Magnitude and Regional Distribution of VQ Ratios in Anaesthetized Horses

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Abstract: We evaluated the regional magnitude and distribution of ventilation / perfusion ($\dot{V}/Q$) ratios in anaesthetized horses at 25 and 50 minutes and found that the images were consistent across time. This suggests that the technique is stable for studying long-term $\dot{V}/Q$ ratio changes during anaesthesia.

1 Introduction

The regional $\dot{V}/Q$ ratio is the main determinant of gas exchange. General anaesthesia significantly impairs gas exchange in horses[2]. We were motivated to assess the magnitude and distribution of $\dot{V}/Q$ ratios over time in horses undergoing anaesthesia in dorsal recumbency.

2 Methods

Four supine recumbent, mechanically ventilated horses undergoing bilateral stifle arthroscopy were included. A custom-made EIT belt was placed prior to surgery. EIT recordings were obtained 25 (T25) and 50 (T50) minutes after anaesthesia induction. At each measurement, a bolus (100 mL) of 7.2% sodium chloride was injected IV. EIT data was collected using 1 ring of 32 electrodes. Images were reconstructed in MATLAB2019a using the EIDORS software package[1] and a horse-shaped forward model. Image elements were reconstructed using a background conductivity of 1 and a conductivity of 0.3 within the lungs. Images were referenced to the end-expiratory lung impedance value at the onset of the saline injection. $\dot{V}/Q$ images were then generated for each time point as follows: a tidal image was reconstructed from the breath at the lowest section of the saline curve. The perfusion image was reconstructed from the lowest point in the saline curve. Tidal and perfusion images were normalized so that each pixel represented the fraction of the average pixel value. The ratio of pixel values in the ventilation and perfusion images were then obtained to form the $\dot{V}/Q$ image. Changes in $\dot{V}/Q$ ratio over time were analyzed globally and regionally. Six lung regions were segmented by dividing the lungs into left and right then subdividing each lung into ventral, intermediate, and dorsal regions. Data was analyzed with 2-way ANOVA and reported as mean $\pm$ SD. Significance was determined at $p < 0.05$.

3 Results and Discussion

The global $\dot{V}/Q$ ratio was not different (p = 0.936) at T25 (1.14 ± 0.13) compared with T50 (1.14 ± 0.14). Likewise, no regional differences were seen at different times. The mean (T25 + T50) regional magnitude of $\dot{V}/Q$ ratios were therefore reported. In the right lung: ventral = 1.15 ± 0.07, intermediate = 1.31 ± 0.13, dorsal = 1.03 ± 0.04. In the left lung: ventral = 1.18 ± 0.13, intermediate = 1.16 ± 0.09, dorsal = 1.01 ± 0.07. The $\dot{V}/Q$ ratio in the ventral and intermediate regions was higher (p = 0.03) compared with the dorsal region in both lungs. The intermediate region was higher (p = 0.004) than the ventral region only in the right lung.

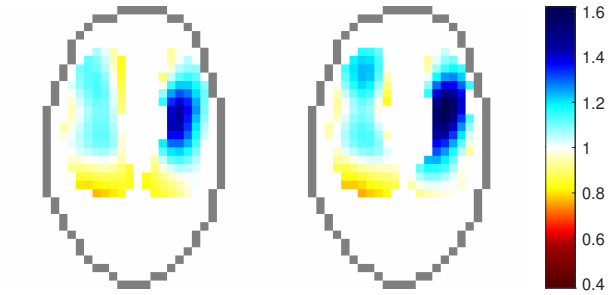

Figure 1: $\dot{V}/Q$ image of one horse at T25 (left) and T50 (right). Pixels values are the ratio of normalized ventilation to normalized perfusion at each time point.

4 Conclusions

EIT can be used to study regional $\dot{V}/Q$ ratios in anesthetized horses. No differences were found related to time, but there was topographic variation.

References

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