The Midlands Paediatric Radiotherapy Service

Surface Guided Radiotherapy in Paediatrics

Liam Herbert
Lead Paediatric, Teenager & Young Adult Specialist Therapeutic Radiographer

The Midlands Paediatric Radiotherapy Service

Paediatric Radiotherapy

- 60 cases across the Midlands
- 2/3 of cases in Birmingham
- 1/3 of cases in Nottingham

University Hospitals Birmingham

- Align RT across six linear accelerators
- No system on Tomotherapy units … yet
  - (2x TomoTherapy & 1x Radixact)
- First in the UK to utilise SGRT with paediatrics

Nottingham University Hospital

- Treated their first cases this year using SGRT

The Midlands Paediatric Radiotherapy Service

Open Face Masks

The Midlands Paediatric Radiotherapy Service

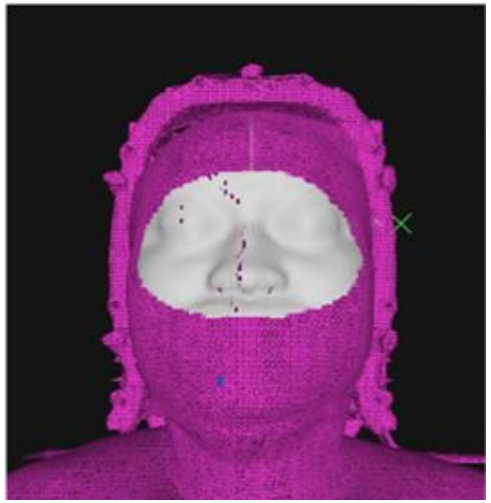
Open Face Masks Pathway

Day One

1. Align CT reference marks and then shift to Isocentre
2. Activate Vision RT
    1. Match any translations by adjusting the couch
    2. If rotations are out, ask patient to rotate (Unclip the mask)
    3. Mark Iso on mask
    4. Post CBCT– Capture for future sessions unless rotations are high

Day 2 onwards

1. Set to Iso straightaway
2. Activate Vision RT
3. Capture for future sessions post CBCT if minimal rotations on image

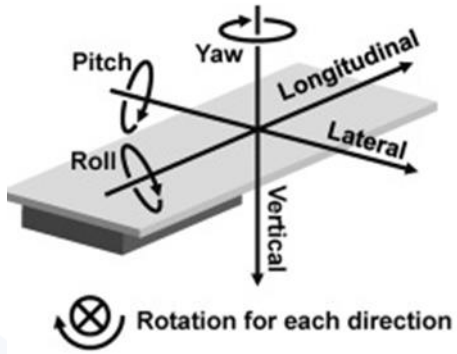


The Midlands Paediatric Radiotherapy Service

Open Face Masks Pathway

The Midlands Paediatric Radiotherapy Service

Open Face Masks



Adults Audit: Open Face Masks with or without SGRT

Rotational Standard Deviation			
	Pitch	Roll	Yaw
Non-SGRT (Group A)	0.97	3.55	1.37
SGRT (Group B)	1.09	1.22	1.23

Translational Standard Deviation			
	Lateral	Longitudinal	Vertical
Non-SGRT (Group A)	0.14	0.29	0.20
SGRT (Group B)	0.12	0.18	0.10

We stopped setting up patients without SGRT due to the high rotations and repeated CBCTs

Would not recommend Open face masks without SGRT

The Midlands Paediatric Radiotherapy Service

Open Face Masks

Adults Audit: Open Face Masks and Midway scans

1st Five #s: midway CBCT to determine any movement during radiotherapy

Mid-way rotational changes on CBCT	
Rotations on all axis ≤1 degree	92/99# (92.9%)
Rotations on all axis >1 ≤1.5 degrees	7/99# (7.1%)

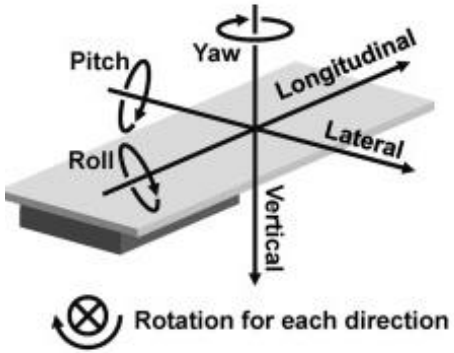
Mid-way translational changes on CBCT	
Translations on all axis ≤1mm	76/99# (76.8%)
Translations on all axis >1mm ≤1.5mm	21/99# (21.2%)
Translations on all axis ≥1.6mm ≤2.5mm	2/99# (2%) AlignRT interrupted delivery of RT on 2/2

In two fractions there was a large shift

- Align RT stopped the treatment due to patient lifting their head
- Repeat scan after cut out showed large shift
- Align RT able to accurately monitor the patient

The Midlands Paediatric Radiotherapy Service

Open Face Masks



We have treated six paediatrics with an open face mask

- Four neuro patients on a radical course (2 x 25# & 2 x 30#)
    - Patients who did not tolerate a standard mask
    - **Avoided delays** & the need for **general anesthetic**
- Two brain mets on a palliative course (5#)

Standard Deviation	Pitch Rotation	Roll Rotation	Yaw Rotation	Lateral	Longitudinal	Vertical
Face-less	1.16	1.23	1.09	0.10	0.14	0.10
Neuro Standard	1.29	1.05	0.78	0.12	0.21	0.10
Neuro Standard **	0.79	0.85	0.64	0.12	0.23	0.09

The Midlands Paediatric Radiotherapy Service

Open Face Masks

	Open Face Mask (Six patients)	**Standard Mask** (Four patients)	**Standard Mask** (Three patients*)
Number of #s	120	119	89
Number of #s with ≥2° rotations	28 (23.3%)	40 (33.6%)	15 (16.9%)
Number of #s with ≥3° rotations	2 (1.6%) (range 3.0 - 3.2)	17 (14.3%) (range 3.0 – 4.0)	3 (3.3%) (range 3.0 – 3.3)
Number of #s with translations of ≥2mm	27 (22.5%) (range 0.2 – 0.38)	40 (33.7%) (range 0.2 – 0.5)	36 (40.4%) (range 0.2 – 0.5)

The Midlands Paediatric Radiotherapy Service

Open Face Masks

Open Face Mask cohort – only needed 2 CBCT rescans:

- x1 adherence
- x1 pre-vomit

Standard Mask cohort – needed 6 CBCT rescans

- x5 set up due to high rotations
- x1 patient unable to tolerate the mask

The Midlands Paediatric Radiotherapy Service

Open Face Masks & SGRT

Higher rotations but within 3°

- Align RT demonstrated similar rotations in the XVI
- Staff not correcting due to parameters within set tolerance

Would not use without SGRT

Align RT was able to accurately monitor two patients to safely interrupt treatment

The Midlands Paediatric Radiotherapy Service

Whole Lung

CT Reference pen marks and Tegaderm dressing instead of tattoos – *but not used*

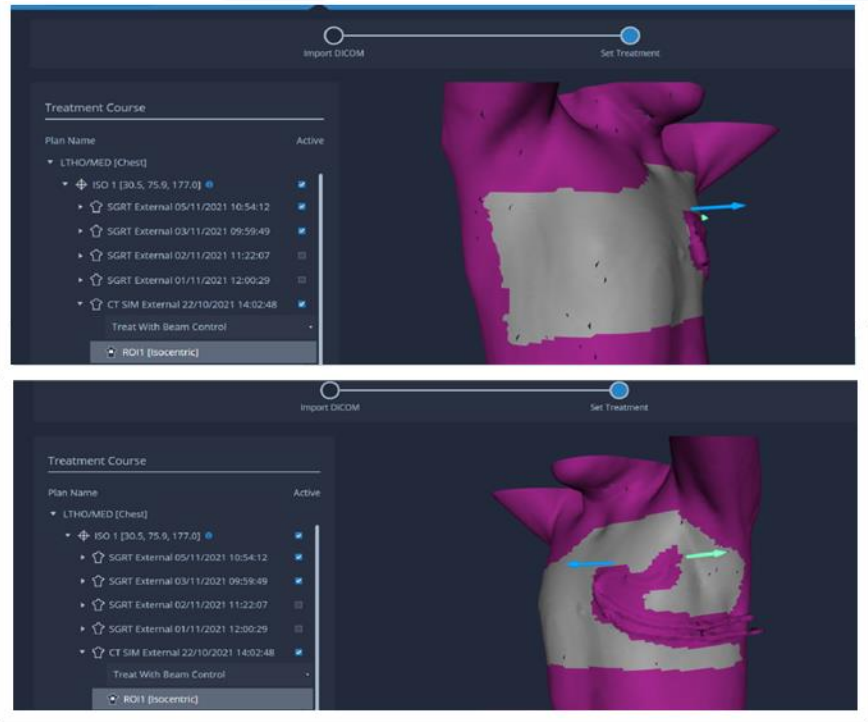
Measurements from wingboard to Xiphisternum & kneefix to inferior edge of umbilicus

Use Align RT to set up

CBCT – capture for future sessions unless high rotations

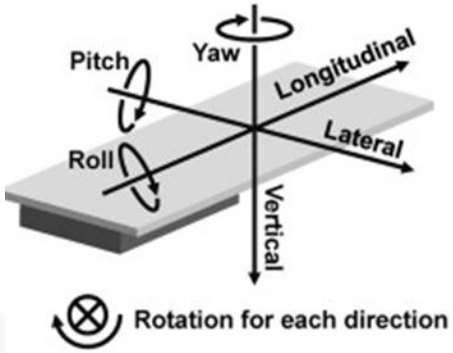
- Use gated capture for larger breathing motion
- + one second delay if camera block

Retract CBCT panels and monitor with beam control



The Midlands Paediatric Radiotherapy Service

Whole Lung



Four patients

- No issues noted with Align RT set-up
- The need to keep the area exposed – dignity issue but patient choice
- Align RT would interrupt when patients were getting bored – Yawning!

Standard Deviation	Pitch Rotation	Roll Rotation	Yaw Rotation	Lateral	Longitudinal	Vertical
Whole lungs	1.00	1.21	1.39	0.14	0.15	0.17

The Midlands Paediatric Radiotherapy Service

Whole Lung

	Whole Lungs (Four patients)
Number of #s	38
Number of #s with ≥2.5° rotations	4 (10.5%)
Number of #s with ≥3° rotations	1 (2.5%) [3.1°]
Number of #s with translations ≥2mm	18 (45%) Range (0.2 – 0.46)
Number of #s with translations ≥3.5mm	5 (13.2%) Range (0.36-0.46)

The Midlands Paediatric Radiotherapy Service

Abdomen Volumes

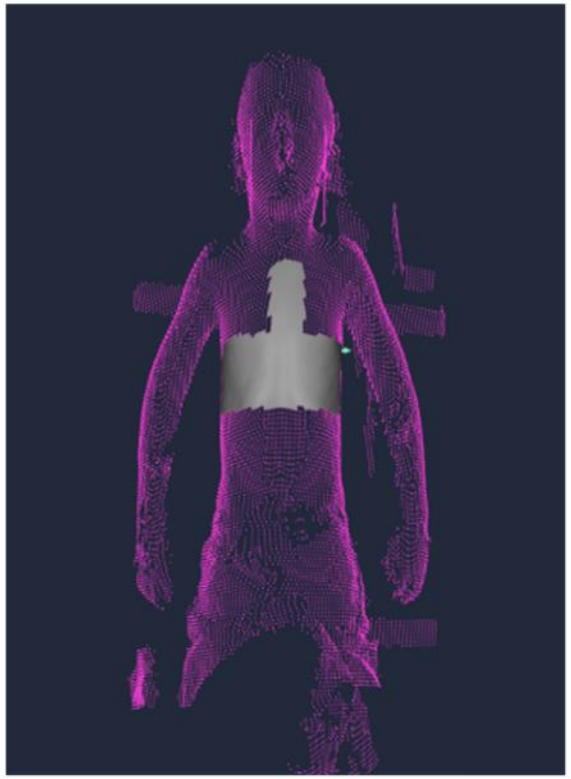
- Concerns regarding poor correlation between internal organ motion & surface guided.

- Rotations can be high following CBCT
  - Significant contour change with bowel gas and weight loss/gain can result in high rotations
  - Contours can change +1cm per #

The Midlands Paediatric Radiotherapy Service

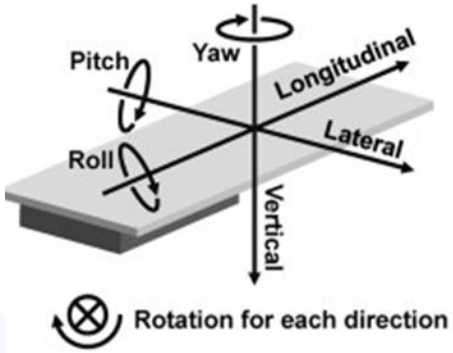
Region of Interest

- Avoid the Hickman line (same goes for Thorax)
- Avoid anaesthetic equipment – tape to the side of the bed
  - look out for ECG on the ROI
- Smaller children – can be difficult to obtain a region of interest
  - Expanding ROI to cover Xiphi process and SSN can help with Sup/Inf capture



The Midlands Paediatric Radiotherapy Service

Abdomen review



5 Abdominal volumes
3 Flanks

- Rotations are within 5 degrees
- Higher translations but we did not routinely “trend” reference capture as we would do with CBCT

	Pitch Rotation	Roll Rotation	Yaw Rotation	Lateral	Long	Vert
All Abdo (SGRT)	1.31	1.09	1.62	0.21	0.30	0.38
Abdo Vol (SGRT)*	1.38	1.07	1.71	0.21	0.30	0.38
Flank (SGRT)*	1.02	1.16	1.30	0.19	0.31	0.38
Flank Standard	1.09	1.39	0.97	0.18	0.30	0.22

The Midlands Paediatric Radiotherapy Service

Abdomen review

	Abdominal Volume (Five patients)	**Flank** (Three patients)
Number of #s	98	30
Number of #s with ≥2.5° rotations *(Pitch)*	31 (31.6%) *(17)*	4 (13%)
Number of #s with ≥3.5° rotations	5 (5.1%) (Range 3.6 – 4.2)	1 (3.3%) (3.6)
Number of #s with translations of ≥0.5 - <1.0cm	24 (24.4%) (range 0.54 – 0.84)	8 (26.7%) (range 0.52 – 0.99)
Number of #s with translations of ≥1.0cm	2 (2.0%) 1 patient Both on Vertical Huge differences in gas & contour	1(3.3%) (1.13) Vertical +2cm contour decrease

Does not exceed 5° rotations

In two patients there were repeat CBCT due to patient movements – triggered on Align RT

Only 3x 1cm shifts but significant changes internally, image match was otherwise good

The Midlands Paediatric Radiotherapy Service

Abdomen review

	CBCT			SGRT		
Patient 1	Pitch	Roll	Yaw	Pitch	Roll	Yaw
#2	2	0	2.2	0	1.0	-1.3
#3	1.3	0.3	2.5	0.1	0.3	-2.4
#4	2	0.5	3.2	2.1	1.8	-2.4
#5	1.5	1.9	3.1	0.9	0.7	-2.4
#6	1	-2.6	-1.4	-0.8	1.0	2.0
Patient 2	Pitch	Roll	Yaw	Pitch	Roll	Yaw
#10	-2.7	-1.0	-0.1	-1.5	1.1	-1.2
#11	-2.6	-1.1	-0.3	-1.5	0.6	-0.8
#12	-3.0	-1.4	-1.5	-1.6	-0.3	0.1
#13	-2.7	-1.7	-1.5	-2.9	-0.4	0.2
#14	-2.7	-0.2	-1.7			

Can we better predict higher rotations?

Need to review ROIs used & CBCT Clipboxes

Not one size fits all

The Midlands Paediatric Radiotherapy Service

Case study

- 7-year-old Neuroblastoma
- Loved Pokémon
- Was perfect for a grand total of 3#s

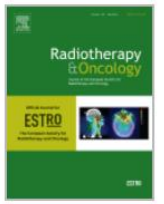
…only 11#s to go

The Midlands Paediatric Radiotherapy Service

ELSEVIER

Radiotherapy and Oncology

Volume 193, April 2024, 110120



Original Article

Paediatric radiation therapy without anaesthesia – Are the children moving?

Tatiana Ritchie [a], Susan Awrey [a], Manjula Maganti [b], Rehab Chahin [a], Michael Velec [a], David C. Hodgson [a], Hitesh Dama [a], Sameera Ahmed [a], Jeff D. Winter [a], Normand Laperriere [a], Derek S. Tsang [a]

[a] Radiation Medicine Program, Princess Margaret Cancer Centre, University Health Network, 610 University Ave, Toronto, ON, M5G 2M9, Canada

[b] Department of Biostatistics, Princess Margaret Cancer Centre, University Health Network, 610, University Ave, Toronto, ON, M5G 2M9, Canada

Received 29 November 2023, Revised 16 January 2024, Accepted 24 January 2024, Available online 3 February 2024, Version of Record 8 February 2024.

The Midlands Paediatric Radiotherapy Service

The Midlands Paediatric Radiotherapy Service

Surface Guided Radiotherapy in Children

- Provides safer monitoring of paediatric patients
  - A cohort of patients where adherence can be a challenge
- Improved patient experience & avoid the need for anaesthetic
  - Open Face Masks & Tattoo-less treatments
- Quicker set ups
  - Straight to isocentre
- Reduce the number of **repeat** on-treatment imaging
  - Assist in difficult set-ups
  - Highlights differences in contours/body shape

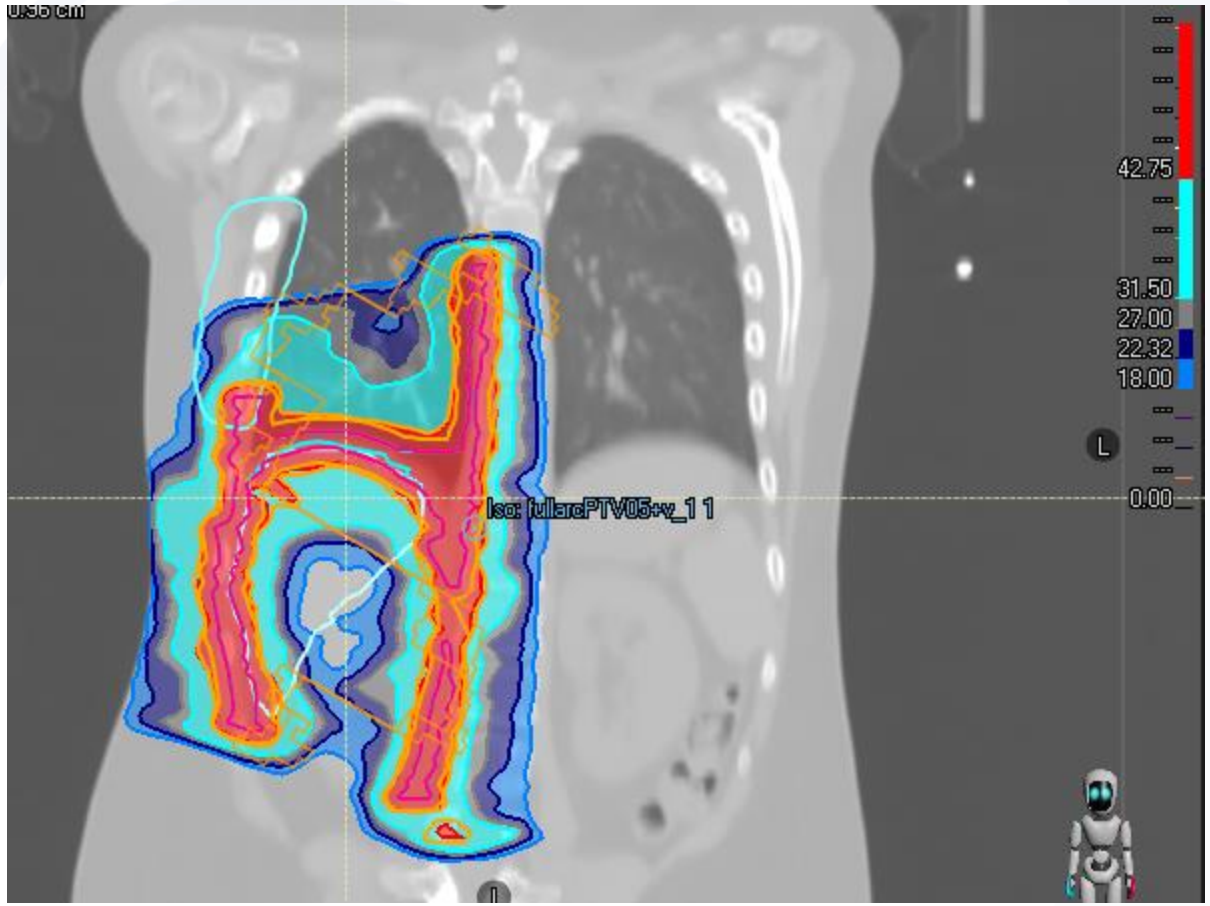
The Midlands Paediatric Radiotherapy Service

Case Study

Relapsed Ewings Sarcoma

#1 of radiotherapy

- Improved appetite
- Increased contour
- Less pain
- Relaxed shoulders



The Midlands Paediatric Radiotherapy Service

Case Study

Day 3

Two scans again but improved positioning to a far less compromised position

Only managed one arc of two

However, captured Align RT for future sessions along with additional pen marks after 2nd CBCT

Day four onwards – only required one scan and out of the room in 20 minutes

Used pen marks and then used Align RT

The Midlands Paediatric Radiotherapy Service

Case Study

Week 3 – further contour change, loss of appetite

Pen marks – were in

Align RT – Average was within tolerance, but deformation showed laterally one side was red and the other blue at the inf of the volume

CBCT – Inf volume falling off laterally – corrected patient position and recaptured

No further repeat set ups/imaging needed