Monitoring remission of equine asthma with EIT

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Abstract: There is great potential for EIT in the diagnosis of obstructive lung diseases. To support further research, we provide an interventional dataset of 3D EIT and lung-function measurements in equine asthma.

1 Introduction

Asthma diagnosis ideally involves the objective assessment of lung function. However, spirometry-based lung function testing is not sufficiently sensitive (e.g. can be normal during remission) and is often poorly tolerated. This study aimed to evaluate the 2-plane / 3D EIT as a non-invasive diagnostic tool in asthma, using horses with severe equine asthma (SEA), and characterize regional lung function changes during corticosteroid treatment. Horses with SEA underwent daily EIT and pulmonary function testing (PFT) for two days of exacerbation (hay exposure) and eight days of dexamethasone treatment. This study aims to advance research on EIT in obstructive lung disease by using 2-plane electrode belts and 3D reconstruction.

2 Methods: Animals

Ten horses with severe equine asthma belonging to the University of Montreal research herd were evaluated (with Animal Care Committee approval 23-Rech-2041). Four geldings and six mares were included: weight 565 ± 71.5 kg and age 14.3 ± 2.4 years. They were fed hay of variable quality twice a day, to induce asthma exacerbation. When clinical signs and pulmonary function confirmation of exacerbation were observed ($R_L > 1\,\frac{\mathrm{cmH_2O}}{\mathrm{L/s}}$), treatment with oral dexamethasone (0.05 mg/kg PO once daily) was initiated and continued for 8 days to return horses to remission ($R_L > 1\,\frac{\mathrm{cmH_2O}}{\mathrm{L/s}}$).

3 Methods: Measurements

A two-plane EIT belt was placed around the thorax of each horse after wetting of the hair with water, and/or application of non-conductive coupling gel (Fig 1). The cranial row of electrodes was placed immediately behind the olecranon at ≈ the 5th or 6th intercostal space. The caudal electrode belt was 25 cm from the cranial row. EIT data were recorded separately to PFT data (before in 7 measurements, after in 22 measurements, simultaneously in 11 measurements). EIT data were recorded using the Sentec BB-Vet EIT system at 50.9 frame/s, using a "skip 4" stimulation/measurement pattern with a "square" electrode placement, and reconstructed with 3D GREIT[1]. Data were recorded for a minimum of two minutes or 10 breaths.

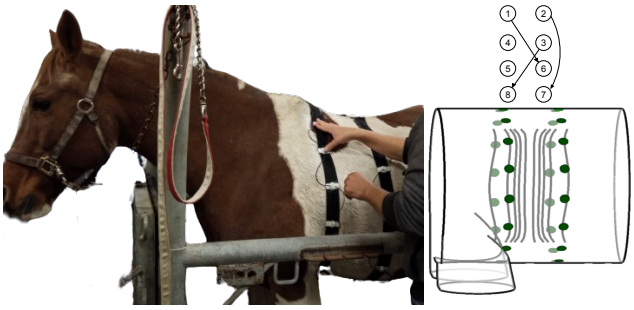

Fig. 1: Left: A horse with two-plane EIT electrode belts. Right: Electrode model sensitivity and stim/meas pattern.

Pulmonary function tests were performed: oesophageal pressure was measured using a thin-walled balloon catheter, while airflow was assessed with a pneumotachograph and differential pressure transducer connected to a respiratory mask. Pulmonary resistance (R_L) and elastance (E_L) were calculated using the lung single compartment model by dedicated software (FlexiWare 7.6). Measurements were performed on days 0, 1, 4, and 7 for nine horses, and on days 0, 1 and 3 for one horse that had a delay to exacerbation.

The dataset (doi.org/10.5281/zenodo.14779514) is available under a CC Attribution 4.0 Int licence.

4 Results and Discussion

EIT has great potential for diagnosis and titration of treatment for obstructive lung disease[2]. EIT research in humans has largely been restricted to observational studies, and the use of single electrode belts which do not measure the full 3D lung regions.

These data offer insight into this disease process. For example, Fig 2 shows increased T_{close} over the treatment phase. We hope that this freely available 3D EIT data set of asthma exacerbation and remission will facilitate improved understanding of EIT's potential to provide useful diagnostic information in these diseases.

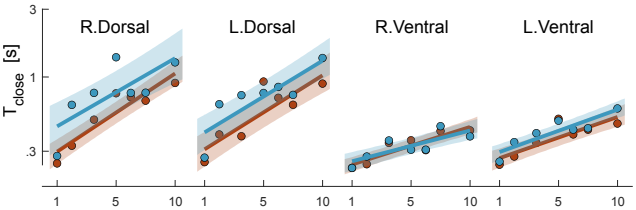

Fig. 2: Opening time (T_{close}) for a horse in eight regions (pink:cranial, blue:caudal), as a function of remission day.

References

[1] B Grychtol *et al* (2016) "3D EIT image …" *Physiol Meas* 37:785
[2] I Frerichs *et al* (2017) "Chest electrical impedance …" *Chest* 72:83