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

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The aim of this study was to compare Impulse Oscillometry (IOS) to a current reference technique (CRT) in the evaluation of respiratory mechanical parameters in horses with obstructive disease, affecting either upper or lower airways. In contrast to the CRT, 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 spectre of frequencies, from 5 to 35 Hz.

Mechanics 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 bronchospastic crisis, induced by exposure to mouldy hay, and (2) in five healthy horses before and after an experimentally induced left laryngeal hemiplegia (LLH). Main results obtained with IOS and CRT 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 ± s.d)

IOS	Before crisis	During crisis	Before LLH	During LLH
R5 Hz (kPa/l/s)	0.062 ± 0.009	0.124 ± 0.016*	0.060 ± 0.005	0.070 ± 0.004°
R20 Hz (kPa/l/s)	0.088 ± 0.011	0.068 ± 0.015	0.077 ± 0.005	0.101 ± 0.008°
X5 Hz (kPa/l/s)	0.011 ± 0.002	-0.106 ± 0.027*	0.001 ± 0.008	0.003 ± 0.007
X20 Hz (kPa/l/s)	0.022 ± 0.008	-0.046 ± 0.009*	-0.020 ± 0.014	-0.012 ± 0.007
CRT				
R_L(kPa/l/s)	0.062 ± 0.016	0.274 ± 0.058*	0.058 ± 0.012	0.069 ± 0.014
Cdyn (l/kPa)	20.937 ± 3.805	4.261 ± 1.830*	16.37 ± 2.512	17.27 ± 3.014

* significantly different from values obtained before crisis (bronchospasm) ($p < 0.05$); ° significantly different from values obtained before LLH ($p < 0.05$).

Both techniques were able to detect a significant difference of respiratory mechanical parameters during an obstruction of peripheral airways. However, not only was the IOS more sensitive than CRT in detecting LLH but it also allowed to differentiate between central and periphal airway dysfunction as the behaviour of R and X in the frequency domain was modified according to the level of obstruction.

To conclude, the IOS seems to be a reliable technique, able to evaluate and localize impaired respiratory mechanics in case of common upper and lower airway obstructions in horses. Compared to the CRT, the IOS was found to be quicker, easier to use and well tolerated by all animals.

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

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Placed in a strictly controlled environment (well ventilated barn with grass silage and wood shavings) during 8 weeks, COPD horses present 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 COPD horses placed in three different environmental conditions : in pasture, in a controlled barn environment, and during acute crisis.

Multiple-breath nitrogen washouts (WO) were performed in six unsedated COPD horses. Principle of the classical WO analysis is to follow the breath-by-breath evolution of the end-expiratory N_2 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 N_2 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, airways 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

	Pasture	Controlled barn environment	Acute crisis
Slope ratio	0.64 ± 0.18 [a]	0.70 ± 0.22 [a]	0.36 ± 0.13 [b]
FRC (L)	55.9 ± 6.9 [a]	40.5 ± 10.9 [ab]	44.1 ± 6.4 [b]

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

During acute crisis, spatial ventilation distribution clearly became more inhomogeneous as a result of airways obstruction. No difference was detected between values obtained after 2 months in pasture and after 2 months in a controlled barn environment. Apparently, 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. Finally, results of FRC measurement suggested presence of gas trapping beyond closed or plugged airways. This gas may not be involved in ventilation and thus FRC could be underestimated.

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LUNG SCANNING IN CALVES USING TECHNEGAS

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In human, the gold standard method to study pulmonary ventilation with scintigraphy relies on the radioactive ^{81m}Krypton gas (^{81m}Kr) steady-state inhalation. Alternative methods used radioactive aerosols and most commonly, nebulized DTPA labeled with ^{99m}Technetium (^{99m}Tc-DTPA). Both techniques have major drawbacks e.g., the ^{81m}Kr generator short half-life limits its availability in clinical practice and the DTPA clearance from lung to blood impedes acquisition of good quality images under pulmonary disease. Technegas (Tgs), an ultra fine aerosol of ^{99m}Tc 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; 91.7 ± 14.2 days) underwent ^{81m}Kr, ^{99m}Tc-DTPA and Tgs pulmonary scintigraphy. The ^{81m}Kr and Tgs images were simultaneously acquired using dual energy windows whereas the ^{99m}Tc-DTPA images acquisition was performed at another occasion. Each pictures were 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 mainly lung parenchyma to that in the central region including the major bronchi. PI expresses the tendency of radioactivity to reach the lung periphery. A relative PI, which is the ratio between the different PI and the PI calculated for ^{81m}Kr, was also defined.

No significant difference was found between Sz(^{81m}Kr) and Sz(Tgs) which were significantly higher in size of approximately 10 % than Sz(^{99m}Tc-DTPA). The calculated PI were 0.42 ± 0.07, 0.47 ± 0.05 and 0.35 ± 0.04 for the ^{81m}Kr, Tgs and ^{99m}Tc-DTPA, respectively. PI(Tgs) was significantly higher than PI(^{81m}Kr) and PI(^{99m}Tc-DTPA). The three ventilation agents significantly differed with a relative PI equal to 1.00 ± 0.00 (by definition), 1.13 ± 0.12 and 0.85 ± 0.17 for the ^{81m}Kr, Tgs and ^{99m}Tc-DTPA, respectively ($p < 0.05$).

From the results, it may be concluded that Tgs is a better alternative than ^{99m}Tc-DTPA for ventilation imaging. Nevertheless, Tgs and ^{81m}Kr 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 radioactivity distribution.

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

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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 (twitch time-to-peak and half-relaxation time) were slightly reduced, and the maximal speed pf shortening of soleus, V_{max} , was reduced by 30%. The maximal power output (in µWatts/ mm^3) was reduced by 50% 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 (eccentric contractions), while muscle lacking only utrophin (*uko* mutants) display a normal resistance to this exacting mechanical challenge. This result supports the idea that the overexpression of utrophin in *mdx* muscle compensates, to some extent, for the lack of dystrophin.

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