Quantifying the benefit of daily on-table adaptation in reducing gastric and duodenal NTCP during stereotactic MR guided adaptive radiotherapy (SMART)

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Background

The role of SABR in the treatment of OMD is firmly established [1]. While generally well tolerated, SABR to abdominal targets can carry a risk of severe gastro-intestinal toxicity [2].

It has been previously demonstrated that daily adaptation can achieve significant reduction in gastric NTCP [3].

We undertook a planning study to quantify the effect of daily adaptation on gastric and duodenal NTCP during SMART to abdominal targets..

Methods

Retrospective planning study. Consecutive patients receiving SMART to abdominal targets were identified. Cases where any part of the stomach and/or duodenum was within 3cm of the PTV on baseline plan were included. SABR was delivered on 0.35T MRIdian Linac (ViewRay Systems Inc). Duodenum and stomach were retrospectively re-contoured on the daily setup imaging. Data extraction was performed using an in-house developed Python application at following timepoints: baseline (baseline plan applied to OARs on simulation imaging), predicted (baseline plan applied to re-contoured OARs on daily setup imaging), adaptive (re-optimised plan applied to re-contoured OARs). Lyman-Kutcher-Burman (LKD) model was used for NTCP calculation. Comparisons were carried out between predicted and adaptive plans to assess adaptation benefit. Number of patients needed to treat (NNT) with SMART to achieve 1 and 5% NTCP reduction were reported

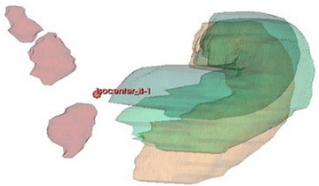

Figure 1: Relative position of the stomach on subsequent treatment fractions in relation to three GTvs being treated simultaneouslykowczarczyk1

Results

Twenty-three SMART treatments to abdominal targets resulting in 115 fully adapted and re-optimised fractions were analysed (**Table 1**).

Age, median (range)		66 (39-83)
Gender (%)	Female	13 (57%)
Primary histology (%)	Colorectal	7 (30%)
	BTC	6 (26%)
	Breast	3 (13%)
	Pancreas	2 (9%)
	Other	5 (22%)
GTV (cc), median (range)		23 (1.5-180)
PTV (cc), median (range)		59 (6.5-242)
Dose (Gy), median (range)		40 (30-60)

Table 1. Patient demographics, tumour characteristics and treatment details

Despite fasting instructions, significant inter-fractional variability in gastric filling with mean percentage difference of 36.8% (±17.5) was observed (**Fig 1**). Daily adaptation was associated with a significant mean gastric and duodenal NTCP benefit of 2.5% (p=0.03). Baseline plan underestimated gastric NTCP by 5.95%. Daily adaptation resulted in mean stomach NTCP reduction of 5.42% (from 6.87% to 1.45%). We observed a reduction of >1% in stomach NTCP in 16.5% delivered fractions (15% of patients) and a reduction of >5% in 13% of fractions (10% of patients). NNT with daily adaptation was 6.7 and 10 to achieve 1 and 5% NTCP reduction, respectively (**Table 2**). No association between baseline GTV or PTV volume, baseline gastric filling and gastric filling variability and NTCP benefit was observed. Targets in the porta hepatis and liver hilum derived the largest benefit from daily adaptation (**Fig 2**)

Structure	Baseline	Adapted	Predicted	Predicted – Adapted	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	P-value
All	0.46 ± 1.07	1.25 ± 3.63	3.83 ± 3.42	2.58 ± 12.3	0.03
Duodenum	0.06 ± 0.05	1.07 ± 3.02	1.19 ± 20.3	0.12 ± 1.29	0.07
Stomach	0.92 ± 1.45	1.45 ± 4.22	6.87 ± 14.3	5.42 ± 17.6	0.18

Table 2. Benefit of daily adaptation in reducing gastric and duodenal NTCP during MR guided adaptive SABR

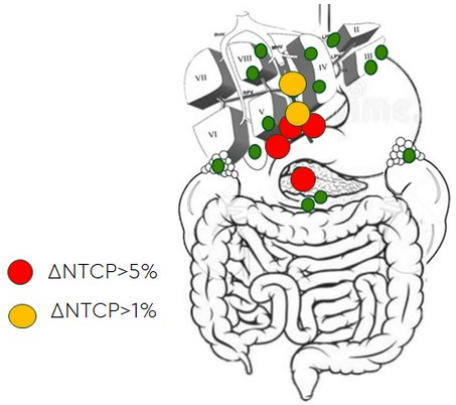

Figure 2: NTCP benefit from daily adaptation colour coded based on target location in the upper abdomen

Conclusion

In this single institution planning study, SMART to abdominal targets resulted in mean absolute stomach NTCP reduction of 5.42% with 1 in 10 patients (1 in 7 delivered fractions) achieving a clinically meaningful NTCP benefit with daily adaptation

References

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