Training Patients with Lung Cancer to Tolerate Mechanical Ventilation for Breathing Regularisation and Extended Breath-Hold

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ACCURAY

Focus of this presentation

Patients with lung cancer trained to allow a ventilator to regularise breathing and to extend their breath hold duration (hypocapnia +60% O2)

Patients studied in 2 groups

- Non-treatment setting (research facility):
  - analysis of variation in degree of regularisation and
  - analysis of breath-hold durations
- Treatment setting (on treatment platform: Accuray CyberKnife):
  - analysis of regularised breathing patterns during radiotherapy treatment
  - analysis of breath-hold durations post-treatment
  - Some comments on imaging in breath-hold

Study Population

Inclusion

- Informed consent
- Adult ≥ 18 years
- MDT-confirmed disease
- WHO PS 0-2
- Not suitable for surgery

Exclusion

- Central/T4 tumours
- Tumour not definable on CT
- Tumour within 2cm of main airway
- Previous RT to that area
- Severe respiratory disease
- SpO_2 <91%

Study Cohort

- Patients consented: 22
- Included in analysis n =16
- Median age: 75 years (52-88)
- M/F: 12/4
- Smoking status: Current= 7
  Former =8 Never 1

Baseline physiological characteristics

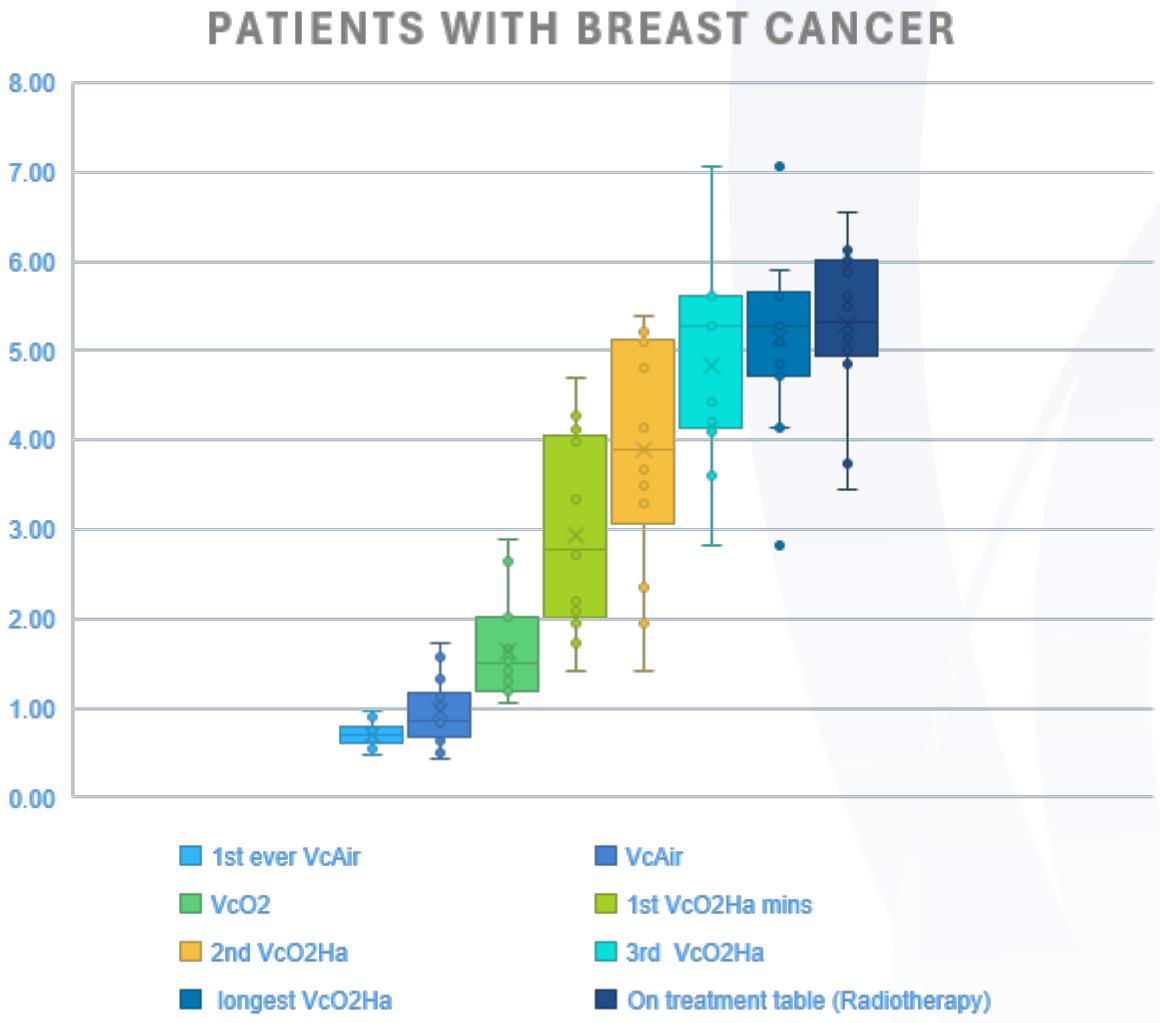
- COPD
- FEV1%
- Disease
- Resting SATs

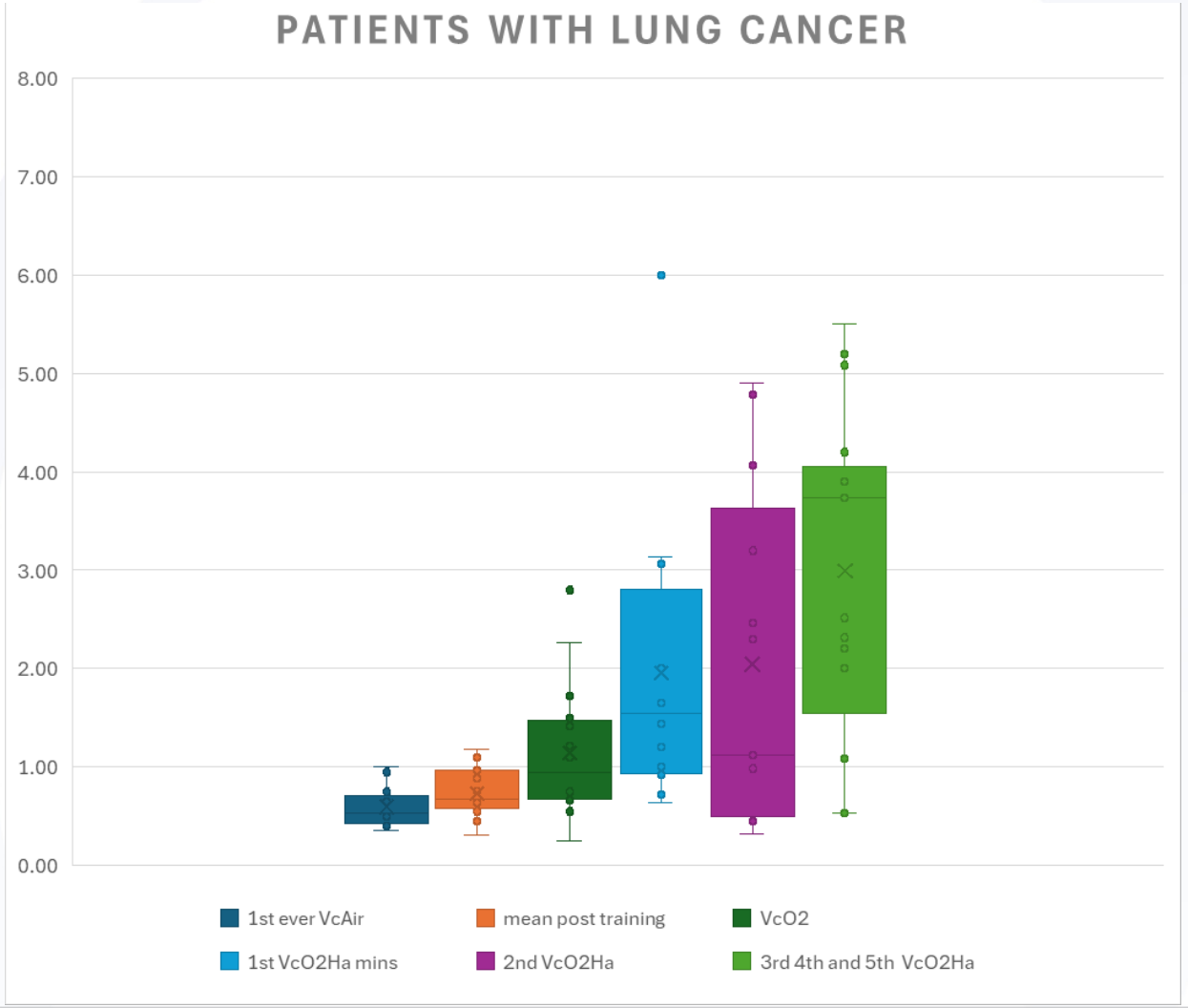
Results: non-treatment setting: Regularisation

- Protocol suggested a period of regularised breathing of ~30 minutes at a frequency ~5-10bpm above their spontaneous rate , reducing PetCo2 levels by 5mmHg below resting levels

- Most patients could tolerate the ventilator at this rate /volume
- Drop-out:
  - Mask discomfort
  - Self-hyperventilation
  - Disease progression

Results: non-treatment setting: Breath-holds





Results: non-treatment setting: Breath-holds

Patient	FEV1% Predicted	Longest Breath Hold (mins)	Previous Medical History
1	114	6.00	-
2	53	5.48	-
3	64	3.13	COPD
4	71	3.20	Previous radiotherapy
5	33	3.90	COPD
6	57	4.85	COPD Severe emphysema
9	60	2.47	Ischaemic Heart Disease
13	75	2.32	Amiodarone
15	102	2.52	Mild COPD
16	65	0.63	COPD, pneumonia
17	72	0.70	Aortic aneurysm
18	72	0.53	Emphysema
19	45	0.62	COPD, COVID 19, pneumonitis.
20	38	2.27	COPD
21	95	0.92	Heart failure
22	99	1.00	Resection right lung

Timeline for a patient : treatment study

Session 1

Research Facility

- Equipment Introduction
- Breath-hold air
- Breath-hold coaching
- Breath-hold 60% oxygen
- Ventilator familiarisation

Sessions 2+

Research Facility

- 60% oxygen Breath-hold
- Breath Hold + Hypocapnia +60% oxygen
- Regularisation – 21% oxygen (30mins)

Penultimate treatment fraction

(CyberKnife)

- Treatment
- 1) Free breathe
- 2) Regularisation 21% oxygen
- Breath Hold + Hypocapnia +60% oxygen
- Image capture

Final treatment fraction

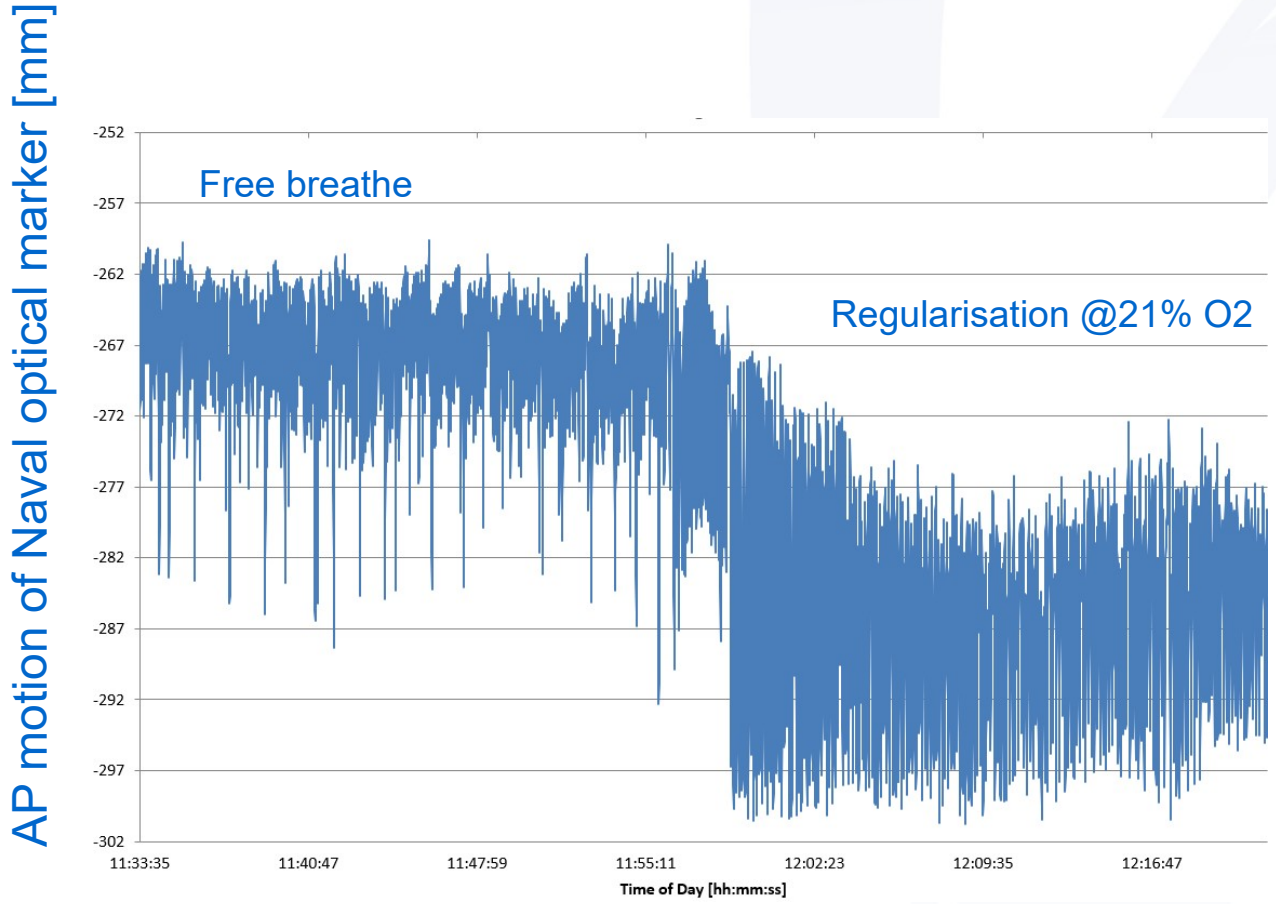
(CyberKnife)

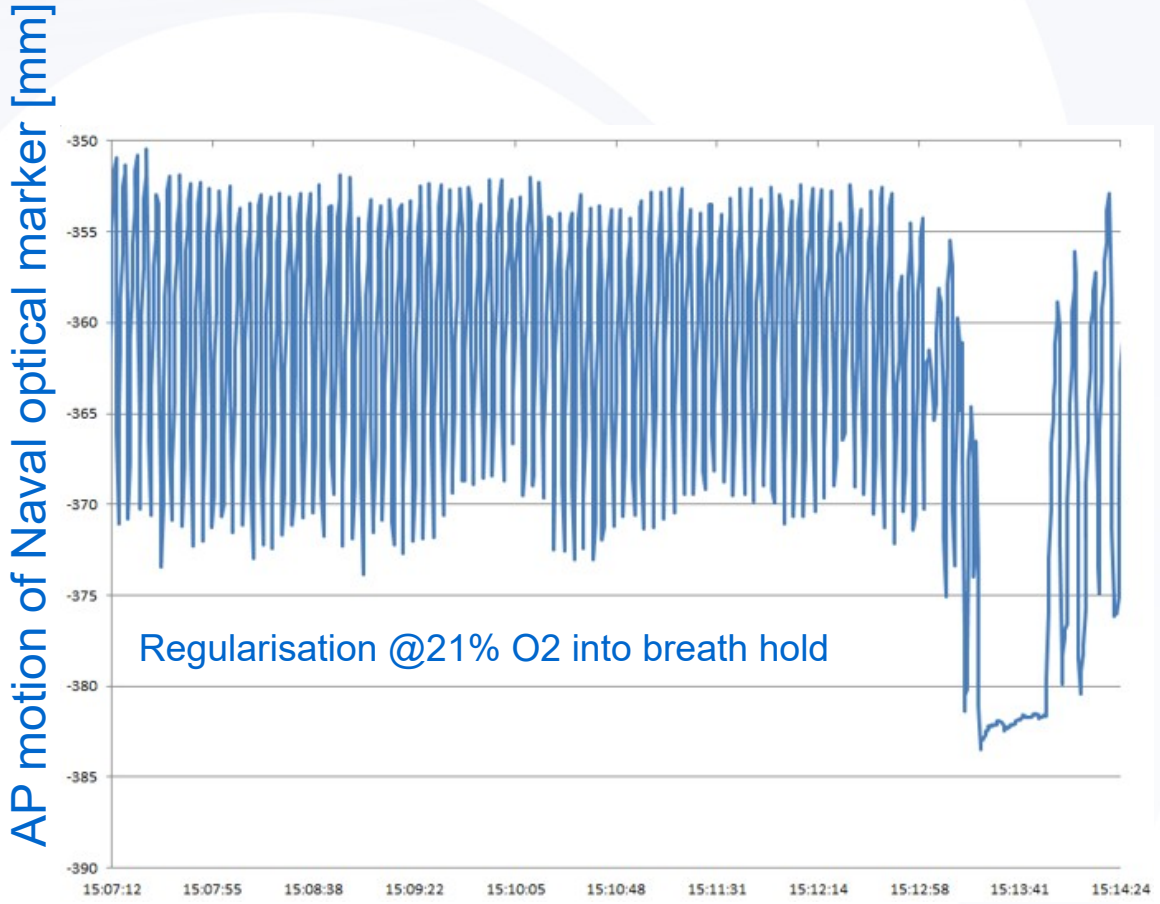
- Treatment in free breathe

Treatment delivery was done using Accuray CyberKnife platform which has the ability to track respiratory motion using optical markers placed on the patient.

Results: Treatment setting: Regularisation and Imaging

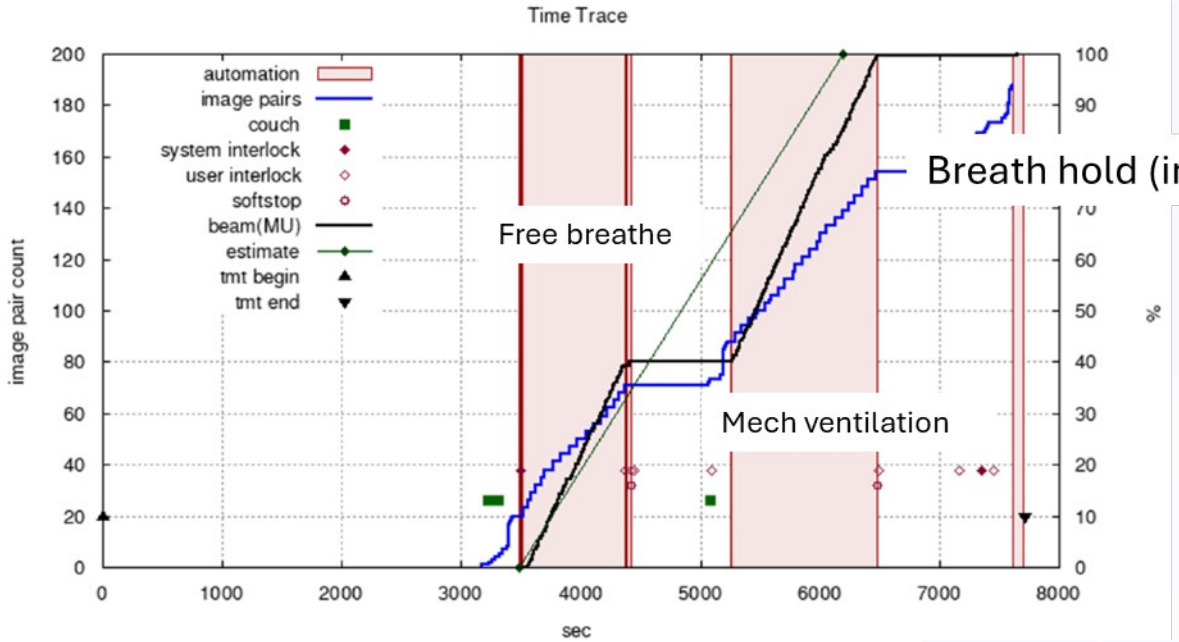
Lesion image for tracking during respiration (L) and in breath-hold (R)



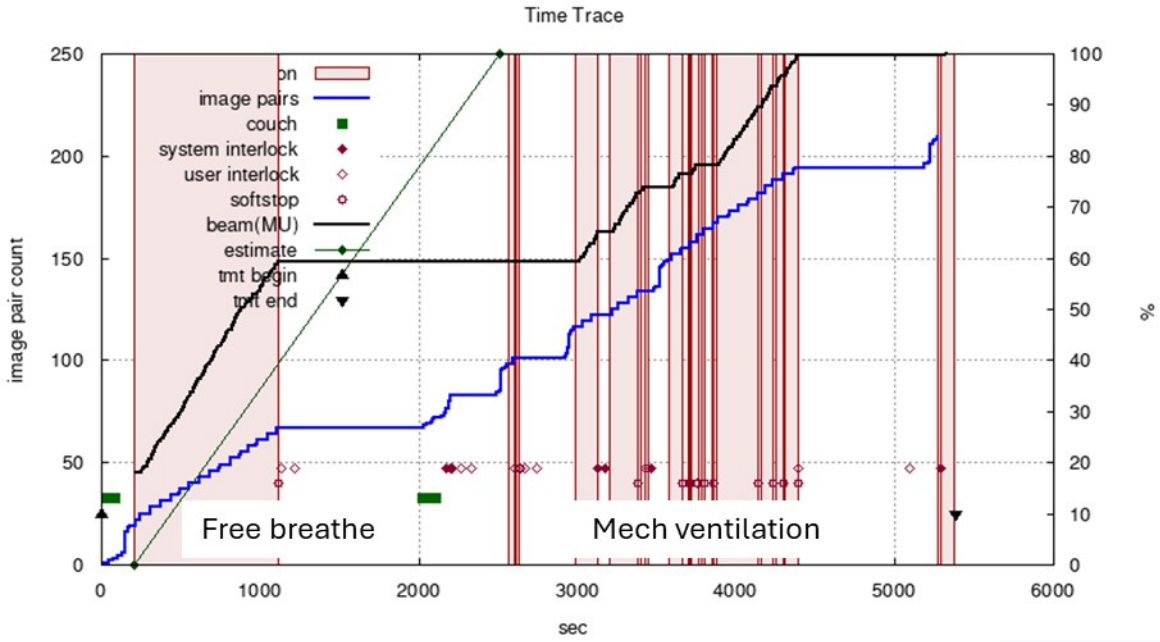


Accuray tracking system images

Accuray plots showing beam on (solid black line) and x-ray image acquisition (blue)
Shaded red area is when the system has been able to achieve a

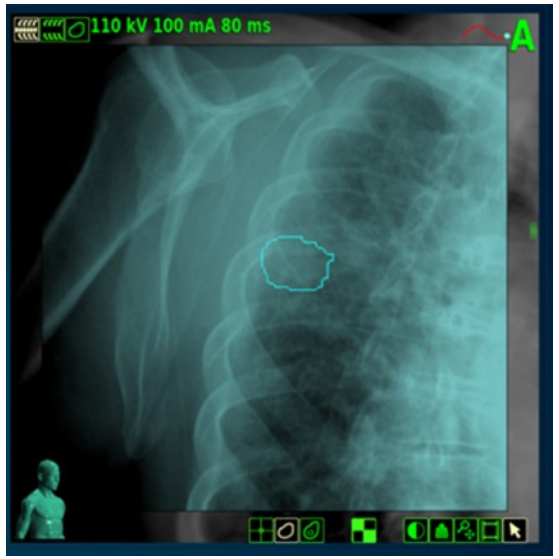


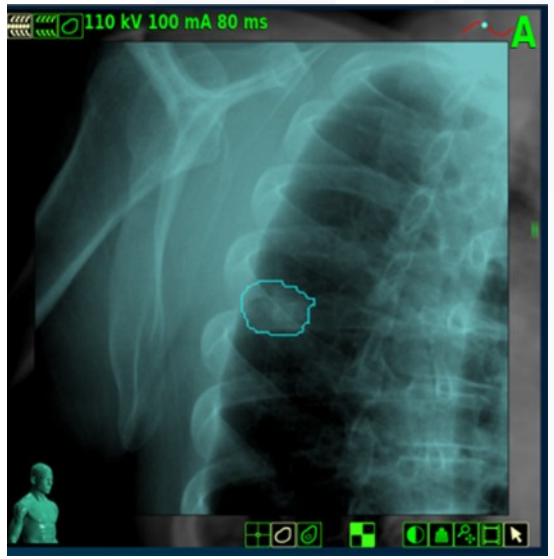
Patient under mechanical ventilation at 5000 seconds and into breath hold



Patient in mechanical ventilation- but struggled with mask positioning: more interrupts

Lesion Image for tracking duration during respiration (left) and in breath-hold (right)





Summary and conclusions

- Lung cancer patients can be trained to use a ventilator to regularise their breathing during treatment.
- In practice, patients were able to maintain ventilator- guided breathing for ~ 20-30 minutes (~ half if a CK fraction)
- Prolonged breath-holds were shown to be feasible following treatment delivery (i.e. after the treatment delivery ended)
- Radiographer training
- Too few patients to draw any conclusions