Reverse auto-planning: Assessing dose escalation in pancreatic stereotactic radiotherapy from a shape database of prior patients

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Purpose/Objectives

- Automatic treatment planning uses a database to look up normal tissue planning objectives for a specified target coverage based upon similar previously treated patients.
- Reverse auto-planning looks for the highest achievable target dose while maintaining the critical structure maximum dose objectives.
- Determining the highest achievable target dose in advance of planning allows for assessment of plan difficulty and for selecting different treatment strategies or dose escalation.

Materials/Methods

- A database of 53 previously treated pancreas SBRT patients is populated with dose and structure information.
- To aid in database driven analysis of the patients, all structure names are mapped to a common set of structures by way of an automatic renaming tool.
- An Overlap Volume Histogram (OVH) describes the relationship between structures in the patient by plotting the Planning Target Volume (PTV) expansion distance required to overlap a percentage of the Organ at Risk (OAR) volume (Figure 1).
- OVH data is generated for each OAR/PTV combination.
- Plotted OVH and Dose Volume Histogram (DVH) show that a greater distance to overlap allows for a lower OAR dose (Figure 2).
- For a new patient, OVH data is generated and used as input to the reverse-auto planning tool (Figure 3).
- The reverse-auto planning tool queries the achievable dose values from the database.
- For each OAR, the achievable target dose and OAR dose is determined from all patients with the same or smaller OVH distances.
- The highest achievable target dose which corresponds to a OAR dose within tolerance is reported.
- For each OAR, the highest achievable target dose is calculated for each patient with a smaller OVH distance by scaling the achieved OAR dose to the protocol limit.
- It is assumed that scaling the dose produces an achievable dose since the dose for all structures is scaled by the same value.
- The lowest achievable target dose reported from the group of per-structure highest achievable target dose is selected as the maximum achievable target dose.
- If the query fails for any structure, the queried value is colored orange.
- All queried OAR doses must be successful to get a valid maximum PTV dose.

Materials/Methods (cont.)

- Reverse-auto planning requires a larger patient database than standard auto-planning to obtain successful queries.
- Unsuccessful queries are from more difficult cases where there is no shape relationship in the database of equal or closer distance.
- A larger database allows for more difficult cases to be successfully queried.

Results

- This tool generates a predictor of plan difficulty.
- OAR objectives are easier to meet on plans with reported higher achievable target dose.
- OAR objectives are difficult or unachievable with lower reported achievable target dose.

Conclusions

- A tool for determining achievable target doses is presented.
- This tool can be used to determine plan difficulty or drive dose escalation strategies.
- Predicted plan difficulty can be used to adjust the treatment strategy.
- Some patients may be determined to be unsuitable for SBRT at the planned prescription levels due to critical structures in close proximity receiving unacceptably high target dose.
- The target dose can be raised for patients which have larger separation between targets and critical structures.

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