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Use of an analgesic to identify pain-related indicators of lameness in sows

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ABSTRACT

Lameness in sows may be associated with pain and poor welfare and requires early detection and treatment. The objective of this study was to use the non-steroidal anti-inflammatory drug meloxicam, as a short-term analgesic to identify characteristics of pain-related lameness in sows. A total of 44 pregnant sows were selected from two experimental sites, and used in a 2 × 2 factorial design. Sows were visually categorized as either non-lame or lame (none with severe lameness), and were either assigned to a placebo (saline) or meloxicam (0.4 mg/kg body weight) treatment. Lameness was assessed using a force plate, kinematic and accelerometer tools on the day before, and after a single intramuscular injection of treatment solution. Data were collected in the same order and at the same time on both days, starting at 7:45, 9:15 and 12:15 for accelerometers, force plate and kinematics, respectively. Before treatment, lame sows made a greater number of steps per min than sound sows ($P=0.013$), and had a tendency to have a lower contralateral ratio of weight applied between the hind legs than sound sows ($P=0.062$). No other differences were observed between lame and sound sows before treatment. Injection of meloxicam decreased the stepping frequency of the left hind legs ($P=0.014$), increased the ratio of tarsal joint angle amplitude between contralateral hind legs ($P=0.05$), and tended to increase standing time after feeding in lame sows ($P=0.09$), indicating an improvement of the lameness condition and at least a short-term analgesic effect of meloxicam. Overall, meloxicam effects on lameness variables were limited. The wide variability in the underlying clinical causes, severity and duration of these naturally occurring lameness cases, as well as the timing of lameness assessment in relation to treatment injection may explain the relative lack of treatment effects on kinematics and force plate variables. More research is needed to identify pathology-specific indicators of pain-related lameness.

1. Introduction

Early detection of lameness is important to provide prompt treatment and hence improve welfare (Flower et al., 2005). Lameness can have multiple origins in sows: osteochondrosis, arthritis, osteoarthritis, osteomyelitis, abscesses, bursitis, and various claw lesions and leg injuries (Heinonen et al., 2013). In finisher pigs, experts have associated causes of lameness with various degrees of pain, and ranked fractures, osteochondrosis dissecans and infectious arthritis as most painful (Jensen et al., 2012). Research to identify and validate pain indicators in sows is very limited despite the necessity to recognise pain-related lameness for welfare reasons. In cows, changes in behaviour or gait following the administration of an analgesic were difficult to identify, while differences in weight distribution on a force plate were observed (Chapinal et al., 2010a, 2010b; Flower et al., 2008; Whay et al., 2005). Whay et al. (2005) hypothesised that behavioural expression of pain is likely to be very subtle and suggested that more work is required to determine behaviours that would be indicators of pain in lame animals. The use of automated methods such as accelerometers to measure stepping, kinematics or force plate (Conte et al., 2014; Grégoire et al., 2013) may help identify subtle changes in the gait and postural behaviour after alleviating pain compared to visual observation. In Europe and Canada, a non-steroidal anti-inflammatory drug (NSAID) called meloxicam, sold under the product name Metacam®, is licensed for the treatment of lameness in pigs at a dose of 0.4 mg/kg i.m. In dogs and chickens, meloxicam is considered as the drug of choice to treat

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osteoarthritis and joint inflammatory diseases (Cross et al., 1997; Hadipour et al., 2011; Peterson and Keefe, 2004). To our knowledge, very few published studies have assessed the effect of meloxicam on swine lameness. Friton et al. (2003) found a reduction in lameness days after the injection of meloxicam in pigs (gilts, sows and finishers), using a scoring system based on the observation of weight-bearing on limbs. More recently, Pairis-Garcia et al. (2014) demonstrated the effectiveness of meloxicam at reducing pain in sows with induced lameness, using nociceptive threshold tests.

The aim of the present project is to use meloxicam as a short-term analgesic to identify, using quantitative methods (force plate, kinematics and accelerometers), characteristics of pain-related lameness in sows that are mildly and moderately lame.

2. Materials and methods

Animals were cared for according to the Canadian Council on Animal Care guidelines (Canadian Council on Animal Care, 2009) and a recommended code of practise (Agriculture and Agri-Food Canada, 1993) and the experimental protocol was approved by the institutional animal care committee of the Dairy and Swine R&D Centre (Sherbrooke, Quebec, Canada) and the University of Saskatchewan's Animal Research Ethics Board (Saskatoon, Saskatchewan, Canada).

2.1. Animals and treatments

A total of 44 primiparous ($n=5$) and multiparous ($n=39$) Landrace × Yorkshire sows (267 ± 34 kg BW) were selected from the Dairy and Swine R&D Centre (DSRDC, $n=16$; Sherbrooke, Quebec, Canada) and the Prairie Swine Centre Inc. (PSC, $n=28$; Saskatoon, Saskatchewan, Canada) and used in a 2 × 2 factorial design. Sows were housed in individual pens of 2.97 m^2 (DSRDC) or in groups of approximately 30 animals with walk-in/lock-in feeding stalls (PSC), both with partially slatted concrete floors. Once per week ($n=11$), four sows (from the same group at PSC) between 29 and 76 days into gestation were selected according to the following criteria: no obvious leg injuries or severe lameness, and not medicated with non-steroidal anti-inflammatory drugs, glucocorticoids or antibiotics within the previous 14 days before the experiment (Friton et al., 2003; Mustonen et al., 2011). Using a visual gait scoring system adapted from Main et al. (2000), sows were individually scored, while walking in a corridor on plain concrete floor, on a scale from 0 to 4 (0: normal gait and even strides; 1: abnormal gait, stiffness, but lameness not easily identified; 2: lameness detected, shortened strides, sow puts less weight or avoids putting weight on one leg; 3: sow does not bear weight on one leg; 4: non-ambulatory) and then categorized as sound (score 0, $n=21$) or lame (score 1, $n=5$ or score 2, $n=18$). Sows scored 3 or 4 were not selected because the study aimed at validating pain-related criteria for early identification of lameness. Therefore, sows that were obviously in pain and non-ambulatory were excluded. Two lame and two sound sows were selected each week.

The day after visual scoring, gait score was visually confirmed and lameness was assessed using the force plate, kinematics and accelerometers tools, as previously described (Conte et al., 2014; Grégoire et al., 2013; Ringgenberg et al., 2010). Then, sows were put back in their home pen. On the following day, the two lame and two sound sows were assigned randomly to either meloxicam treatment (Metacam®, Boehringer Ingelheim Vetmedica GmbH, Ingelheim am Rhein, Germany) or a placebo treatment (saline solution), to which the experimenter was blind and lameness was assessed again using the same methods in the same order. The dose of meloxicam of 0.4 mg/kg body weight recommended by the manufacturer (20 mg/ml, 0.02 ml/kg) was administered as a single intramuscular injection in the neck region at 7:15. Stepping behaviour, weight distribution and gait were measured on each sow within an 8 h-period after the i.m. injection. In sows, the time to reach the maximum plasma concentration (T_{max}) after per os administration of 0.5 mg/kg of meloxicam was 2.4 h, and half-life ($T_{1/2}$) was 6.83 h, while the i.v. half-life was 6.15 h (Pairis-Garcia et al., 2014a). When 0.6 mg/kg were administered i.m. to piglets, T_{max} ranged from 0.4 to 1.8 h (Fosse et al., 2011). Therefore, measurements in the present experiment were likely performed around the time at which the drug was the most effective. Data were collected in the same order and at the same time on both days (day before and day of treatment), starting at 7:45, 9:15 and 12:15 for accelerometers, force plate and kinematics, respectively. All measurements were recorded by the same experimenter. The number of sows was initially balanced between treatments within experimental farms but one sow was moved a posteriori from the Sound-Meloxicam to the Lame-Meloxicam group because her lameness score increased between the day of selection and the day before treatment. Therefore, numbers of sows per treatment were 12 for Lame-Meloxicam, 11 for Lame-Placebo, 10 for Sound-Meloxicam and 11 for Sound-Placebo.

2.2. Measurements and calculations

2.2.1. Accelerometers

Acceleration recordings were made for 1 h following the start of feeding to determine the number of steps per min while the sow stood, following a procedure previously used (Conte et al., 2014). Sows were fed in a trough within their individual pen (DSRDC) or in a feeding stall (PSC) where they were kept for 1 h. One accelerometer (Hobo Pendant® G Data Logger, Onset Computer Corporation, Pocasset, MA, USA), safely protected inside a Velcro®-pocket and a Vetrap™ 3M™ covering, was placed on each hind leg. The device recorded the acceleration on the *x*-axis (10 data per second), for 1 h. A step was considered true if the *x*-axis acceleration was < 0.6 g or > 1.4 g (Ringgenberg et al., 2010), while the animal was in a standing position. The latency to lie down after feed delivery, corresponding to acceleration on the *x*-axis < 0.59 g, was also determined. Data from recordings were read using the Hoboware® Pro software (Onset Computer Corporation, Pocasset, MA, USA).

2.2.2. Force plate

The force plate (Pacific Industrial Scale Co. Ltd., Richmond, BC, Canada) consisted of four individual stainless steel platforms (front: 101.6 × 30.5 cm^2, rear: 111.8 × 30.5 cm^2), each resting on four single-ended beam load cells. A feeder was included on the front gate to draw the sow's attention towards a standardized direction. The total weight and the weight placed on each platform (14 data per second) were recorded and saved using the Pacweight Animal Weight custom software (Pacific Industrial Scale Co. Ltd.). Two cameras were used to record the position of the sow's legs using the Omnicast video surveillance system (Genetec Inc.©, version 4.6, 2001–2012, Montreal, Quebec, Canada), which was synchronized with the Pacweight Animal Weight custom software. Sows were measured for a period of 15 min, but only periods when the sow stood with her head in the feeder and her legs in the correct platform were kept and any body weight per reading higher or lower than 5% of the average body weight of the sow was eliminated as previously described (Conte et al., 2014).

For each leg, the average percentage of weight (% BW) was calculated. The average ratio of lower to higher weight applied by contralateral legs was calculated separately for fore and hind legs (contralateral ratio). Weight shifting was evaluated according to