Implication of the spatial resolution of the conventional dose-volume histogram (DVH) analysis in the radiation therapy treatments.

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Purpose: To assess the accuracy of IMRT plans using a novel approach of spatial-DVH (sDVH) analysis in the Histogram Analysis in Radiation Therapy (HART).

Background:
- History of HART:
  - An open source software system *(2008),
  - An efficient and accurate DVH analysis program,
  - Cumulative-DVH (cDVH) and sDVH analysis features,
- The cDVH analysis loses the spatial information of the dose-distribution such as “hot” and “cold” spots, in the evaluation of the advanced radiation therapy plans,
- A cDVH curve can be resolved into the components of spatial-DVHs (sDVHs; x-, y- and zDVHs respectively).

Materials and Methods:
- HART software was developed in MATLAB based codes.

Results and Discussions:

- Cumulative DVH (cDVH) simulation in HART:

Fig. 2 Figure demonstrates the cDVH analysis of the larynx (V200 = 0.24 ± 0.02) in an IMRT plan of a typical head and neck (HN) cancer patient.

- Space based DVH (xDVH) simulation along x-planes:

Fig. 3 The x-component of the cDVH analysis (xDVH) as shown in the Fig. 2 of the larynx (V200 = 0.26 ± 0.02) in the IMRT plan of the HN cancer patient.

- Space based DVH (yDVH) simulation along y-planes:

Fig. 4 The y-component of the cDVH analysis (yDVH) as shown in the Fig. 2 of the larynx (V200 = 0.27 ± 0.02) in the IMRT plan of the HN cancer patient.

- Space based DVH (zDVH) simulation along z-planes:

Fig. 5 The z-component of the cDVH analysis (zMVH) as shown in the Fig. 2 of the larynx (V200 = 0.26 ± 0.02) in the IMRT plan of the HN cancer patient.

- The sDVH analysis found the isotropic distribution of the low-density hot-spots (< 5% per unit slice) in 57 ±12% (N=10) and 93 ±2% (N=10) of the slices of the parotid glands and larynx respectively, however the high-density hot-spots were uniformly polarized in the space in the 90 ±8% (N=10) of the slices of the submandibular glands in the sequential IMRT boost (SqIB) treatment plans.

Conclusion:
- The sDVH analysis is the more precise and practical approach for the in-depth analysis of the radiation therapy treatment plans.
- In this study, the hot-spots estimated from the sDVH analyses, were consistent with the cDVH analyses at higher resolution (1 mm).
- Future work: To develop 4 dimensional space-time DVH analysis features compatible with various types of commercial TPSs.

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References:

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