A Study of Sequential and Simultaneously Integrated Boost IMRT Methods in Head and Neck Cancer

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Introduction:

IMRT in H&N cancer has yielded significant dosimetric improvements compared to the conventional 3D conformal radiotherapy. The benefits shown in several studies were delivering higher dose to target volumes while limiting the dose to organs at risk, especially for parotid gland, spinal cord and brainstem. H&N cancer can be treated using the sequential IMRT based on a conventional fractionation approach or the simultaneous integrated boost technique (SIB). The SIB-IMRT approach is used to increase the fraction dose to the boost volume while maintaining the dose to the elective volume at a lower dose level. Several studies with the SIB-IMRT showed that the technique produced better coverage of boost volume and less doses to critical organs and normal tissues in addition to fewer fraction treatment. However, the sequential IMRT may be better than SIB-IMRT for some H&N cases depending on medical and biological parameters. Currently, the fractionation strategy, biologic effectiveness and parameters affecting the clinical outcomes are being investigated in H&N cancer.

Materials and Methods:

- Retrospective study of 10 sequential and 17 SIB IMRT cases
- Pinnacle (v.8.0, v.9.0 and v.9.2; Philips Healthcare)
- 9 beam angles for both techniques (The quality of plans improves with number of beams, reaching a saturation level at 9 in H&N IMRT)

Results:

- Index analysis from dose-volume histograms (DVHs)
  1. Homogeneity index:
     \[ HI = D_{95\%}/\text{prescription dose (PD)} \]
  2. Radiation conformality index:
     \[ RCI: \frac{PTV_{PD}}{PTV_{0.95PD}} \]
- DVH statistics utilized to estimate the radiobiological outcomes of TCP and NTCP using the Poisson statistics and JT Lyman models in the HART
  1. Critical spots:
     - Normalized volume > normal tissue tolerance dose TD50,5 (>2/3 organ)
  2. Hot spots:
     - Normalized volume > PD
- Quality factor (QF):
  Calculated by giving equal weight (0.10) to all of the 10 indices [HI, RCI, target coverage index (TCI), critical organ scoring index (COSI), prescription isodose target volume conformal index (PTV1), modified dose homogeneity index (MHI), conformation number (CN), Target volume ratio (TVR), Dose gradient index (DGI), and new conformity index (NCI)]. QF<1 indicates the overdose treatment; QF>1 represents under-dose treatments; and QF=1 represents an ideal case for an optimal radiotherapy plan.

Conclusions:

For both boost methods mean HIs were comparable while mean RCI was better with SqB than SIB method. QF was significantly better in SIB than in SqB. Critical spots and hot spots were reduced in SIB method. Both SqB and SIB methods yielded similar NTCP for larynx and esophagus. Although better parotid sparing with SIB method than SqB was observed; due to the differences in tumors, stages and doses more patient data and detailed analyses should be followed for comparison. The radiobiological outcome-related analysis using DVH can be utilized to evaluate different treatment planning techniques.

References: