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Relationship between clinical signs and results of impulse oscillometry in pigs originating from the field

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ABSTRACT

The aim of the present study was to assess the contribution of clinical data to the variability of impulse oscillometric test results observed previously by Püllen et al. (2014). Fifty-eight German hybrid pigs from 29 different herds with unknown respiratory status were examined in the context of routine diagnostics as part of herd health service. Routine clinical examination was extended to a total set of 29 parameters, representing detailed clinical signs of the respiratory system, and to lung function testing applying the impulse oscillometry system (IOS). The resulting linear relationship between clinical data and variables of pulmonary mechanics had a mean r^2 of 0.52. Clinical parameters predominantly representing the lower respiratory tract closely correlated with established impulse oscillometric indices reflecting peripheral airways. Because of a restricted relationship between pulmonary functional disorders and clinical data, additional diagnostic methods are required to reveal the proportion of variance undefined by clinical examination.

1. Introduction

Clinical signs of porcine respiratory diseases are variable and can be characterised by sneezing, coughing, dyspnoea, nasal discharge, fever, anorexia, depression and poor growth. Growers and finishers around 16–20 weeks are most affected (Dee, 1996; Done and White, 2003). Because of their predominantly polyaetiological character including infectious and non-infectious risk factors, respiratory diseases in swine are often referred to as the "porcine respiratory disease complex" (PRDC) (Honnold, 1997; Thacker and Thanawongnuwech, 2002).

Diagnosis ideally includes clinical signs, dissection with gross pathology and histology and the detection of pathogens in the affected tissues (Nathues et al., 2012). In both the commercial pig industry and experimental designs, herds or single pigs are usually examined for respiratory tract infections by clinical inspection (Kitikoon et al., 2009; Labarque et al., 2002; Stricker et al., 2013), while fixation of the animal, required for physical examination, is generally kept to a minimum (Jackson and Cockcroft, 2002). Since clinical signs are often non-specific, dissection combined with molecular and microbiological analyses are additionally needed for a comprehensive diagnosis. However, euthanasia of pigs leads to economic and welfare concerns as well as to critical limitations for the statistical significance of the results.

A new method to characterise pulmonary disorders in the living pig is impulse oscillometry. This is a non-invasive method which generates information on respiratory mechanics and ventilation within a short time. In human medicine, impulse oscillometry has routinely been applied to the analysis and diagnosis of respiratory diseases (Smith et al., 2005). Besides human medicine, the method has been validated to improve diagnosis in different species, mainly in calves and horses (Reinhold et al., 1996, 1998; van Erck et al., 2004).

Few studies on impulse oscillometry in pigs have been conducted to date. Validated by Klein and Reinhold (2001) and Klein et al. (2003), the IOS has been used to assess lung function in pigs experimentally challenged with *Chlamydia spp.* and porcine reproductive and respiratory syndrome virus (Reinhold et al., 2005; Wagner et al., 2011). The method was tested for usability to characterise lung function in pigs originating from the field for the first time by Püllen et al. (2014). This study proved a high repeatability of lung function tests, together with a high interindividual variability.

The aim of the present study was to evaluate the contribution of clinical data to the variability of impulse oscillometric traits in pigs from the field.

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Table 1
Description of clinical scores used in the present study.

	Score					
General examination	0	1	2	3		
Body condition	Normal	Moderate	Poor	Very poor		
Behaviour	Normal	Calm	Very calm	Apathetic		
Posture	Normal	Hunched back				
Rectal temperature °C						
Pulse/min						
Heart beat	Regular	Irregular				
Breath/min						
Special examination	Score					
Upper respiratory tract	0	1	2	3	4	
Nasal discharge	Absent	Yes				
Quality of nasal discharge	Absent	Serous	Seromucoid	Mucoid	Purulent	
Degree of nasal discharge	Absent	Mild	Moderate	Severe		
Localisation of nasal discharge	Absent	Unilateral	Bilateral			
Sneezing	Absent	Yes				
Sniffing	Absent	Yes				
Respiratory movements of the snout	Absent	Yes				
Ocular discharge	Absent	Yes				
Lower respiratory tract	0	1	2	3	4	5
Type of breathing	Costo-abdominal	Costal	Abdominal	Dyspnoea after exercise	Dyspnoea during rest	
Auscultation	Normal	Abnormal bronchial breath sound				
Degree of abnormal bronchial breath sound	No bronchial breath sound	Mild	Mild-moderate	Moderate	Moderate-severe	Severe
Adventitious lung sound	Absent	Crackle				
Adventitious lung sound	Absent	Rhonchus				
Adventitious lung sound	Absent	Wheeze				
Adventitious lung sound	Absent	Pleural friction rub				
Adventitious lung sound	Absent	Stretor				
Localisation of adventitious lung sound	Absent	Tracheal	Tracheo-bronchial	Broncho-alveolar		
Localisation of adventitious lung sound	Absent	Unilateral	Bilateral			
Phase of breathing when adventitious lung sound is heard	Absent	Inspiration	Expiration	Both		
Coughing	Absent	Yes				
Degree of coughing	Absent	Mild	Moderate	Severe		
Type of cough	Absent	Dry	Productive			

2. Materials and methods

2.1. Animals

Fifty-eight German hybrid pigs (25–30 kg body weight), which originated from 29 conventional herds of unknown respiratory health status, were used in the current study. Two pigs from each herd were chosen from one pen for routine diagnostics in the context of herd health service. They were transported to the Clinic for Swine of the Justus-Liebig-University Giessen for further diagnostics, including clinical examination and lung function testing. The pigs were housed pairwise overnight on straw bedding in 6 m^2 tiled boxes. They were fed twice daily with a commercial fattening feed (energy content 15 MJ metabolisable energy/kg; protein 160 g/kg) and supplied with water *ad libitum*. All parts of the project were approved by the veterinary department of the regional authority of Giessen (Regierungspräsidium Giessen).

2.2. Clinical examination and data recording system

After a setting-in period of six hours, the pigs were clinically examined by a single observer. General examination included body condition, posture, behaviour, rectal temperature, heart and respiratory rate. A detailed examination of the pulmonary apparatus included breathing pattern, auscultation, the presence of dyspnoea, coughing, sneezing and ocular or nasal discharge. The results were recorded and assessed, using a clinical score for the general and special examination (Table 1).

2.3. Analysis of lung function

The impulse oscillometry system (MasterScreen IOS, Care Fusion) was applied for lung function testing. The detailed protocol of lung function measurement and the principles of the IOS have been described previously (Püllen et al., 2014).

Each pig was sedated with diazepam (1.5–2.0 mg/kg body weight IM; Faustan, Temeler Pharma) 15 min before lung function testing and placed in a canvas sling with openings for the limbs. The head was stabilised to maintain a physiological head position and a tightly fitting face mask was used to connect the animal to the measuring (= measuring system) system. After a setting-in period of approximately 3 min, the IOS was utilised for lung function analysis. Five measurement impulses were applied per second, and each individual run lasted 30 s, yielding a total of 150 independent results per run. The sampling rate for pressure and flow was set at 200 Hz, selecting 32 sampling points after each impulse for data analysis. Based on our previous study (Püllen et al., 2014), the mean value of the first six IOS runs was calculated and used for further statistical analysis.

The following variables of respiratory mechanics and ventilation were analysed by the IOS software: respiratory rate (RR); tidal volume (VT); the two spectral parameters, i.e. respiratory resistance (R_{rs}) and respiratory reactance (X_{rs}) each at 3, 5, 10 and 15 Hz;