison, Wisconsin) for clinical use and since 09/04 our first patients have been treated in the context of prospective REB approved clinical trials. We report here the results of our first clinical trial where HT was evaluated for the delivery of palliative radiation treatments.



HT: daily image guidance with intensity modulated delivery



Materials and Methods

Patients with symptomatic locally advanced or metastatic disease suitable for a palliative course (30 Gy/10 fractions) were enrolled. Patients were stratified for treatment according to anatomic site (head/neck vs. thorax vs. abdomen/pelvis). The PTV was contoured as the region of symptomatic disease with a 5-10 mm margin for setup uncertainty. Pretreatment MVCT was used in all patients to correct for setup and detect systematic anatomy changes. Primary outcome was treatment "success" defined as: HT plan equal or superior to a comparison 3DCRT plan; successful in-phantom verification of the HT plan; $\geq 8/10$ fractions delivered by HT; no toxicity attributable to HT $>$ grade 2. An overall success rate of 80% by anatomic site was set as a target to confirm HT as safe and reliable for routine clinical use and 6-12 patients per anatomic site were enrolled as part of the trial. Examples of treated HT distributions are illustrated in Fig. 1.

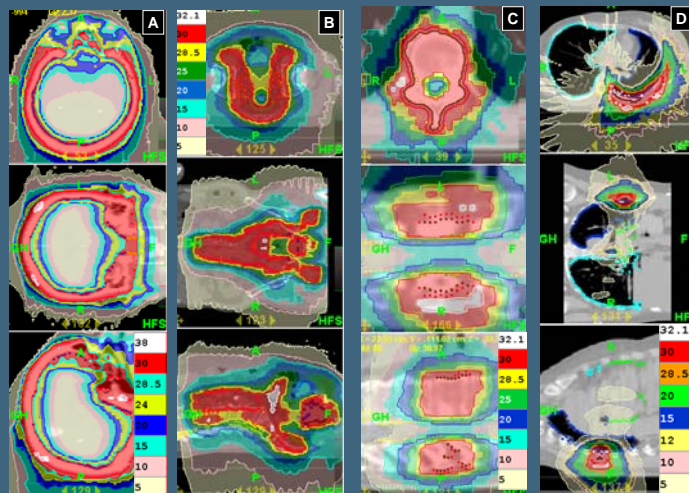


Fig. 1. Examples of novel OAR sparing enabled by tomotherapy: A. whole calvarial radiation with brain sparing; B. Prostate + nodal radiation with bowel sparing; C. vertebral body with central cord sparing; D. chest wall with lung sparing

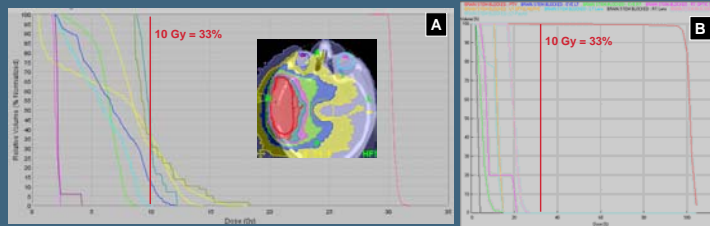


Fig 2. Example of case where non-coplanar 3DCRT offered better OAR sparing: A. HT DVH (dose in Gy, 33% marked); B. 3DCRT DVH (dose in %)

Primary Endpoint

From 09/04-12/05, 25 (7 head/neck; 12 thoracic; 6 abdomen/pelvis) sites were treated in 24 patients (median age 69). Treatments were "successful" in 21/24 patients and "unsuccessful" in 3 (due to machine downtime). Greater than 80% delivery success was achieved in each anatomic site. 209/250 (84%) of planned fractions were actually delivered by HT. Treatment related toxicity was grade 2 or less in all patients (Common Toxicity Criteria). Thus, the primary endpoint of the trial was met.

Target Coverage

Median PTV volume treated was 688 cc and median number of organs at risk (OAR) used for inverse treatment planning was 4 (range 1-7). HT was qualitatively scored (through DVH and isodose distribution comparisons) as superior to 3DCRT in 14 and equivalent in 11. Planning target volume coverage (PTV D95) was equivalent or superior to 3DCRT in all cases.

OAR Comparisons

Among a total of 111 paired comparisons of clinically relevant OAR DVH points (i.e. V20 for lung, Dmax for spinal cord) HT was deemed superior (HT DVH value $<$ 95% of 3DCRT DVH value) in 40%, equivalent (HT 95%-105% of 3DCRT value) in 37% and inferior (HT $>$ 105% of 3DCRT value) in 33%. In the cases where OAR by HT sparing was deemed "inferior", OAR sparing was still well within clinically acceptable limits and usually was associated with improved sparing of other organs in the same patient (i.e. represented a weighted balance of multiple OAR sparing by HT). In only one case (a lateralized middle ear tumor) did 3DCRT with non-coplanar fields improve significantly better OAR sparing than HT (Fig. 2).

Treatment Process and Patient Satisfaction

Median vector shift following pretreatment MVCT was 4.3 mm (SD 1.7) and was smaller for head/neck patients (2.0 mm SD 0.6, $p < 0.0001$), likely reflecting the use of immobilization shells. Average treatment was 28 (SD 12) minutes; with MVCT/positioning a mean of 20 (SD 10) minutes and treatment delivery a mean of 7 (SD 5) minutes. Using a 10-point visual analog scale, patient satisfaction with HT was high (86% satisfied to very satisfied).

Conclusions

HT was successfully deployed for treatment of a diverse group of patients, offered advantages over 3DCRT in many cases and was well tolerated.