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Evaluation of the use of Dynamic Conformal Arc as an Improved Method of Spinal Palliation

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INTRODUCTION

- Long term survival of metastatic patients provides an opportunity to rethink conventional treatment delivery for spinal metastasis.
- Historically, simple 3D-conformal (3D-CRT) fields have been used to mitigate disease symptoms.
- 30% of 3D-CRT patients experience acute toxicity due to dose to critical organs.
- Re-irradiation and treatment to adjacent sites benefits from minimizing cumulative doses to organs at risk (OAR).
- Dynamic Conformal Arc (DCA) **Figure 1.** is an alternative to 3D-CRT, potentially increasing target coverage and conformality, while reducing intermediate to high doses to adjacent tissues.

PURPOSE / OBJECTIVES

- Arc therapy may improve dose distributions compared to static fields.
- This study evaluates the efficacy of DCA as an alternative to 3D-CRT for spinal palliation.
- Planning time and dose metrics were compared between 3D-CRT and DCA.

MATERIALS / METHODS

- 10 retrospective T-spine patients treated with 3D-CRT fields were re-planned in RayStation using DCA.
- Templated beam arrangement **Figure 1**: three coplanar arcs (right lateral, anterior, and left lateral) with 1mm lateral margins and 5mm superior/inferior margins.
- Approximately 50% of MU are delivered from the anterior arc, while the remaining 50% are delivered from the lateral arcs.
- MU weighting, margining, and beam energy are optimized as needed.
- PTV (spine), esophagus, bowel, kidneys, lungs, liver, and spinal cord are used for analysis.
- Dosimetric analysis and comparison between planning modalities is performed in MimVista.

RESULTS

- Target conformality significantly improved using DCA. Target coverage (V95%), lung V20%, and conformality index (CI) improved from 78.3 → 93.2%, 1.5 → 4.3%, 1.9 → 1.2.
- Arc therapy may increase dose to proximal tissues and therefor, caution is important to ensure dose constraints are maintained. Average lung V5% increased from 24 → 34% and mean liver 3.0 → 3.6 Gy.
- All differences are statistically significant (student t-test, $p < 0.01$).
- DCA plans resulted in improved dose homogeneity, lowering PTV hot-spots.
- Average planning time is 22 ± 12 minutes and comparable to 3D-CRT.

DISCUSSION

- Planning time may be reduced for DCA through automation using templates and scripts, further simplifying the planning process.
- Since this study, we have started using DCA for all levels of the spine.
- DCA requires the same insurance authorization as 3D-CRT, while providing potential clinical benefits.

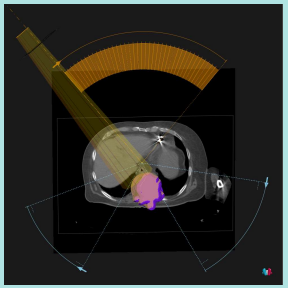


Figure 1 Templated beam arrangement

DYNAMIC CONFORMAL ARCS

- Arc therapy using constant beam output.
- Forward planning technique, requiring no optimizations, resulting in fast calculation times.
- JAW/MLC conform to the target and avoid OAR per gantry segment through an arc.
- Individual segment JAW/MLC can be user modified.
- Weights and energies can be adjusted for each arc.

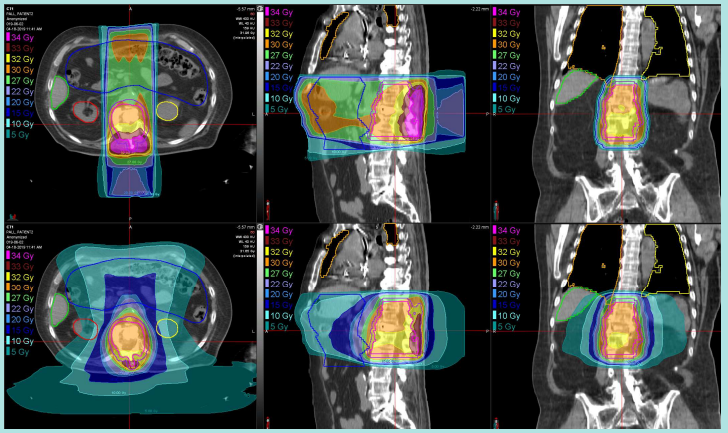
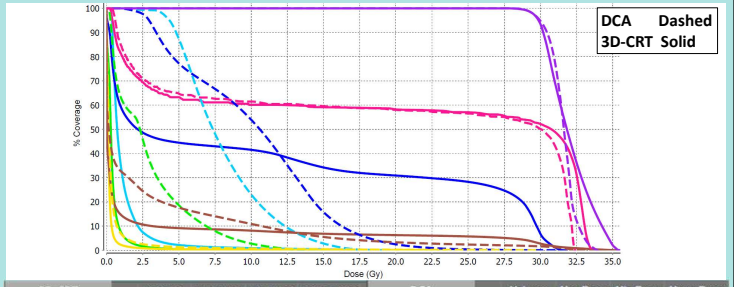


Figure 2 3D-CRT (top) and DCA (bottom) dose distributions. Dose conformality and homogeneity are improved in DCA plans. DCA spreads the low dose bath over a larger region.



3D-CRT	Volume	Max Dose	Min Dose	Mean Dose
Cord	36.33	33.8	0.18	19.59
PTV_T10-L1	700.59	35.51	27.66	32.01
skin	51264.46	35.51	0	2.38
Lung_Total	2692.8	29.82	0	0.22
abdominal cavity	3702.57	31.53	0	11.01
liver	1242.45	23.75	0	0.44
Kidneys	264.92	24.61	0.27	1.19

DCA	Volume	Max Dose	Min Dose	Mean Dose
Cord	36.33	32.44	0.33	19.29
PTV_T10-L1	700.59	33.99	26.33	31.58
skin	51264.46	33.99	0	2.92
Lung_Total	2692.8	29.9	0	0.46
abdominal cavity	3702.57	32	0.89	10.15
liver	1242.45	15.16	0.08	2.86
Kidneys	264.92	19.04	1.1	8.01