A crowd-knowledge-based analysis of DVHs in SBRT: first steps towards a national virtual audit

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Introduction and Objectives

Currently, most of the multicenter analyses on treatment planning rely on selected data extraction from the dose volume histogram (DVH) of each plan. Different treatment planning systems employ different algorithms to generate the DVH. This bias can cause a grouped analysis due to possible poor data consistency. In order to make data comparable, a homogeneous method for data extraction is necessary. In this work we used a consistent method to present a preliminary analysis of multiple data coming from a national survey on stereotactic body radiotherapy (SBRT) planning.

Methods

Case:

- A Spine tumor case (Fig.1) was shared among 9 radiation oncology centers.
- Considered organs at risk (OARs) were: Cord PRV, Heart, Esophagus, Stomach, Small Bowel, Kidneys and Liver.

Plan Objectives:

- The dose prescription was 30 Gy in 3 fractions.
- Dose constraints on the planning target volume (PTV) were:
  - At least the 90% of the PTV had to be covered by the prescribed dose.
  - PTV coverage less than 90% was considered a minor deviation.
  - PTV coverage less than 80% was considered unacceptable.
  - No restriction was imposed on maximum dose within the PTV.
  - The V105% (of the prescribed dose) had to be 1 cm away from the PTV edge.
- Dose constraints on OARs were set as in Tab.1.

<table>
<thead>
<tr>
<th>OARs</th>
<th>V105 GY ≤ 0.35cc</th>
<th>V21.9 GY ≤ 0.03cc</th>
<th>V30.0 GY ≤ 0.03cc</th>
<th>V25.2 GY ≤ 0.03cc</th>
<th>V21.9 GY ≤ 0.03cc</th>
<th>V0.35 GY ≤ 0.03cc</th>
<th>V25.2 GY ≤ 0.03cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cord PRV</td>
<td>V18.0 GY ≤ 0.35cc</td>
<td>V21.9 GY ≤ 0.03cc</td>
<td>V30.0 GY ≤ 0.03cc</td>
<td>V25.2 GY ≤ 0.03cc</td>
<td>V21.9 GY ≤ 0.03cc</td>
<td>V0.35 GY ≤ 0.03cc</td>
<td>V25.2 GY ≤ 0.03cc</td>
</tr>
<tr>
<td>Heart</td>
<td>V24.0 GY ≤ 15cc</td>
<td>V30.0 GY ≤ 0.03cc</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Esophagus</td>
<td>V17.7 GY ≤ 5cc</td>
<td>V25.2 GY ≤ 0.03cc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stomach</td>
<td>V16.5 GY ≤ 10cc</td>
<td>V22.6 GY ≤ 0.03cc</td>
<td></td>
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<td></td>
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<tr>
<td>Small Bowel</td>
<td>V16.5 GY ≤ 5cc</td>
<td>V25.2 GY ≤ 0.03cc</td>
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<tr>
<td>Kidney</td>
<td>V15.0 GY ≤ 35%</td>
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<tr>
<td>Liver</td>
<td>V15.0 GY ≤ 700cc</td>
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</tr>
</tbody>
</table>

Table 1: OARs dose constraints

Planning and Post-processing:

- The VMAT delivery technique was employed by each center.
- All data were collected in DICOM-RT format.
- A script was developed in R language using the RadOnc R-Package for DVHs recalculating using a single algorithm.
- Specific DVH points collected from the 9 centers were compared with those recalculated with RadOnc.
- Using the data recalculated with RadOnc, a consistent multiple-DVH analysis was performed and relevant dose parameters were compared.
- This preliminary analysis was focused only on dose parameters relative to the planning target volume (PTV).

Results

- Differences between collected and recalculated DVHs were minimal (i.e. within 1%). However in one case a difference of 1.5% (~0.5Gy) was found for the D2% to the PTV.
- The multiple-DVH analysis showed a notable variability on target dose level (Fig.2).

![PTV Multiple-DVH](image1)

![PTV Doses](image2)

- The D2% to the target deviated from its median value up to 34%. Deviations of comparable magnitude were found for the mean dose. These differences were caused mainly by different planning optimization strategies, rather than by the use of a specific treatment technology.
- The variability was reduced when considering the dose level corresponding to the prescribed target coverage (i.e. D90% in Fig.2). This could be attributed to a clear indication on the coverage constraint given in the planning guidelines.

Conclusions

- A homogeneous calculation and extraction method of DVH data was applied to a grouped analysis of SBRT plans.
- The bias due to different DVH calculation algorithms was eliminated by employing a single independent calculation method.
- The observed differences suggest that comparable standards in patient treatment among different centers can be obtained if a consistent high-level data sharing capability is granted [1].
- In the strive to harmonize the planning process, this analysis constitutes a first step toward the creation of a platform of crowd-knowledge-based planning guidelines. This platform could give a high-quality benchmark to less experienced centers that are willing to implement SBRT techniques (concept expressed in Fig.3).

![PTV Multiple-DVH](image3)

![PTV Doses](image4)

- The variability of comparable magnitude were found for the mean dose. These violations of comparable magnitude were found for the D2% to the PTV.

References