

### INTRODUCTION

Prospective dose escalation clinical trial may often be limited with respect to contraindications and dose limitations on surrounding structures. Liver SBRT aims to treat hepatic metastasis in a curative intent as surgery and radiofrequency which desired a higher dose prescription at meanwhile sparing the healthy liver tissue, bowels and duodenum. If we leave the radiobiological modeling debate alone, whether there is any limits or technical ceiling in the physical dose escalation and dose sparing? With increased degree of freedom in the proton therapy via arc trajectory, spot-scanning proton arc (SPArc) therapy, as a merging novel treatment technique, could potentially offer an unconventional dose escalation. The study used a liver CT structure to demonstrate the capability of dose escalation. At meanwhile, raise a question to a society, what dose level shall we escalate to with the merging techniques.

### METHODS AND MATERIALS

A liver cancer patient with CTV 1377cc, GTV 305cc for dose escalation and the remaining healthy liver tissue 626cc. The right kidney, bowel and duodenum were abutting the CTV which makes this case challenge in planning and dose escalation almost impossible with the convention technique such IMPT or VMAT. In the clinical plan, 2-field IMPT were used and prescribe the dose to 50 Gy in 15 fx without exceeding the dose limitation of OARs. SPArc plan was generated using the same robustness parameter 5mm setup uncertainties and 3.5% range uncertainties. GTV structure is used for dose escalation until one of the OARs reach its limitation. GTV and CTV dose coverage were compared.

### RESULTS

With all the dose constrains meet in the SPArc dose escalation planning. The GTV reached mean dose 405Gy compared to 53 Gy in IMPT. In addition, D99 of GTV received 100Gy in comparison 51Gy in IMPT. CTV received a mean dose 163 Gy in SPArc in comparison with 53Gy in IMPT. All the OARs met the clinical constraints.

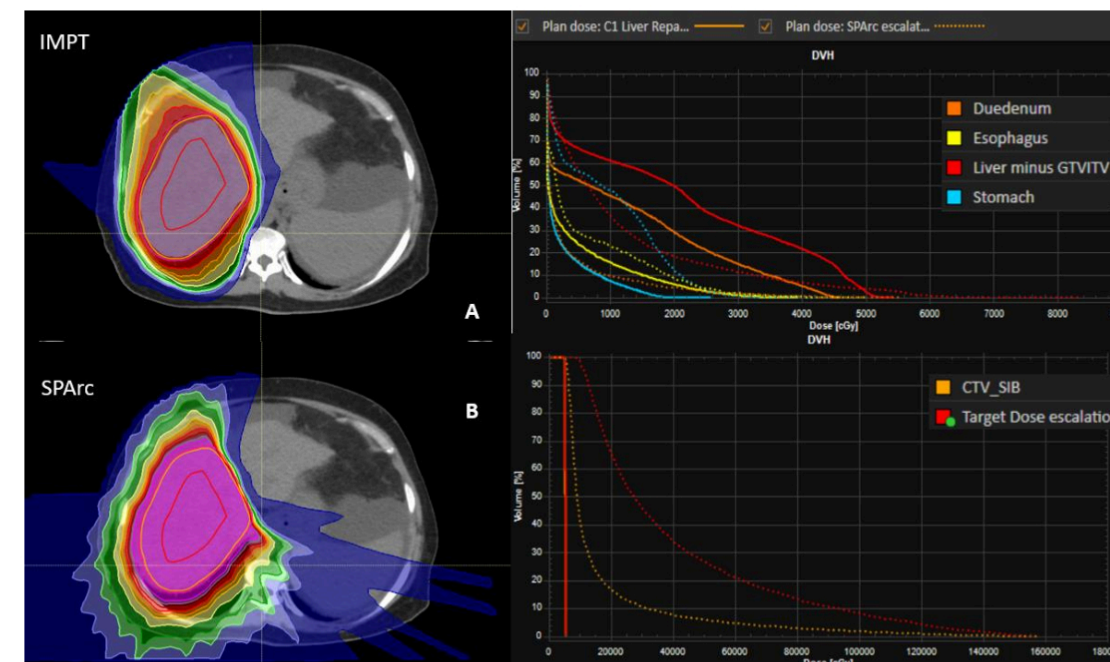


Fig. 1. Dose comparison between IMPT and SPArc unconventional dose escalation planning.

		SPArc	IMPT
CTV	D99% (Gy)	55.44	50.75
	Mean dose (Gy)	163.31	53.45
GTV	D99% (Gy)	100.98	52.60
	Mean dose (Gy)	405.48	53.67
Liver-CTV	Mean dose (Gy)	20.51	11.67
Bowel	D0.5cc (Gy)	45.71	44.87
	D5cc (Gy)	29.54	43.11
Duodenum	D0.5cc (Gy)	36.76	44.54
	D5cc (Gy)	15.93	39.93
Kidney	Mean dose (Gy)	1.48	11.35

Table 1. Dosimetric metrics comparison between IMPT and SPArc dose escalation

### CONCLUSIONS

With the degree of optimization and treatment delivery freedom in the proton arc therapy, unconventional dose escalation could be achieved clinically. The question is what dose level we shall go to and what quality assurance procedure, as a physicist, should be thinking of in order to prepare for such changes in the treatment paradigm.

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