Applicability of Deep Learning assisted Internal Margin generation in SBRT for Hepatocellular Carcinoma Using 4D CT with Free Breathing

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Objectives

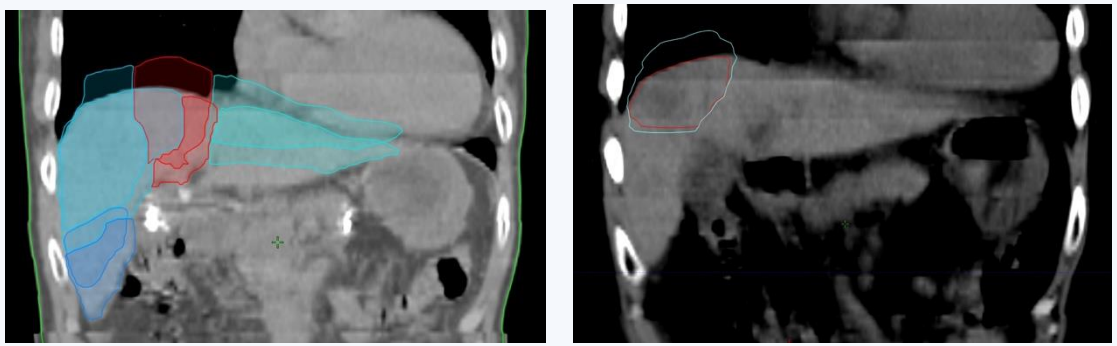
- SBRT is an established treatment for hepatocellular carcinoma (HCC)
- Free breathing 4DCT is commonly used for motion management, but internal margin (IM) generation is operator-dependent because the tumour is often poorly visualised
- To evaluate the feasibility of a deep learning (DL)-assisted workflow to derive IM in patients with HCC treated with SBRT

Methods

- Retrospectively analysed 8 consecutive patients with 10 HCC treated with SBRT under free breathing between Jan and Apr 2025
- Included only cases where the tumour was clearly visualised across all 4DCT respiratory phases
- Oncologist-derived IM were reviewed and verified by a liver SBRT expert
- A DL based auto-contouring model delineated all liver segments, which was used as surrogates for tumour motion.
- An affine transformation matrix tracked segment motion across respiratory phases, and the he resulting DL-derived IM was compared with the oncologist-derived margin

Result

- 10 lesions were analysed: 6 in left lobe and 4 in right lobe
- Mean oncologist-derived IM was 14.5 mm
- Mean DL-derived IM for the tumour-containing segment was 15.2 mm
- Paired t-test analysis showed no statistically significant difference between oncologist- and DL-derived IM (t=-0.9, p=0.39)
- Average runtime for the DL-assisted workflow was 8 minutes per case



Conclusion

- The DL-assisted workflow produced IM comparable to those generated by experienced oncologists, with meaningful time savings
- These findings support further development and validation of the workflow for integration into routine liver SBRT planning
- Large-scale internal and external validation studies are ongoing

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