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)

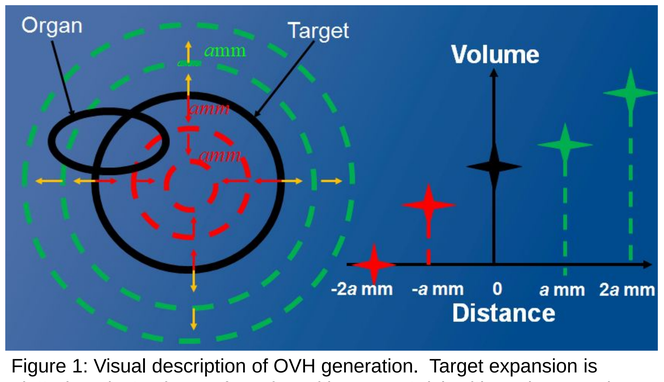

Figure 1: Visual description of OVH generation. Target expansion is plotted against volume of overlap with organ at risk with each expansion.

- 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)

Materials/Methods (cont.)

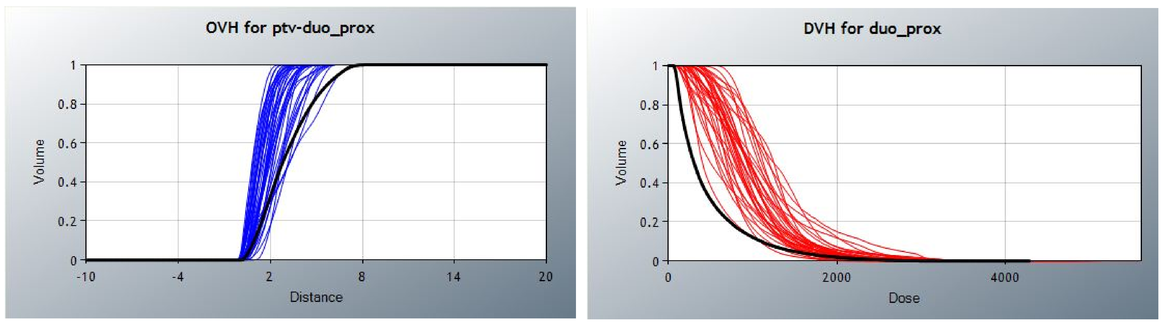

Figure 2: Overlap Volume Histograms represent relative volume of overlap of the OAR with the target as a function of expansion distance of the target. They can be read as Y% of the OAR is within X cm of the target. All patients with OVH curves left of the black line are harder to plan. The black DVH represents the same plan.

- 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.

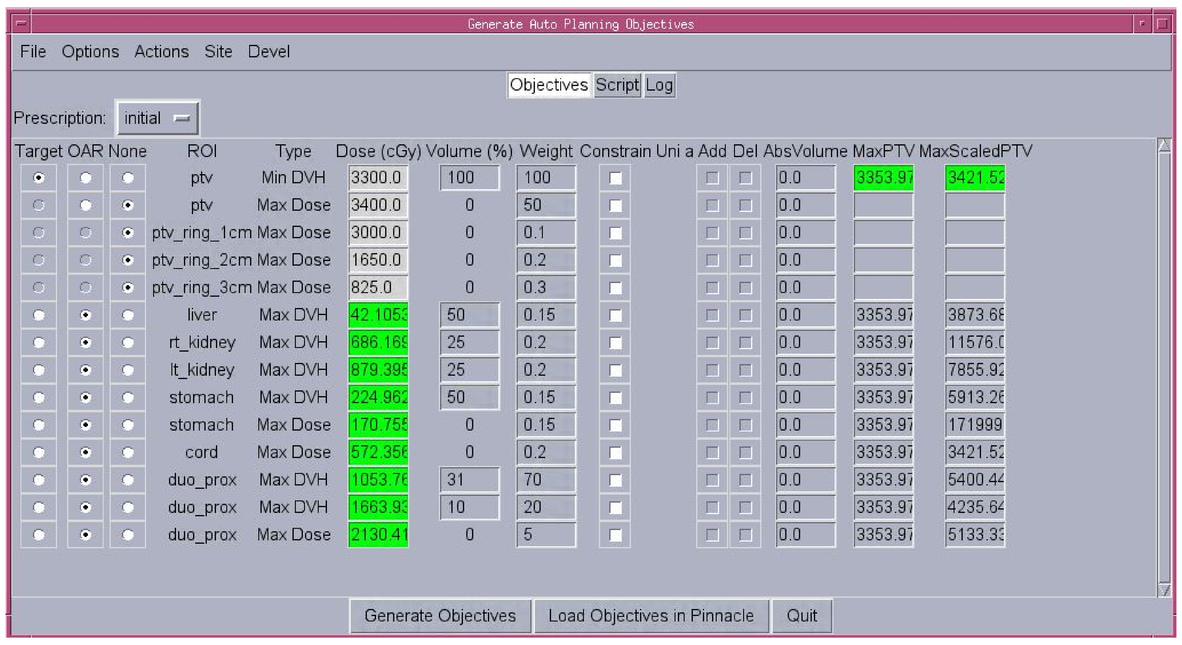

Figure 3: Reverse-auto planning dose lookup. Successful lookups are colored in green, unsuccessful lookups in orange. MaxPTV is the maximum PTV dose associated with the achieved value. MaxScaledPTV is the maximum PTV dose when the achieved critical structure dose is scaled to the tolerance limit

- 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

- 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

Acknowledgements

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