Do Advances in Radiotherapy Planning Technology Lead to Improved Palliative Radiotherapy?

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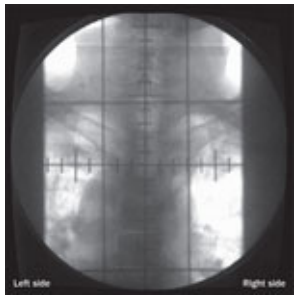
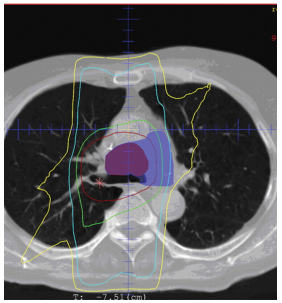


Background



- Technology has revolutionize radiation oncology
- Palliative patients - requiring simple (1-2) beam arrangements
  - 3D planning improves target delineation
- Clinical outcomes?

The role of CT simulation in WBRT. Gripp et al, IJROBP 1999; 45 (4):1081-1088
The impact of virtual simulation in palliative RT for NSCLC. McJury et al, R&O 2001; 59 (3): 311-318
CT simulation compared with clinical mark-up in palliative radiotherapy: a prospective study. Haddad et al, IJROBP 2006; 65 (3): 824-829
A dosimetric comparison of different treatment plans for spine RT. Andic et al, JECCR 2009; 28: 2

Objectives

Evaluate the impact of different planning approach (3D) CT simulation vs. (2D) Digital radiograph based in palliative RT for bone metastases

- Dosimetry
- Decision making
- Clinical outcome

Schema

prospective cohort design

Historical cohort

Diagnostic images reviewed

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2D field definition using DRR

↓

Clinical outcomes evaluated @ wk 1, 3

Study cohort

Diagnostic images
Document
Intended target

↓

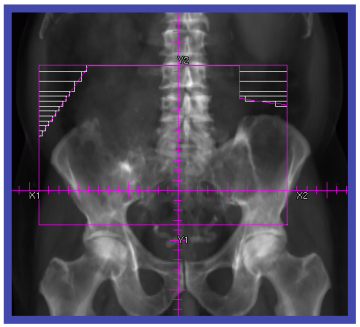
2D field defined (DRR)
2D study plan

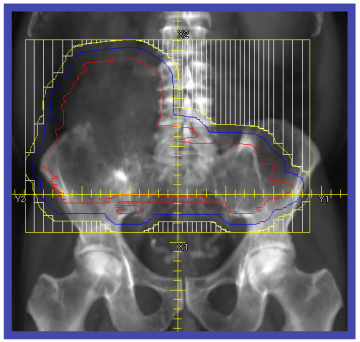
↓

3D CT sim images
Target definition
3D study plan
Patient treated

↓

Clinical outcomes evaluated @ wk 1, 3, 6





Inclusion Criteria

- Bone metastasis requiring palliative RT
- Pain present
- Suitable for simple beam arrangements
- Able to express symptom score
- Available for telephone follow up

Outcomes

- **Changes in target volume**
  - Any change
  - Clinically significant change (post hoc)
  - >1 vertebral body change
  - >3 cm difference
  - Significant shielding change to shield normal structure(s)

- **Factors predictive of change**
  - Site treated
  - Presence of soft tissue disease
  - Availability of diagnostic 3D imaging (CT/MRI)
  - Time between diagnostic 3D imaging and planning

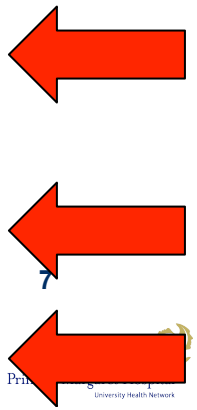
- **Radiotherapy dose being delivered to target and normal structures**
  - V_{95}, PTV coverage, I_{MIN}, HT over-dosage

- **Symptom response**
  - Pain reduction at wk 3
  - Fatigue, appetite, nausea symptom change at wk 3
  - 0-10 scale

Results

Study group: 92 sites (81 patients)

Demographics	*Study cohort (3D) n=81*
Median age	63 yrs (range 37-85)
Sex	
Female	47/81 (58%)
Male	34/81 (42%)
Primary tumour type	
Lung	24/81 (29%)
Breast	22/81 (27%)
Prostate	7/81 (9%)
Other	28/81 (35%)
Site treated	
Spine	48/92 (52%)
Pelvis/Hip	31/92 (34%)
Other	13/92 (14%)
RT dose fractionation	
20Gy/5#	57/92 (62%)
8Gy/1#	32/92 (35%)
Other	3/92 (3%)
3D diagnostic imaging avail (CT/MRI)?	
Yes	66/92 (72%)
No	26/92 (28%)
Median time b/w CT/MRI to CT sim?	17 days (range 1-164)



Impact of decision-making

- **Any change** 52% (48/92)
- **Clinically significant change** 27% (25/92)

- **Reason for change**
  - Unsuspected local disease 88% (42/48)

Factors predictive of change

Presence of soft tissue disease p = 0.02

Time gap from 3D diagnostic imaging to RT planning p = 0.09

Treated site p = 0.81

3D imaging availability p = 0.25

Factors explored	*Clinically signif change n=25*	*No change n=44*	*p-value*
3D diag imaging avail (CT/MRI)	15/25 (60%)	35/44 (80%)	p=0.25
Median time b/w diag scan & CT sim	13 days (2-46)	18 days (1-164)	p=0.09
Treated site	56% spine 36% pelvis/hip	55% spine 36% pelvis/hip	p=0.81
Associated soft tissue tumour present	8/25 (32%)	2/44 (5%)	**p=0.02**

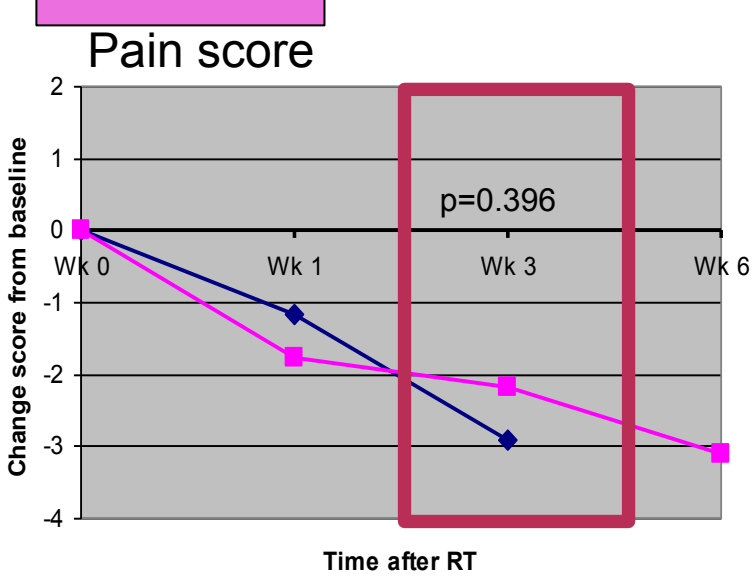
Dosimetric impact

Mean	*3D plans*	*2D plans*	*p-value*
Volume receiving prescribed dose (V95)	**1250cc^3 (±1061)**	**1557cc^3 (±1484)**	**p<0.01**
% target receiving prescribed dose (ideal = 100%, accept > 90%)	**92.9% (±11.8)**	**73.6% (±23.4)**	**p<0.01**
Minimum dose to target	**84.0% (±14.1)**	**40.2% (±33.1)**	**p<0.01**
Proportion of normal tissues receiving high dose (adjusted) (ideal = 0)	**2.5 (±2.2)**	**4.1 (±8.6)**	**p=0.04**

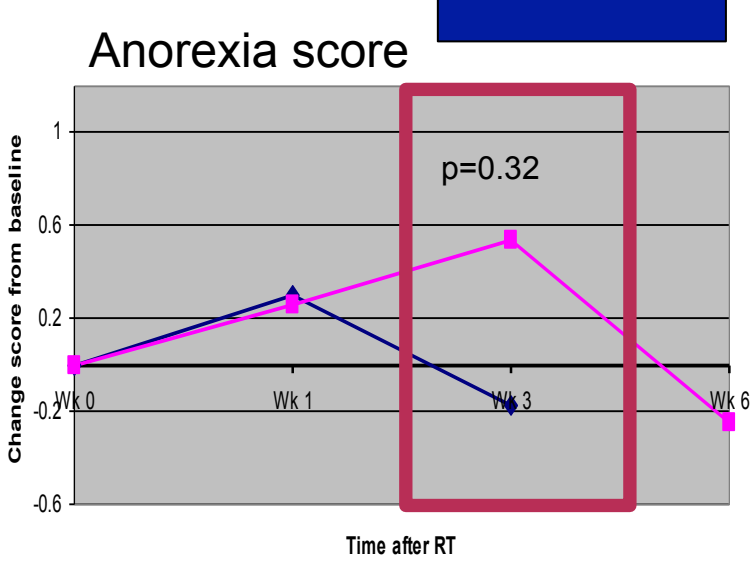
Patient reported outcomes

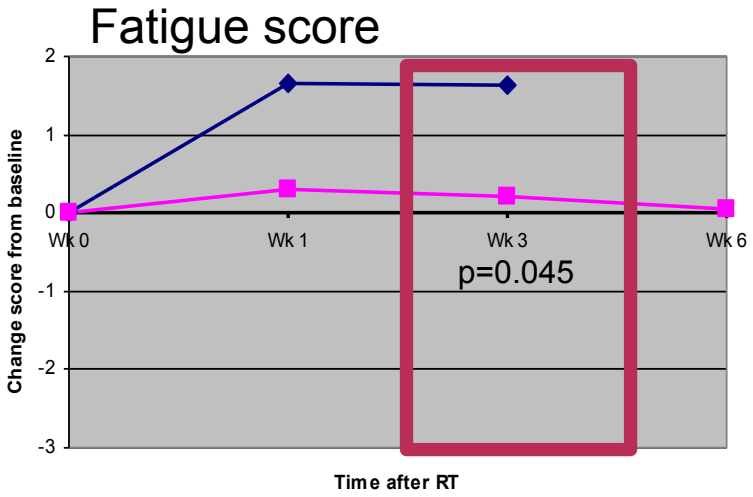
Historical 2D treated

Study 3D treated

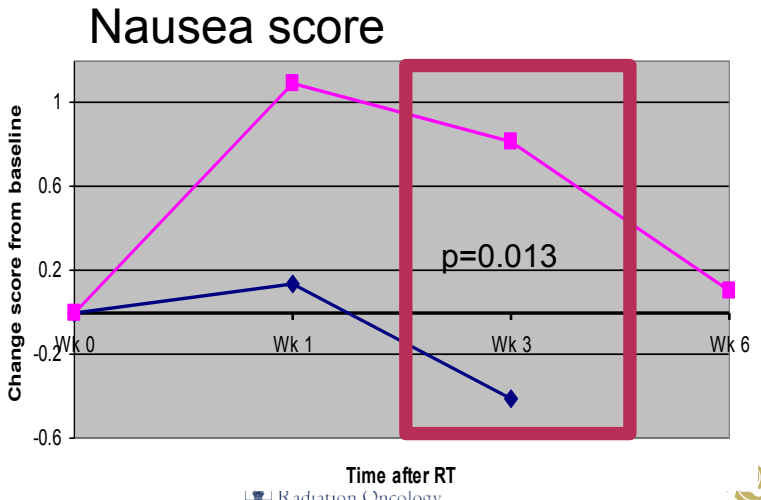


+ Worse





- Improve



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Conclusions

3D planning resulted in 52% of cases being changed; 27% clinically significant changes

3D planning leads to

- smaller volumes irradiated to high doses
- superior planning target coverage
- improved healthy tissue sparing

Patients with soft tissue disease and “dated” diagnostic imaging are most likely to benefit from 3D planning

Conclusions

- We were unable to demonstrate a superior clinical outcome in 3D planned patients (historical controls)
- Only randomized trial(s) would establish the impact of 3D planning on patient outcomes
- Best way of leveraging technology (complexity) for the benefit of patients requiring palliative RT