Non-invasive mechanical ventilation in stereotactic arrythmia radiotherapy for ventricular tachycardia

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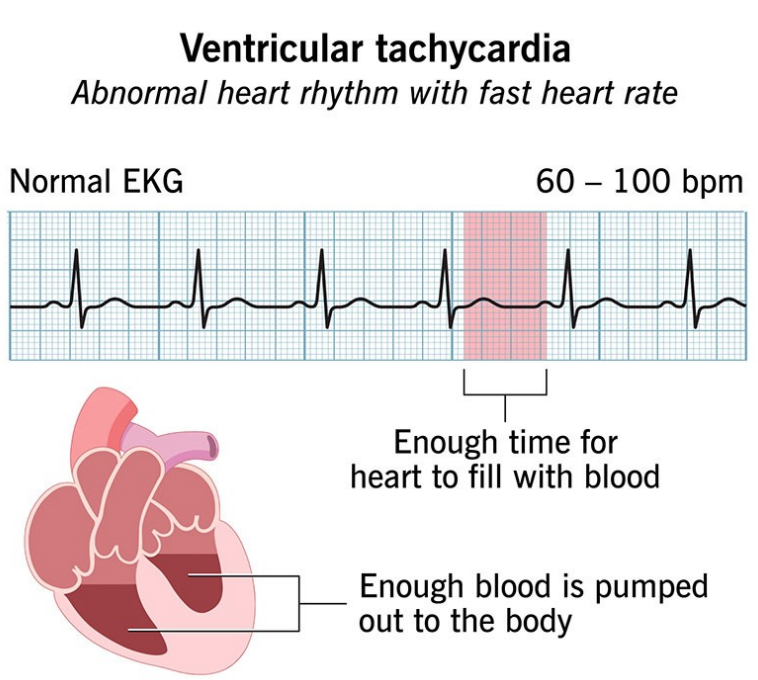
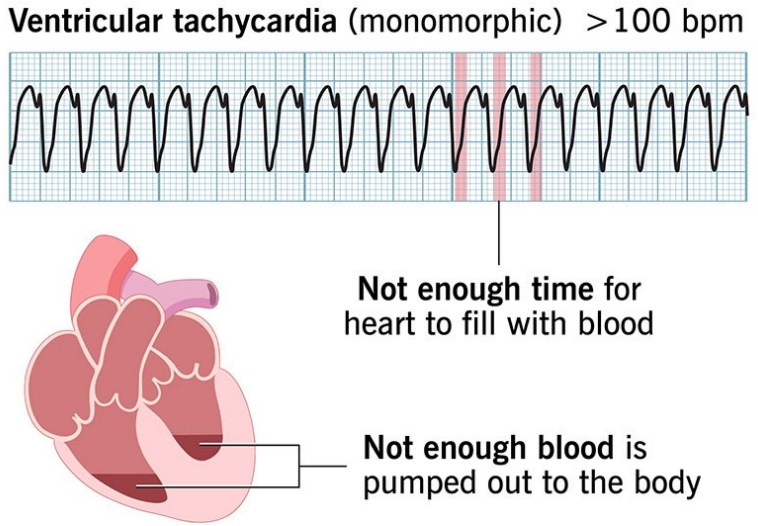
*Positive End Expiratory Pressure

Ventricular Tachycardia

- Incidence of 16/100.000 for idiopathic VT
- Increasing risk with age

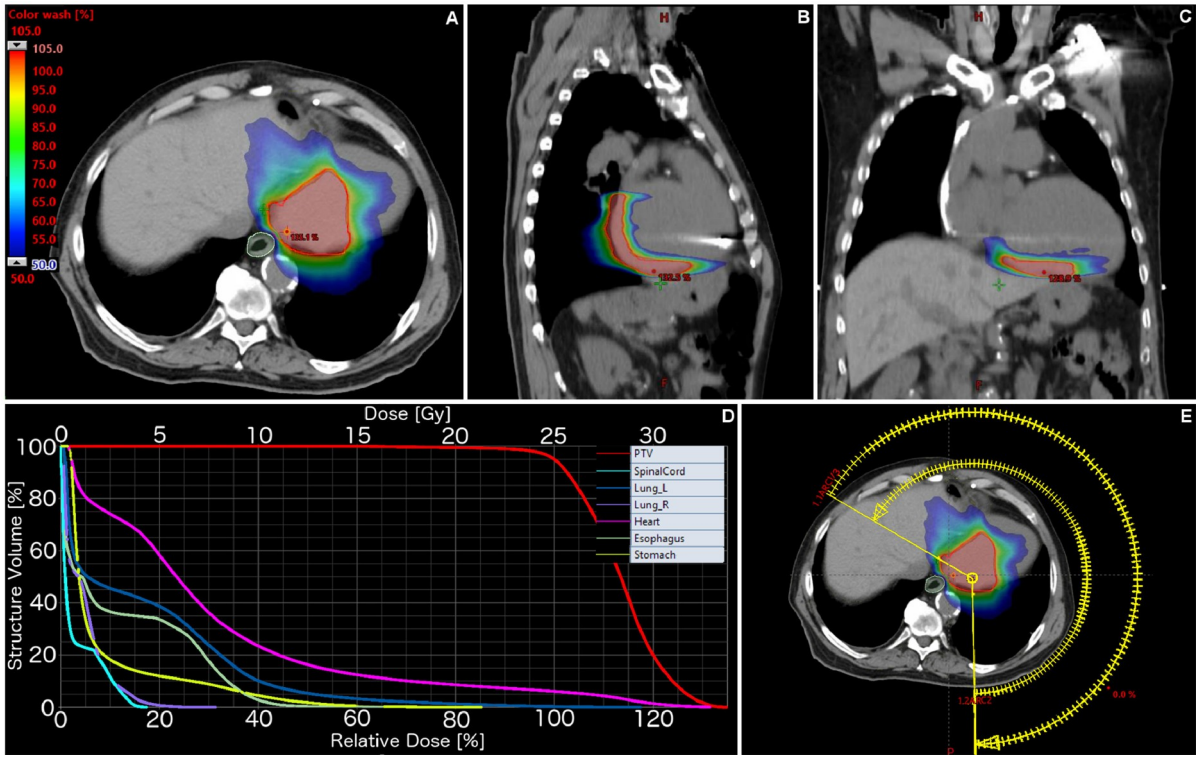
- Current treatment includes
- Implantable cardioverter-defibrillator (ICD)
- Anti-arrhythmia medication
- Catheter ablation of VT substrate





Stereotactic Arrhythmia RadioTherapy (STAR)

- Single fraction of 25Gy to VT substrate
- 75% reduction in VT events at 6 months
- Main organ-of-interest is stomach
  - Risk of gastric toxicity can limit PTV dose



Non Invasive mechanical ventilation

- Safe and comfortable
  - Subject conscious and unmedicated
  - Subject always in control
- Impose a breathing pattern

Goals
- Regularize to minimize breathing motion
- Control average lung volume
  - Optimize for beneficial anatomy

Aim

1. Quantify reduction in respiratory motion during NIMV with 60 brpm + 15cm H_2O PEEP* (NIMV60P) compared to free breathing

2. Quantify minimal distance between the heart and stomach

*Positive End Expiratory Pressure

Data

- Included N=22 healthy volunteers
- All patients underwent at least one MRI session and N=19 two MRI sessions

- During each MRI session:
- 3D scan during BH-exhalation, BH-inhalation and NIMV60P
- 6 minute 2D cine MRI during free breathing and NIMV60P

DATA: 38 sets of 2D MR scans (N=19 healthy volunteers)

Breathing motion: FB vs RB

50% reduction

Median diaphragm motion: 30 mm, IQR 16 mm

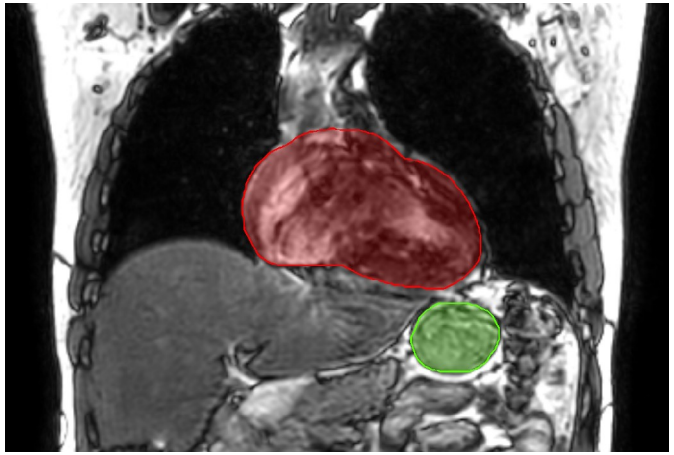
Median diaphragm motion: 15 mm, IQR 7 mm

Heart-Stomach Distance free breathing

Created union of heart and stomach during Bhin and Bhex to emulate FB envelope

- Overlap in 27/41 MRI sessions
- Minimal heart stomach distance in remaining sessions was 3.4 mm

A)



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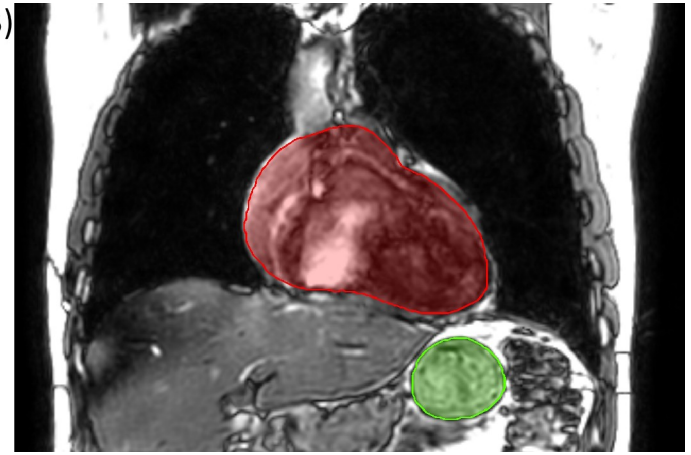

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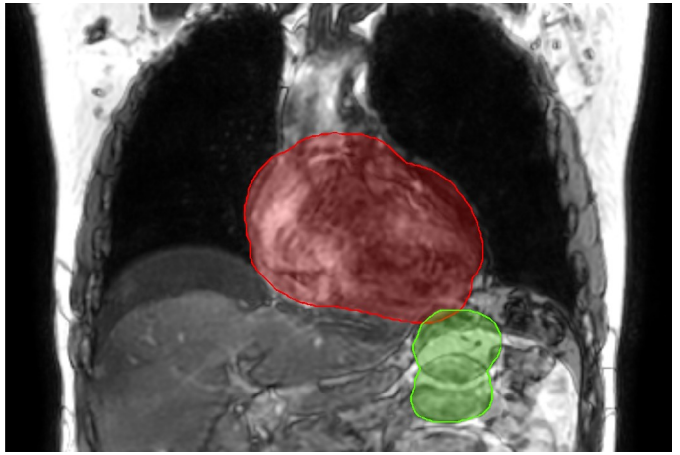

DATA: 41 sets of 3D MR scans (N=22 healthy volunteers)

Heart-Stomach Distance 3D

- Median minimal heart-stomach distance was:

- A) NIMV60P: 16.8 mm
- B) BH-inhalation: 10.3 mm
- C) BH-exhalation: 4.6 mm

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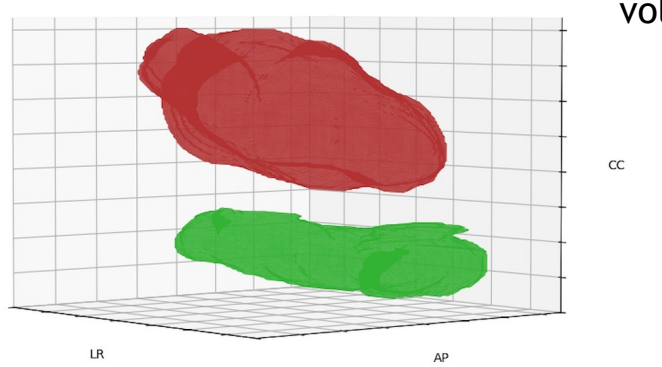

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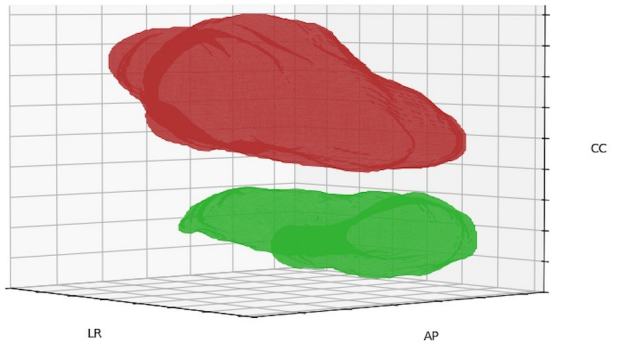

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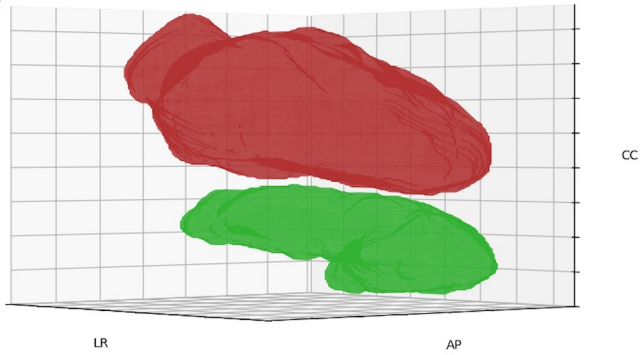

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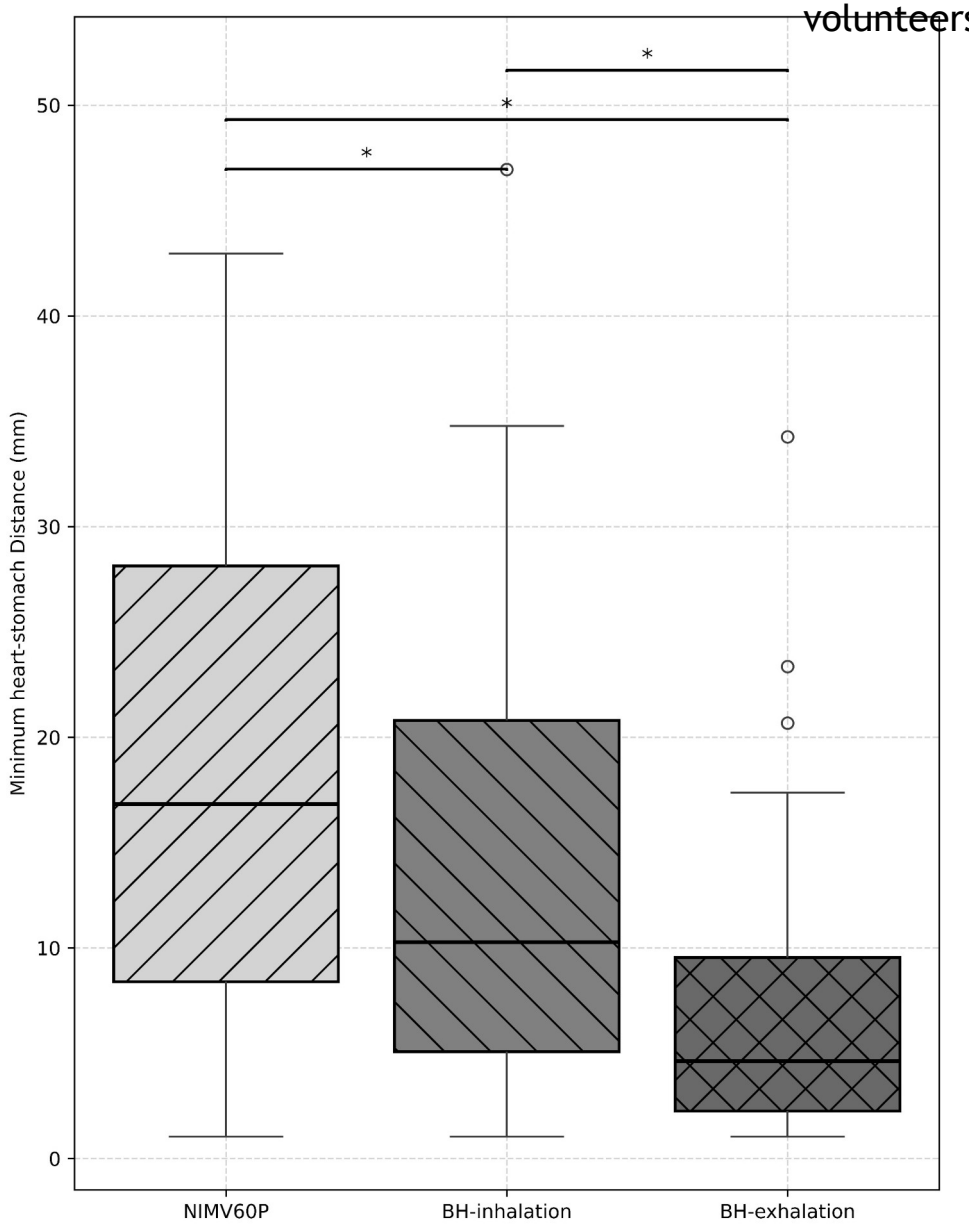
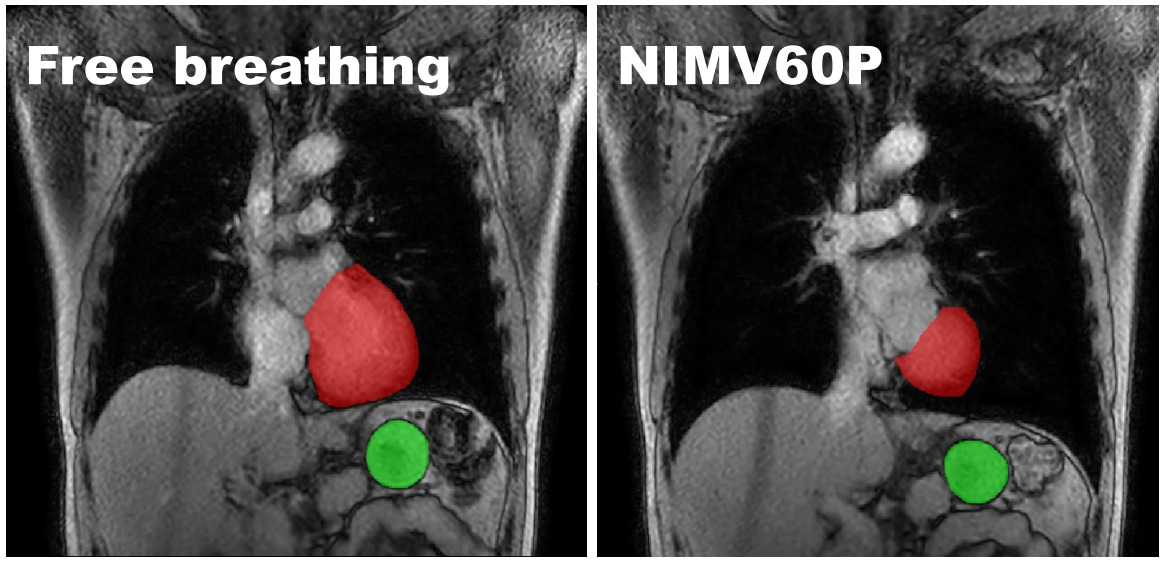
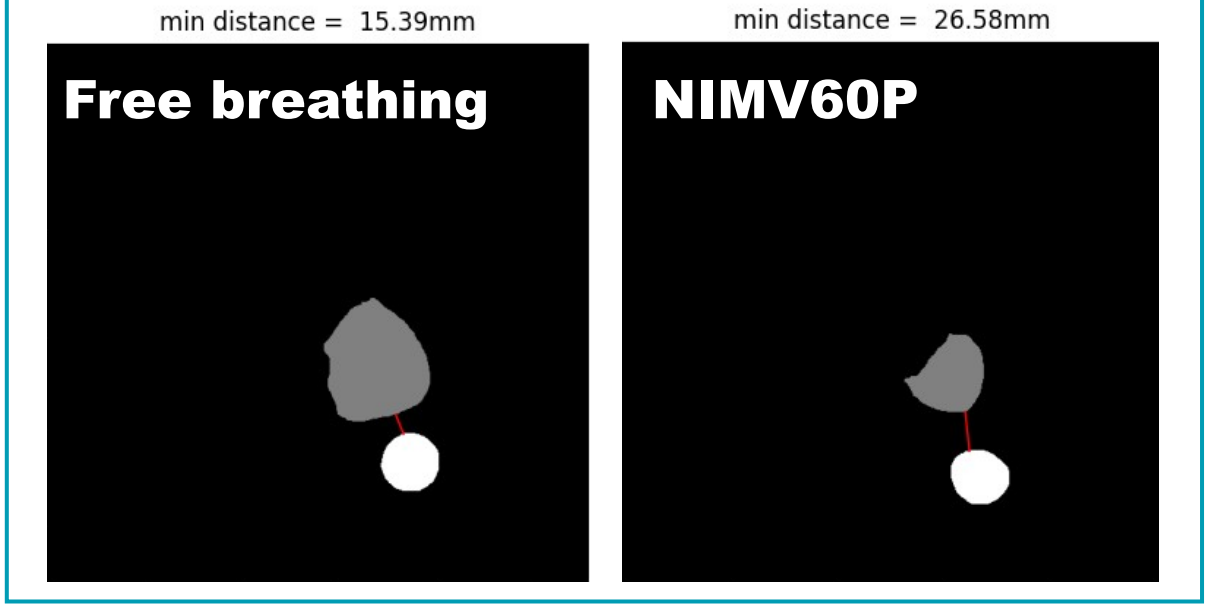


Heart-stomach distance over time

Quantify minimal distance between caudal heart border and cranial stomach wall over time

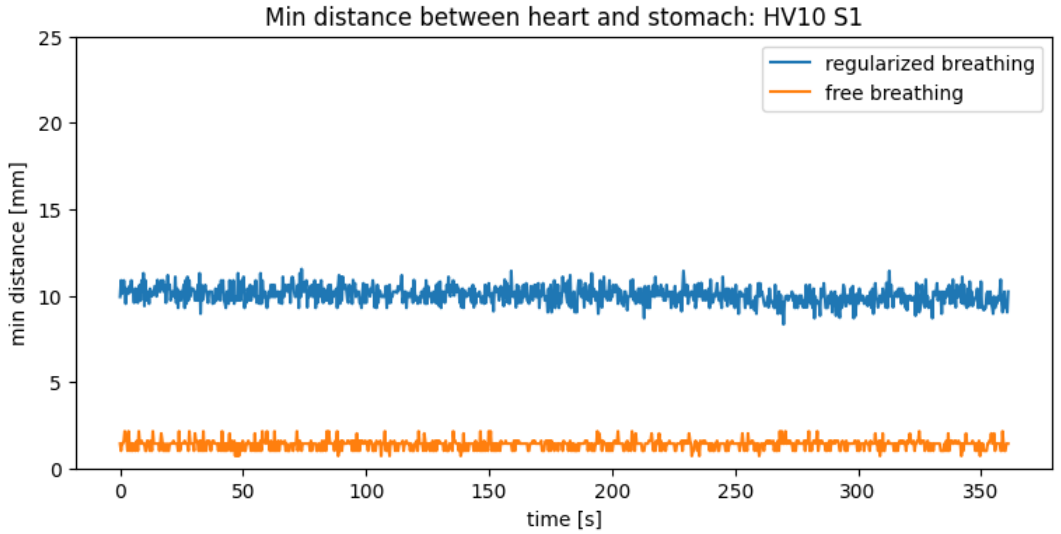


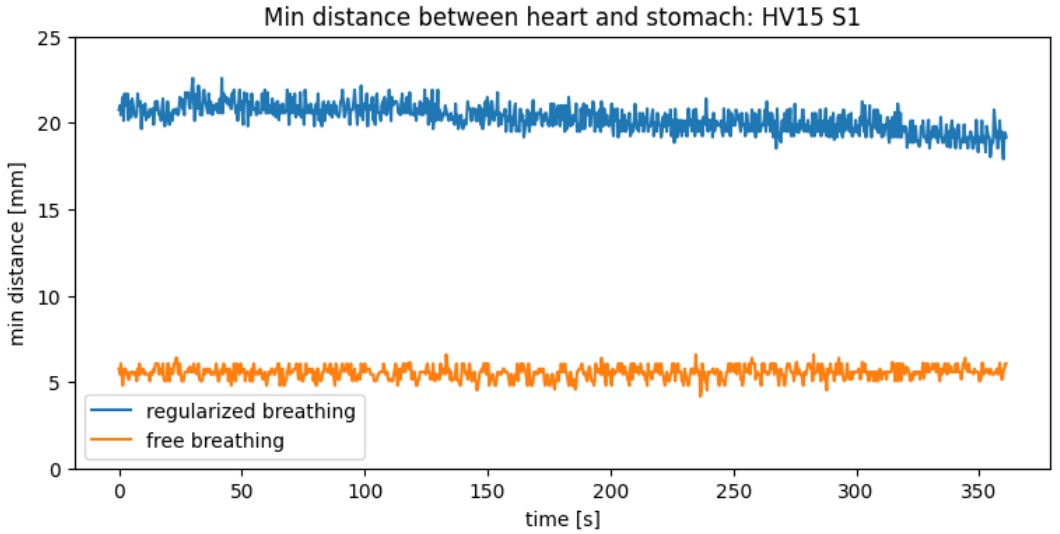


Heart-stomach distance over time

Median heart-stomach distance was significantly higher during NIMV60P

- 19.2mm vs 7.1mm ($p < 0.001$)





Conclusions

1. 50% decrease in median diaphragm motion with ventilation induced RB
   - Stable position of diaphragm, heart and stomach

2. Significantly increased heart stomach distance during RB vs FB and BH conditions

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