Breathing Control for Motion Management

umcg

Mechanical ventilation in radiotherapy for intrathoracic tumours: a hypothesis under pressure?

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Conflict of interest disclosure

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Post of executive / consultant		None
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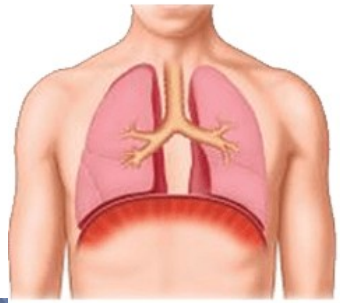
Continuous and Bi-level po**s**it**i**ve airway pre**s**sure for mo**t**ion mitigation of intra-thoracic tumors tr**e**ated with **r**adiotherapy (SISTER-study)

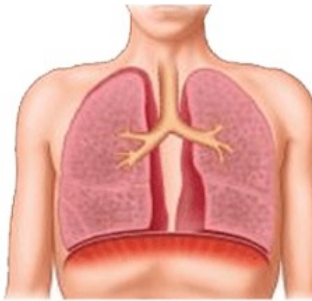
- Aim: find the optimal CPAP/BiPAP setting that results in the largest reduction of target motion

Hypothesis

1. Hyperinflation
   - Flattening of diaphragm → reduction of tidal volumes
   - Displacing OAR away from tumor

2. BiPAP with small pressure difference and high back-up frequency
   1. May enable complete control over patient's breathing
   2. Smaller tidal volumes
   3. Stable breathing pattern


Normal Lungs

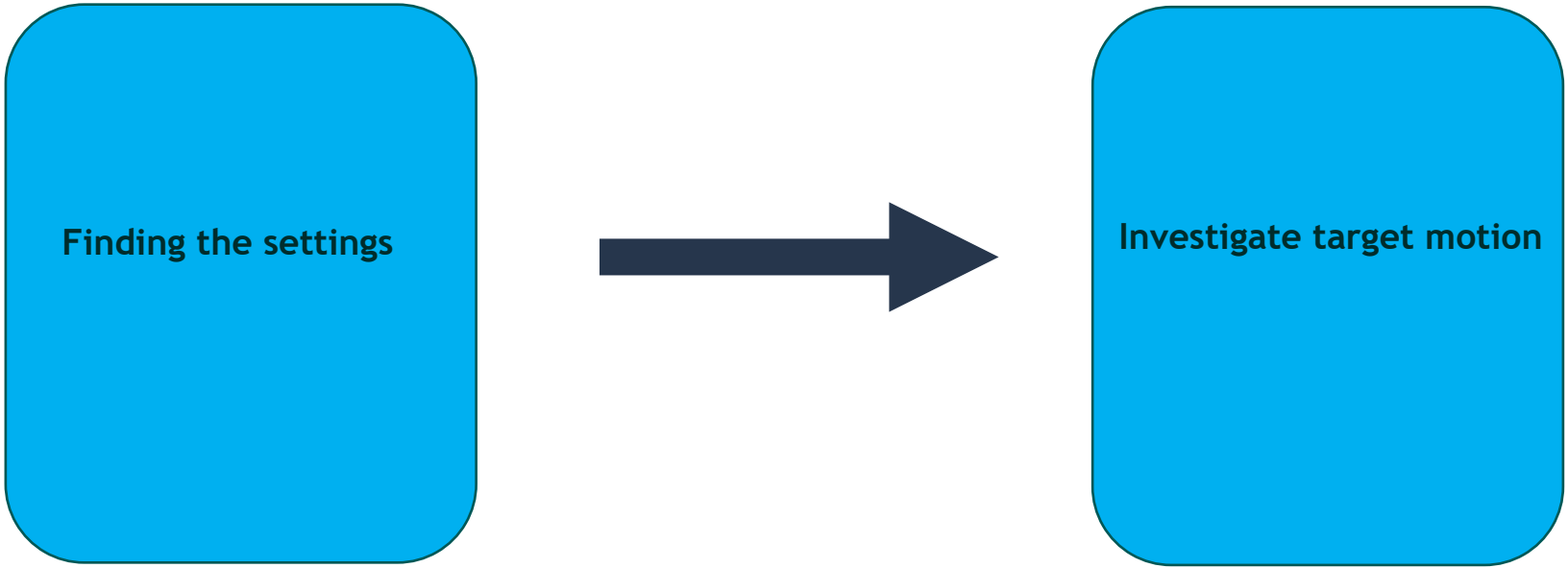

Hyperinflated Lungs

UMCG Center for home ventilation

→ Philips Respironics BiPAP A40 Pro

- Easy in use
- Readily available
- Wide experience and in-hospital support

Study: 2 phases



Design: phase 1

Inclusion

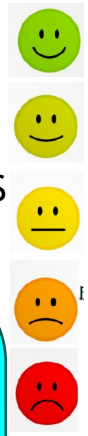
- 5 pts lung cancer
- 5 pts esophageal cancer or malignant lymphoma

Apply different settings

- CPAP 5 cmH_2O
- CPAP 10 cmH_2O
- CPAP 15 cmH_2O
- BiPAP 14/10 cmH_2O with low frequency
- BiPAP 14/10 cmH_2O with high frequency

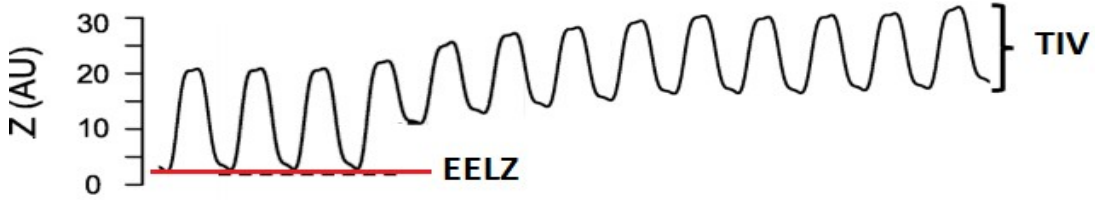
Measurements

- Tolerability/Comfort
- Safety
  - CO2 level
  - Oxygen saturation
  - Heart rate
- Breathing amplitudes
- Breathing variability



Phase 1: measure pulmonary volume changes

- EIT: Electrical impedance tomography
  - Increase/decrease of gas within the lung can be determined



- **TIV**: tidal impedance variation → ~ tidal volume
- **EELZ**: end-expiratory lung impedance → ~ end-expiratiory lung volume

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Results – Phase 1

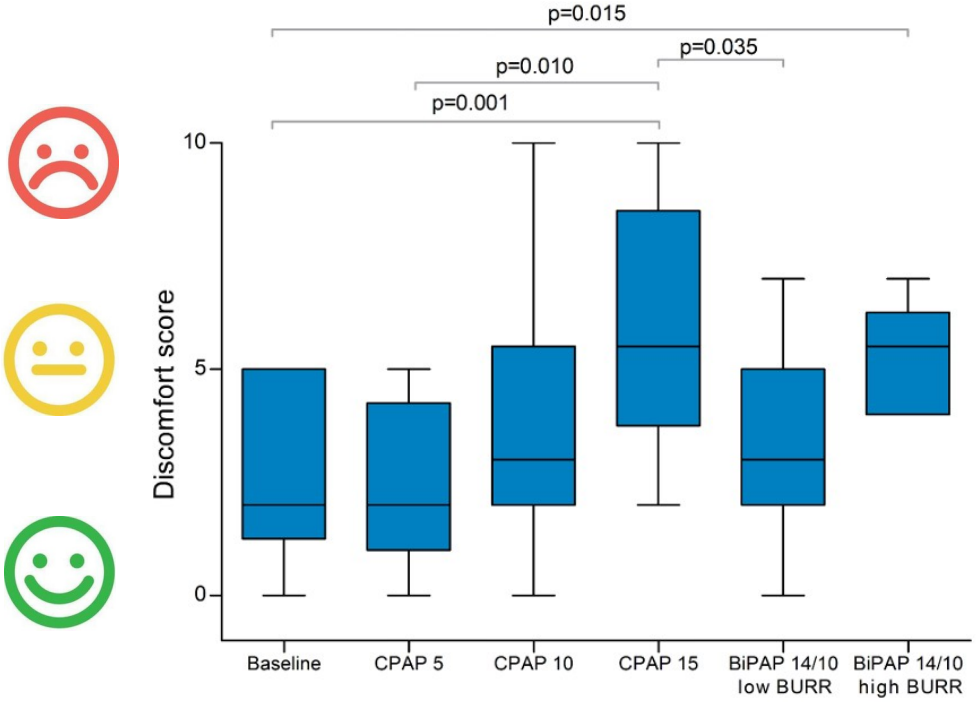
- Stable pCO_2, O_2 and HR for all settings

#	Sex	Age	Radiotherapy due to
1	M	67	Lung carcinoma (cT4N1)
2	M	33	Lymphoma (Hodgkin stadium II)
3	M	56	Lung carcinoma (cT1cN2M1b)
4	M	61	Lung carcinoma (cT4N2M1b)
5	M	70	Lung carcinoma (cT2aN2M0)
6	M	80	Lung carcinoma (cT2aN3M0)
7	M	58	Esophageal carcinoma (cT3N0-1M0)
8	M	34	Lymphoma (Hodgkin stadium IIB)
9	F	23	Lymphoma (Hodgkin stadium IIB)
10	M	20	Lymphoma (Hodgkin stadium IIA)

Results – Phase 1

Tolerability and comfort

- 1 patient did not tolerate CPAP 15



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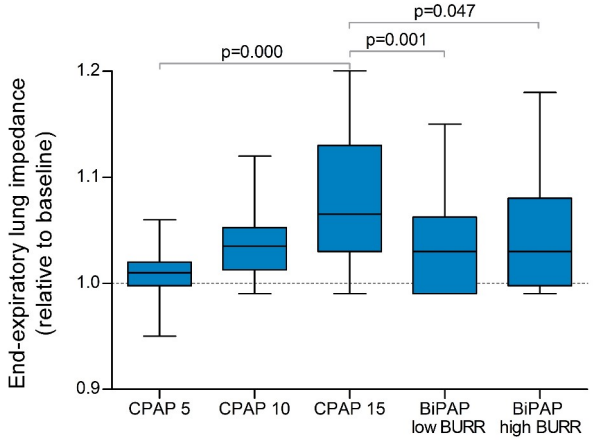
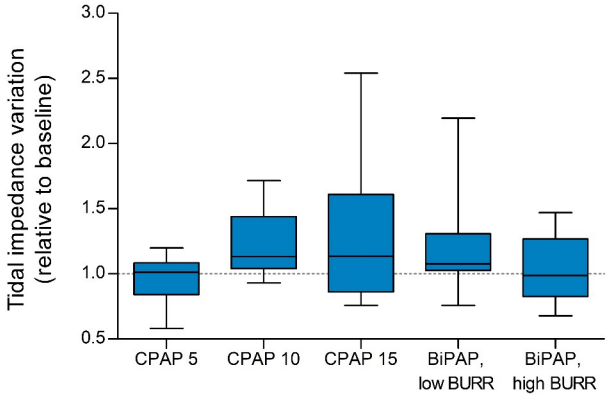
Results Phase 1

Electrical Impedence Tomography measurements



Hyperinflation



Tidal volume =

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Results Phase 1 - Summary

- Hyperinflation is present
- This hyperinflation does not lead to lower tidal volumes
- BiPAP with high back-up frequency was selected for phase 2 of the study:
  - Some degree of hyperinflation
  - Relatively small tidal volumes
  - When patient is used to BiPAP, results may improve

Phase 2 - Method

- Eligibility: Lung/oesophageal cancer patients, malignant lymphoma

- Training session to accommodate to BiPAP (no extra O_2); tweak breathing rate
  - Set the ventilator to 2 breaths above patients own breathing rate

- CT for RT planning with/without BiPAP → repeated weekly
  - Radiotherapy is delivered without BiPAP

Phase 2 - Results

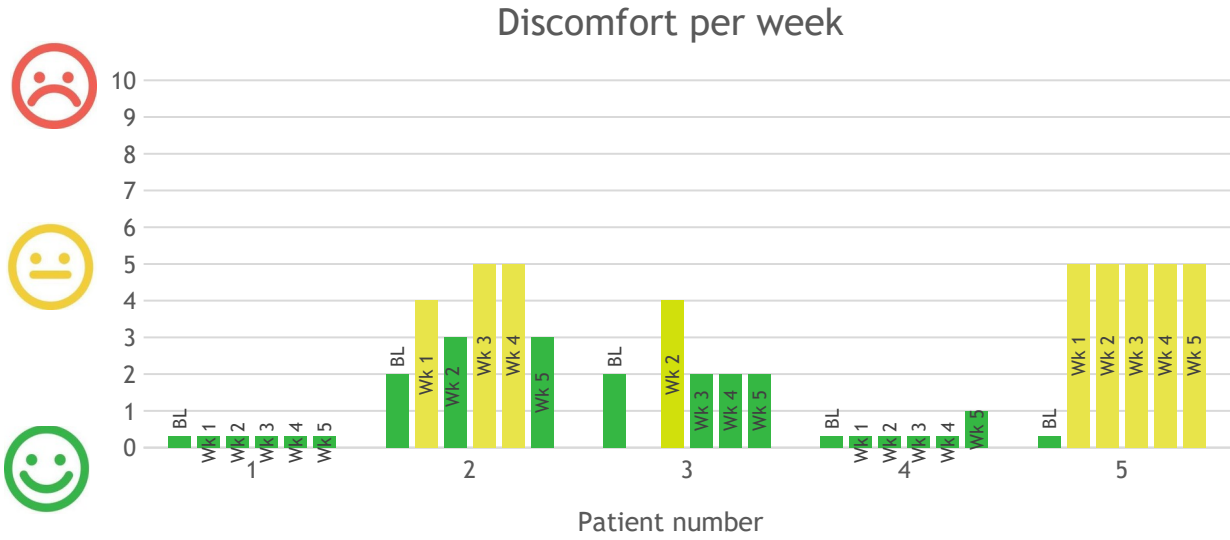
- All lung cancer patients
- Median age: 63 (range 56-71)
- Median FEV1 (%): 49 (range 29-81)
- COPD: yes 3/5.

Patient	Tumor location	TNM
1	Main bronchus	cT4N2M1a
2	Lower Lobe (R)	cT4N2M0
3	Upper Lobe (R)	cT1aN2M0
4	Lower Lobe (R)	cT2aN1M0
5	Upper Lobe (L)	cT4N1M0

Phase 2 - Results

- Feasibility:
  - 1 patient could not fulfil trainings procedure (withdrawn from study).

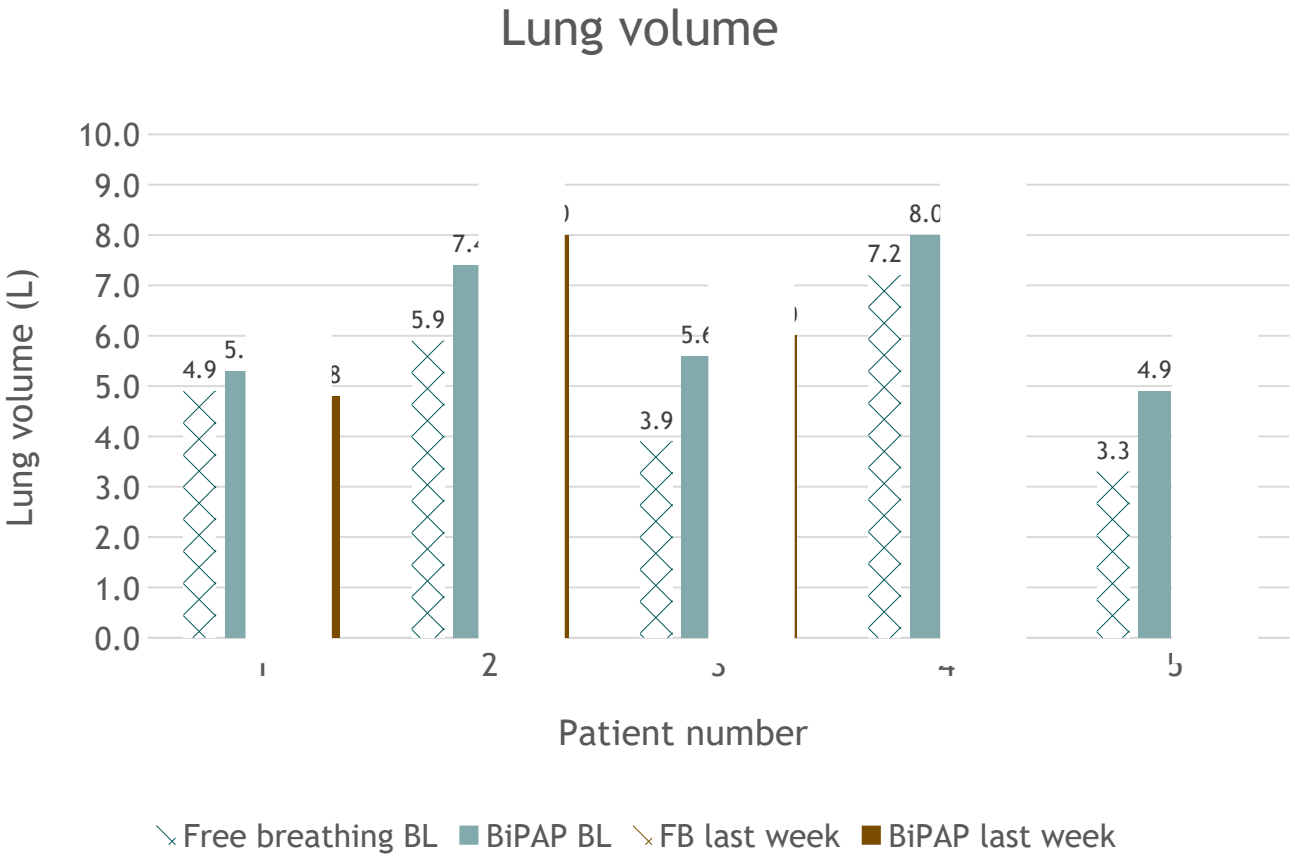
- Discomfort scores:



Phase 2 - Results

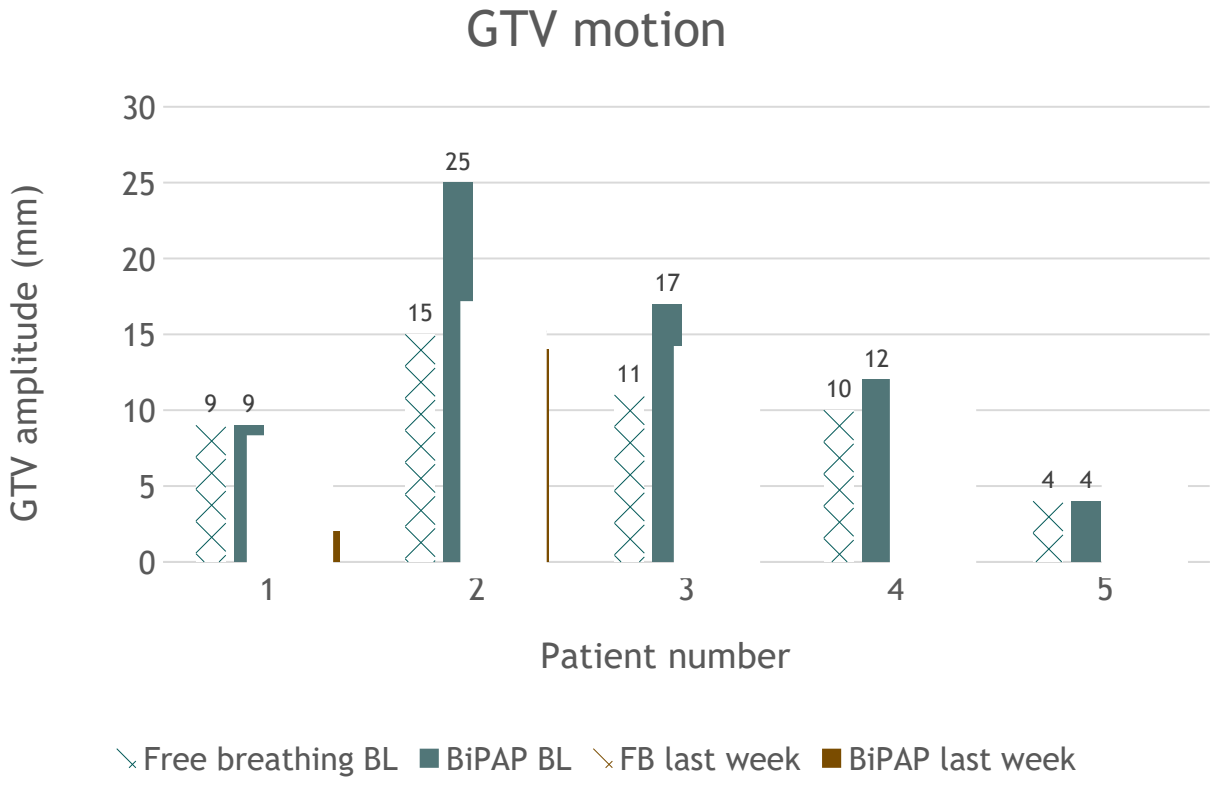
- Lung volumes and tumour movement extracted from the radiotherapy CTs
  - Baseline and last week of radiotherapy

Phase 2 - Results



Phase 2 - Results

- Tumour motion



Summary

- BiPAP was well tolerated
- BiPAP ventilation increases lung volume
- So far mixed results regarding reduction in tumour motion
- Future:
  - Include more patients
  - Improve training/instruction of the patient using BiPAP
  - Re-evaluate the settings of the mechanical ventilator
  - Learn a lot at this meeting to improve the outcomes!

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