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## Introduction

Daily adaptive MR-guided stereotactic ablative radiotherapy (MRgRT SABR) reduces treatment margins, improves organ at-risk (OAR) sparing, and improves target control. Treatment planning for MRgRT SABR must often be revised to meet conflicting objectives such as plan deliverability and treatment time. Thus, the base plan and its daily adaptation accuracy are essential for a successful MRgRT SABR treatment. This study includes twelve prostate, liver, and thorax MRgRT cases to find the optimal balance between the target coverage, treatment time, dose spillage, calculation and daily adaptation (post-A3i Upgrade) accuracy.

## Method

Our initial procedure avoided the couch edges due to their high density and positioned the arms either on the chest or by the side for patient comfort. We were also using the default calculation parameters with a fixed segment approach. This study divided the topics into three stages where, I) The ability of the treatment planning system (TPS) to accurately account for high-density regions in the couch edges was assessed using patient-specific QA measurements (Sun Nuclear MR-ArcCheck, LAP RadCalc) in pelvic cases; II) The impact of arms-up immobilisation on treatment dosimetry and delivery time was assessed for thorax and abdominal cases; III) The optimal dose calculation parameters were analysed for plan deliverability, target coverage, dose spillage, treatment time, total monitor units and plan adaptation abilities.

Stage 1 added eight extra beams through the couch edges to previous patient plans and used the same objectives. That meant approximately 25% primary beam passed through the high-density region of the couch.

Stage 2 deleted the arms for actual treatments and added extra beams through the couch edges.

This approach allowed us to calculate the dose distribution as the arms were up and had the freedom of irradiating from the couch corners. That stage was also assessed the same as Stage 1.

Gamma analysis had 2% and 2 mm criteria with a 15% threshold.

Stage 3 used the freedom of irradiating from any angle by using the first and second stage points. It also used the new settings that change the calculation parameters without amending the objectives or dose constraints. This section included actual adaptive plan analysis to assess the daily adaptation abilities.

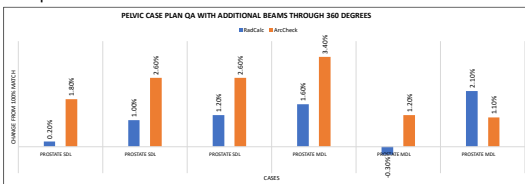


Figure 1. The QA results for prostate single (SDL) or multiple (MDL) dose level cases.

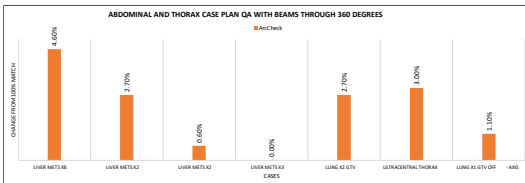


Figure 2. The QA results for abdominal and thorax cases.

Beam	36.25Gy PTV100 DPP (4/20/20)	34.45Gy PTV85 DPP	34.45Gy PTV85 DPP (3/2/2)	40Gy CTVest DPP	40Gy CTVest DPP (2/2/2)	Segment MU	Total Time min
SLD 1	87.29%	-2.70%	90.36%	-1.91%	-21.00%	68.00	6.20
SLD 2	89.30%	-2.00%	90.85%	-1.15%	-14.82%	79.00	6.21
NEW 1	92.36%	1.47%	98.19%	0.12%	75.16%	41.00	7.10
NEW 2	92.89%	2.05%	98.30%	0.23%	74.56%	33.00	6.38

Figure 3. An adaptation accuracy sample of the new calculation settings on a 40 Gy simultaneous 36.25 Gy S# prostate case.

## Results

Stage 1 QA accuracy is shown in Figure 1. ArcCheck analysis pointed a maximum of 2.60% on SDL and 3.40% on MDL prostate cases. RadCalc point dose measurements deviated at most for 1.2% on SDL and 2.1% on MDL cases from the treatment planning system.

Stage 2 included some of the most challenging abdominal and thorax cases; the maximum inaccuracy for ArcCheck analysis was less than 4.6%.

Stage 3 changes in the required number of histories, histories per area, segments, accuracy, bixel and efficiency reduced the median treatment time and the number of beams by 20% and 26%, respectively, where the coverage for the prescription dose increased by 4%. The new settings also eliminated the calculation differences between the treatment planning (V2) and delivery (A3i) systems. Thus, the adaptation accuracy went up to 100%, as a sample is shown in Figure 3.

## Conclusion

MRgRT is relatively novel and open for development. Our study demonstrated that I) The couch edges are safe to put beams through; II) Lifting the arms benefits the treatment as long as the patient can compensate for it; III) The calculation settings play an essential role in the plan optimisation and their daily adaptation.

Whilst the full descriptions will be released in the upcoming article, this study significantly helped us reduce the treatment times while improving overall planning quality by combining the A3i multiple-user workflow. Our new approach brought us more conformal and easily adapted treatment plans with less MU for every case.

## References

- Gungor et al. Practical Radiation Oncology. Volume 11, Issue 1, pg e11-e21
- Hackett, et al. MR Linac Radiotherapy. 1<sup>st</sup> Edition