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Evaluating the Pre-Clinical Release of a Commercial Auto-contouring Software for use in CT-based Gynecological Brachytherapy

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Introduction

- High-dose-rate (HDR) brachytherapy (BT) plays an important role in the management of many gynecological cancers.
- Segmenting organs-at-risk for planning is time-consuming and subject to inter-observer variability [1].
- Deep-learning-based auto-contouring tools have been introduced into the clinic, primarily in the setting of external beam radiotherapy [2].
- Auto-contouring of normal tissues within BT presents additional challenges due to the presence of applicators and CT markers, which may decrease contrast to noise ratio and increase high density artifacts in CT images, potentially resulting in organ contour deformation [3].

Aim

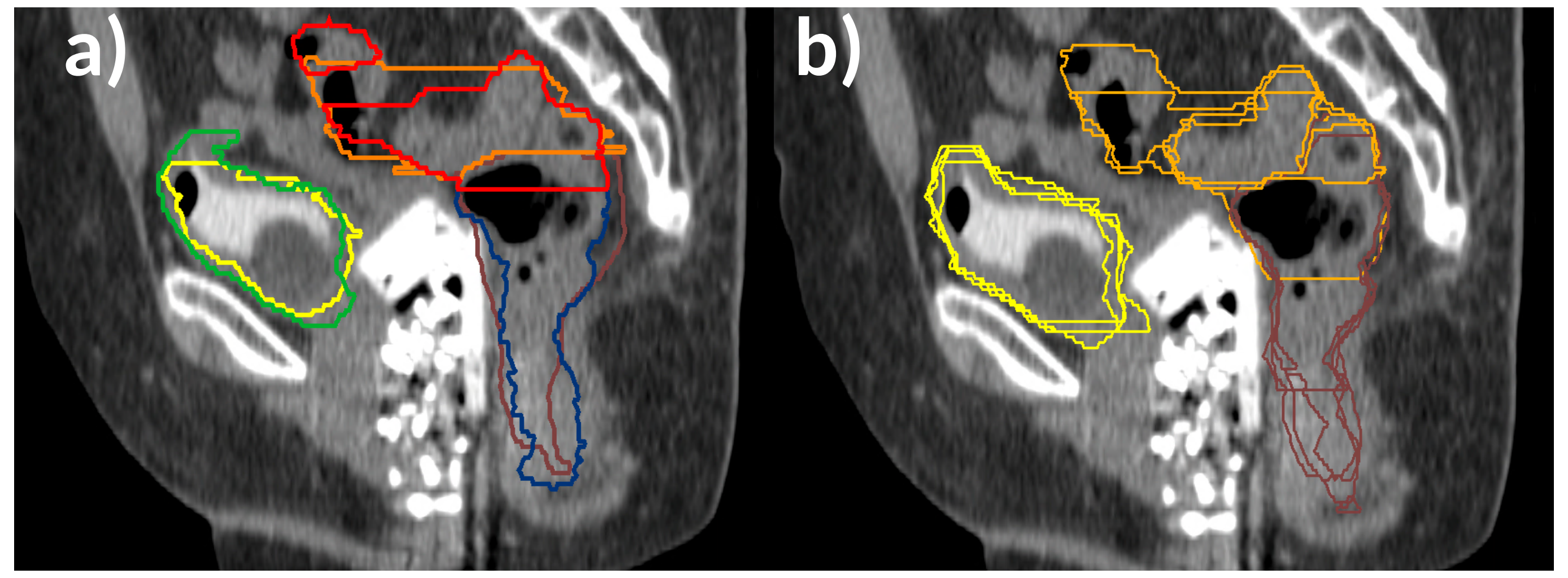
To evaluate the pre-clinical release of a commercial deep-learning-based auto-contouring software, **Limbus Contour, for use in gynecological BT.**

Methods

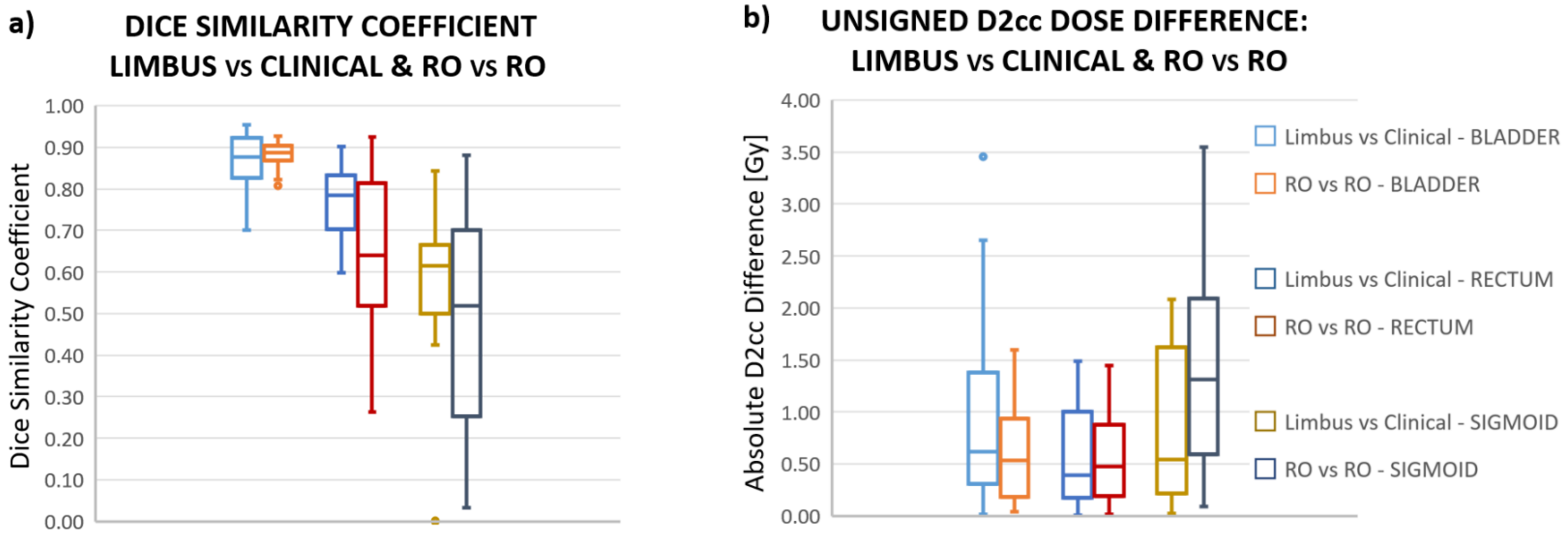
- **CT images** were collected from 135 patients treated at a single institution using **plastic and titanium applicators** including: tandem and ring, tandem and ovoid, and template-based interstitial.
- From this cohort, 107 patients were included within a multi-institutional training dataset of >250 patients. All images were re-contoured to ensure consistency.
- To evaluate model performance, a held-back dataset of **23 patients** from this cohort was selected for **model testing.**
- Segmentation accuracy was evaluated for Bladder, Rectum, and Sigmoid.
- To assess inter-observer contouring variability, the remaining **five patient datasets were re-contoured by four experts** (3 Radiation Oncologists [ROs], 1 Radiation Oncology Fellow).
- **Dosimetric and geometric differences were compared** between Limbus and Physician contours for the 23-patient testing dataset and benchmarked against the corresponding results from the 5-patient inter-observer dataset.

Results

- The mean ± standard deviation (SD) **Dice similarity coefficient** (DSC) when comparing **<u>Limbus vs clinical contours</u>** and **<u>RO vs RO retrospective contours</u>** were respectively:
  - 0.87 ± 0.07 and 0.88 ± 0.03 for bladder (p=0.32)
  - 0.77 ± 0.09 and 0.64 ± 0.20 for rectum (p=0.004)
  - 0.57 ± 0.21 and 0.48 ± 0.27 for sigmoid (p=0.27)
- The corresponding comparisons for **mean distance to agreement** were respectively:
  - 1.4 ± 0.6 mm and 1.4 ± 0.4 mm for bladder (p=0.83)
  - 2.3 ± 1.0 mm and 5.0 ± 4.2 mm for rectum (p=0.002)
  - 16.1 ± 25.7 mm and 16.1 ± 14.6 mm for sigmoid (p=0.99)
- The mean ± SD unsigned **D2cc** dose differences for Limbus vs clinical contours and RO vs RO retrospective contours were respectively:
  - 0.94 ± 0.90 Gy and 0.60 ± 0.43 Gy for bladder (p=0.11)
  - 0.57 ± 0.49 Gy and 0.57 ± 0.46 Gy for rectum (p=0.98)
  - 1.1 ± 1.7 Gy and 1.5 ± 1.1 Gy for sigmoid (p=0.46)



Sagittal CT showing: a) clinical vs Limbus contours for bladder (yellow vs green), sigmoid (orange vs red) and rectum (brown vs blue), and b) the same structures contoured by four radiation oncologists (bladder = yellow, sigmoid = orange, rectum = brown).



Box-and-whisker plots showing: a) DSC for Limbus vs clinical contours (23 patients) and RO vs RO retrospective contours (5 patients x 4 ROs), and b) Absolute D2cc difference between Limbus vs clinical contours and RO vs RO retrospective contours.

Conclusions

- When comparing auto-contoured bladder, rectum, and sigmoid structures with the clinically used contours, **dose metrics were similar to metrics seen when RO contours were compared with one another**.
- **Geometry metrics were also similar**, except for rectum, where Limbus agreed better with the clinical contours than ROs with one another, potentially due to variation in the rectal-sigmoid interface.

Future Work

- Retrospective contouring will be repeated, but where ROs are provided the Limbus contours to edit as needed. Comparisons will include:
  - Timing data with and without AI contours, to assess possible efficiency improvements
  - Geometric and dosimetric variability, to assess whether inter-physician variability decreases when AI contours are provided as a starting point

References

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