

Introduction

MR-guided online adaptive radiotherapy (MRgRT) on a 0.35T MR-linac facilitates safe high-dose stereotactic ablative radiotherapy to targets immediately adjacent to gastrointestinal organs at risk (GI-OARs), such as locally advanced pancreatic cancer (LAPC). Through improved soft tissue delineation, adaptive recontouring/replanning and gated beam delivery, MRgRT both minimises margin size and allows the clinical team to account for changes that occur in the position of OARs both within and between fractions. We present a case study illustrating these principles, along with data derived from 20 consecutively treated LAPC patients.

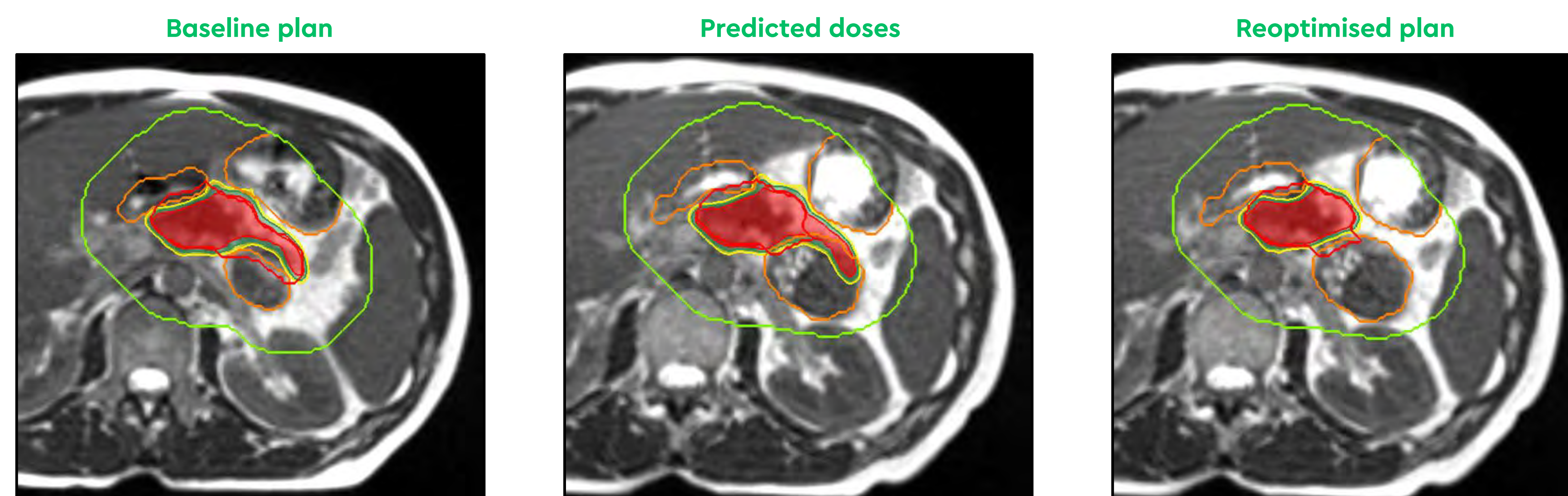
Daily adapted MR-guided SABR case study




A 58 year old patient with locally advanced pancreatic cancer (T4N0) which remained inoperable after chemotherapy. MDT review determined the patient was suitable for MR-guided SABR as part of the Compassionate Access Programme.

A baseline treatment plan was created from the planning MR and CT simulation. During daily plan adaption, the target volume and nearby OAR contours were adjusted. At each fraction, two treatment plans were created: the predicted dose from the baseline plan re-calculated on the daily anatomy and a reoptimised plan.

The baseline treatment plan shows excellent coverage of the high dose PTV region, whilst sparing the adjacent gastro-intestinal stomach, duodenum and small bowel OARs (GI-OARs). However, at fraction 1 the change in position of the GI-OARs would have resulted in significantly exceeding GI-OAR dose constraints had the predicted plan been delivered. Following reoptimisation a suitable plan was created and delivered which maintained optimal target coverage whilst sparing the GI-OARs.

Treatment was delivered in breath-hold using real-time cine MR image tracking with beam gating to monitor intrafraction motion.

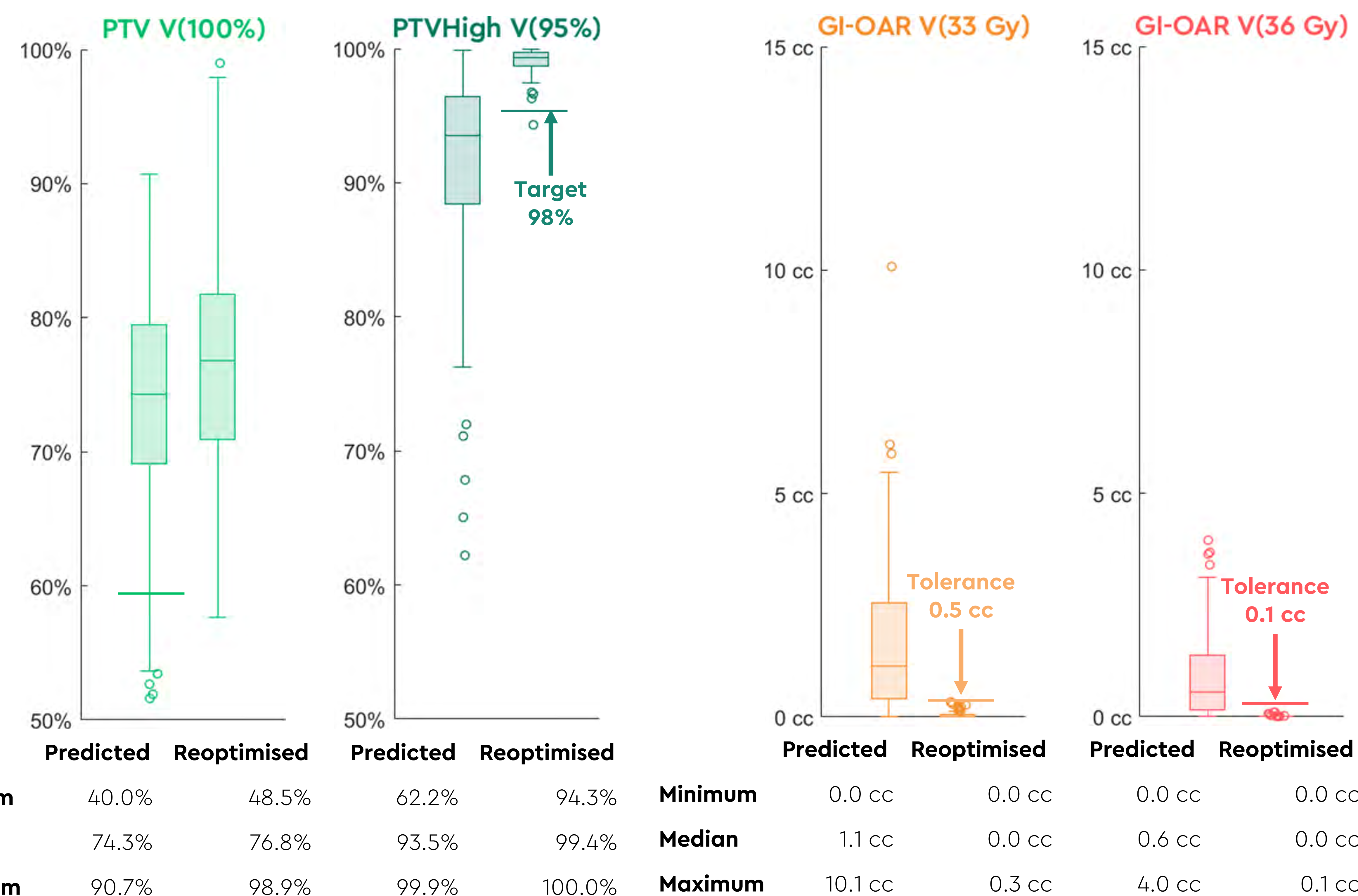


	Baseline	Predicted doses	Reoptimised plan
 40 Gy	PTV	V(100%)	76.7%
 36 Gy	PTV High	V(95%)	99.5%
 33 Gy	GI-OAR	V(36 Gy)	0.0 cc
		V(33 Gy)	0.0 cc
		1.6 cc	0.0 cc
		2.5 cc	0.0 cc

Maintaining target coverage whilst sparing organs at risk

The PTV coverage and GI-OAR doses from the predicted and reoptimised plans for 100 consecutive LAPC fractions were reviewed. In many cases, the exquisite soft tissue contrast of the MR-linac allowed precise patient setup and therefore the volume of the PTV receiving the prescription dose (PTV V100) was slightly improved between the predicted and reoptimised fractions (72.1% vs 76.6%, $p = 0.001$). During the adaptive process, the region of the PTV which does not overlap nearby OARs (PTVHigh) is recreated based on daily anatomy. Daily reoptimisation improved PTV-high coverage by median of 5.4% ($p = 1e-20$) whilst ensuring that GI-OAR constraints were met by significantly reducing the GI-OAR V33 ($p = 8e-17$).

Box and whisker plots summarising key metrics of the predicted and re-optimised treatment plans.



References

Rudra S, Jiang N, Rosenberg SA, Olsen JR, Roach MC, Wan L, Portelance L, Mellon EA, Bruynzeel A, Lagerwaard F, Bassetti MF. Using adaptive magnetic resonance image-guided radiation therapy for treatment of inoperable pancreatic cancer. *Cancer medicine*. 2019 May;8(5):2123-32.

Tyagi N, Liang J, Burlison S, Subashi E, Sripes PG, Tringale KR, Romesser PB, Reyngold M, Crane CH. Feasibility of ablative stereotactic body radiation therapy of pancreas cancer patients on a 1.5 Tesla magnetic resonance-linac system using abdominal compression. *Physics and imaging in radiation oncology*. 2021 Jul 1;19:53-9.