Belgian Society of Fundamental and Clinical Physiology and Pharmacology

Abstracts of the Winter Meeting
14 February 1998, Louvain-en-Woluwe, Belgium

Table of contents

Author index ................................................................. R242

Abstracts ................................................................. R243–R254
29

ASSESSMENT OF RESPIRATORY MECHANICS WITH IMPULSE OSCILLOMETRY IN HORSES WITH UPPER AND LOWER AIRWAY OBSTRUCTION

E. van Eijk, D.H. Duiviver, T. Art and P. Lekeux

The aim of this study was to compare Impulse Oscillography (IOS) to a current reference technique (CFT) in the evaluation of mechanical parameters in horses with obstructive disease, affecting either upper or lower airways. In contrast to the CFT, which requires the introduction of an esophageal balloon-tipped catheter for the evaluation of pleural pressure changes, the IOS is based on the forced oscillation principle and is therefore totally non-invasive. The IOS enables to measure resistance (R) and reactance (X) in a spectrum of frequencies, from 0.5 to 10 Hz. Mechanicals of breathing were determined using both methods in random order, (1) in six horses suffering from Chronic Obstructive Pulmonary Disease (COPD) before and during a bronchoplastic crisis, induced by exposure to mouldy hay, and (2) in five healthy horses before and after an experimentally induced left lower laryngeal hemiplegia (LLH). Main results obtained with IOS and CFT in both conditions are summarized in Table 1.

Table 1: Mechanics of breathing in 6 COPD-affected horses before and during an acute crisis, and in 5 horses before and after LLH (results expressed as mean ± SD).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Before crisis</th>
<th>During crisis</th>
<th>Before LLH</th>
<th>During LLH</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOS</td>
<td>R (pa/s)</td>
<td>0.46 ± 0.09</td>
<td>0.56 ± 0.10</td>
<td>0.50 ± 0.10</td>
</tr>
<tr>
<td></td>
<td>X (pa/s)</td>
<td>0.35 ± 0.07</td>
<td>0.38 ± 0.08</td>
<td>0.36 ± 0.07</td>
</tr>
<tr>
<td>CFT</td>
<td>R (pa/s)</td>
<td>0.42 ± 0.08</td>
<td>0.46 ± 0.09</td>
<td>0.40 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>X (pa/s)</td>
<td>0.36 ± 0.07</td>
<td>0.38 ± 0.08</td>
<td>0.36 ± 0.07</td>
</tr>
</tbody>
</table>

30

IMPACT OF DIFFERENT ENVIRONMENTAL MANAGEMENTS ON SPATIAL DISTRIBUTION OF VENTILATION IN COPD HORSES

Vandepoort S., Reiff F., Voloin D., Duiviver D.H., Art T., Lekeux P.

Placed in a strictly controlled environment (well-ventilated barn with grass slurry and wool shaving) during 8 weeks, COPD horses presented similar clinical state and pulmonary function parameters as healthy horses. Nevertheless, their bronchial reactivity is different from that measured in the same horses after two months in pasture or in healthy horses. The aim of this study was to evaluate potential changes in ventilation distribution and functional residual capacity (FRC) in chronically affected horses placed in three different environmental conditions; in pasture, in a controlled barn environment, and during acute crisis.

Multiple-breath nitrogen washouts (WG) were performed in six ungraded COPD horses. Principle of the classical WG analysis is to follow the breath-by-breath evolution of the end-expiratory N2 concentration. The analysis of this procedure consisted in calculating the slope ratio and the FRC, giving information on the spatial homogeneity of the ventilation on the one hand, and on the volume of gas remaining in the lung after a normal expiration, on the other hand. When the lung is perfectly homogeneously ventilated, the alveolar N2 concentration decreases exponentially with the numbers of breath. In such cases, the slope ratio is equal to 1. Any deviation from unity indicates a nonhomogeneous spatial distribution of ventilation. For FRC, always obstruction could induce an entrapment of air at the end of normal expiration. Results are summarized in Table 1.

Table 1 - Values of slope ratio and FRC in different environmental situations. Means ± SD

<table>
<thead>
<tr>
<th>Condition</th>
<th>Slope ratio</th>
<th>FRC (L)</th>
<th>Acute crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td>0.04 ± 0.19 a</td>
<td>0.70 ± 0.22 a</td>
<td>0.39 ± 0.12 b</td>
</tr>
<tr>
<td>Controlled barn</td>
<td>0.59 ± 0.40 a</td>
<td>0.40 ± 0.12 a</td>
<td>0.44 ± 0.41 b</td>
</tr>
</tbody>
</table>

Values with no common designations are significantly different (p < 0.05).

During acute crisis, spatial ventilation distribution clearly became more homogeneous, as a result of airway obstruction. No difference was detected between values obtained after 2 months in pasture and after 2 months in a controlled barn environment. Apparent modifications in the lower airways, reflected by alterations of the reactivity after 2 months in a controlled barn environment, are not associated with increased spatial ventilation maldistribution. Findings support the hypothesis of a role of gas trapping beyond closed or plugged airways. This gas may not be involved in ventilation and thus FRC could be underestimated.

31

LUNG SCANNING IN CALVES USING TECHNEGAS

D. Doyon, J. Cogna and P. Lekeux

In human medicine, the gold standard method to study pulmonary ventilation with scintigraphy relies on the radioactive 81mKr/Krypton gas (18mKr) steady-state inhalation. Alternative methods used radioactive aerosols and most commonly, nebulized DTPA labeled with 99mTc/Technetium (99mTc-DTPA). Both techniques have major drawbacks e.g., the 81mKr/Krypton generator short half-life limits its availability in clinical practice and the DTPA clearance from lung to blood imitates a direct injection of a good quality images under pulmonary disease. Technegam (Tgs), an ultra fine aerosol of 99mTc labeled carbon clusters may be an interesting alternative to study the ventilation in bovine.

In order to test this hypothesis, six healthy double-muscled Belgian White and Blue calves (99.3 ± 15.9 kg; 91.2 ± 14.2 days) underwent 18mKr/99mTc-DTPA and Tgs pulmonary scintigraphy. The 18mKr and Tgs images were simultaneously acquired using dual energy windows whereas the 99mTc-DTPA images acquisition was performed at another occasion. Each picture was compared for their size (SZ; i.e., the number of pixels included in the lung image's border) and the penetration index (PI) defined as the quotient between the count density in the peripheral region containing main lung parenchyma to that in the central region including the major bronchus. PI expresses the tendency of radioactivity to reach the lung periphery. A relative PI, which is the ratio between the different PI and the 18mKr-PI calculated, was also defined.

No significant difference was found between 18mKr and Tgs (PI) which were significantly higher in size of approximately 10 % than 99mTc-DTPA. The 18mKr-PI were 0.42 ± 0.07, 0.47 ± 0.05 and 0.35 ± 0.04 for the 18mKr, Tgs and 99mTc-DTPA, respectively. Tgs showed a significantly higher PI than 18mKr (PI) and 99mTc-DTPA. The three ventilation agents significantly differed with a relative PI equal to 1.00 ± 0.00 (by definition), 1.19 ± 0.12 and 0.98 ± 0.17 for 18mKr, Tgs and 99mTc-DTPA, respectively (p < 0.05).

From the results, it may be concluded that Tgs is a better alternative than 99mTc-DTPA for ventilation imaging. Nevertheless, Tgs and 99mTc-DTPA distribution patterns are not perfectly matched. Significance of this finding on ventilation to perfusion ratio determination should be investigated as well as effects of pulmonary diseases on radiocactivity distribution.

Laboratory for Functional Investigation, Faculty of Veterinary Medicine, University of Liége, Bât. B42, Sant Tilman, B-4000 Liége, Belgium

32

CONSEQUENCES OF THE COMBINED DEFICIENCY IN DYSTROPHIN AND UROPTHIN ON THE MECHANICAL PROPERTIES AND MYOSIN COMPOSITION OF LIMB AND RESPIRATORY MUSCLES OF THE MOUSE

N. Deconinck *, J. Rafael *, G. Becketts-Beauk *, D. Kahr *, K. Davies * and J.M. Gills *

The mechanical properties and the myosin isoform composition were studied in three isolated muscles (EDL, soleus diaphragm) of mutant mice lacking dystrophin and utrophin (dko). They were compared to the corresponding muscles of the normal and the dystrophin-deficient (mdx) mice. In comparison to mdx muscles, dko muscles show a significant reduction of the normalised isometric force, confirmed by the reduced muscular activity of the whole animal. Kinetics parameters (wet time-to-peak and half-relaxation time) were slightly reduced, and the maximal speed of shortening of soleus, Vmax, was reduced by 30%. The maximal power output (in Watts/ mm²) was reduced by 56% in dko soleus. In the three muscles studied, the relative myosin heavy chains (MHC) composition showed a shift towards slower isoforms. Dko EDL presented a dramatic decrease of the resistance to tetanic contraction with forced lengthenings (escentric contractions), while muscle lacking only utrophin (mdx mutants) display a normal resistance to this existing mechanical challenge. This result supports the idea that the overexpression of utrophin in mdx muscle compensates, to some extent, for the lack of dystrophin.

*Present address
a) Departement de Physiologie, Université Catholique de Louvain, 1200 Bruxelles, Belgium;
b) Genetics Unit, Department of Biochemistry, University of Oxford, England, UK.