Short communication

The effect of continuous grouping of pigs in large groups on stress response and haematological parameters

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ABSTRACT

The consequences of an ‘all in–all out’ static group of uniform age vs. a continuously dynamic group with litter introduction and exit every third week were examined with respect to stress response and haematological parameters in large groups of 60 pigs. The experiment included a total of 480 pigs from weaning at the age of 4 weeks to the age of 18 weeks after weaning. Limited differences were found in stress and haematological parameters between pigs in dynamic and static groups. The cortisol response to the stress test was increasing with the duration of the stress test in pigs from the dynamic group while it was decreasing in the static group. The health condition and the growth performance were reduced in the dynamic groups compared with the static groups. In the dynamic groups the haematological parameters indicated an activation of the immune system characterised by an increased number of neutrophils and an increased N/L-ratio.

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1. Introduction

Introduction of new facilities in pig pens including cooling facilities for thermoregulation and access to sufficient quantities of material to enable proper investigation and manipulation activities will lead to a decrease in the amount of space available to each pig. Several studies indicate that a low space allowance per pig increases aggression and/or induces social stress (e.g. Randolph et al., 1981; Meunier-Salaun et al., 1987; Barnett et al., 1992; Turner et al., 2000). A dynamic grouping strategy, where the introduction of an intact litter of weanlings takes place concurrently with the removal of the pigs ready for slaughter throughout the growing period, has advantages compared with ‘all in–all out’ static groups of uniform age in that the space allowance is unchanged throughout the growing period and is relatively increased in the last part of the growing period. The strategy should thus prevent social stress, especially in the last part of the finishing period at a low space allowance (Meunier-Salaun et al., 1987). However, the benefit may be counter-balanced by the continuous re-infection causing a persistent although probably lower infection pressure as well as social stress due to continuous mixing of pigs from different environments.

The aim of the present experiment was to study the consequences of an ‘all in–all out’ static group of uniform age vs. a continuously dynamic group with litter introduction and exit every third week for the stress response and haematological parameters of pigs housed in large groups (60 pigs).

2. Materials and methods

2.1. Experimental pigs

All procedures involving animals were approved by the Danish Animal Experiments Inspectorate in accordance with the Danish Ministry of Justice Law no. 382 (June 10, 1987) and Acts 333 (May 19, 1990), 726 (September 9, 1993) and 1016 (December 12, 2001). The experiment included a total of 480 pigs (48 litters; distributed in 8 pens) of the Landrace or Yorkshire breeds or the Yorkshire/Landrace or Yorkshire/Landrace/Duroc crossbreeds. The pigs entered the experiment at weaning at the age of 4 weeks and left at 18 weeks after weaning.

A static group (STA) was generated of 6 litters each consisting of 10 pigs of the same age, and a dynamic group (DYN) was generated of 6 litters each consisting of 10 pigs of different ages. Every third week an intact litter was introduced into a dynamic group with 5 older litters and the day before
introducing a new litter the oldest litter (10 pigs) were slaughtered. Litters were assigned to treatment groups in accordance with equal distribution of sex and breeds. In each pen 6 piglets from one litter were chosen as focal animals for more detailed investigations into stress and haematology. The focal animals were chosen so that male and female pigs were represented equally.

2.2. Experimental design

The pig house consisted of eight pens (8 m × 4.4 m), four with dynamic groups and four with static groups, dimensioned for 60 pigs. Each pen contained a lying area (8 m × 1.5 m) equipped with a cover (8 m × 1.3 m), with solid floor littered with shavings and divided into six sections (dens), two of which were closed at the front by means of transparent rubber strips. In addition, the pens contained a feeding area with 4 self-feeders as well as a self-feeder for roughage (straw mixed with alfalfa hay) and four water nipples. The floor in the open area was partially flat deck floor and partially slatted floor.

In the pens with dynamic groups, one of the lying sections made up a part of an introduction pen, a beginning (1.3 m × 3.7 m) for newly weaned litters. The covered part (1.3 m × 1.3 m) of the beginning pen was closed at the front by transparent rubber strips. The walls of the beginning pen facing the rest of the pen consisted of vertical bars. On each side an adjustable roller regulated the exit from the beginning pen. The beginning pen was equipped with a tray for feeding and a drinking trough for water. The pen was equipped with a 7-cm layer of chopped straw.

The newly weaned litter was kept in the beginning pen for the first eight days after weaning. On day 9 the rollers were opened which gave the newly weaned litter the opportunity to leave the beginning pen. The large pigs could not enter the beginning pen. On day 19 after weaning the rollers were shut down and the newly weaned litter was forced to form an integral part of the other pigs in the pen.

The first 12 days the pigs were fed restrictively with weaning feed (18.9% crude protein, 9.3 MJ net energy (NE) per kg) four times a day (7.00 h, 10.00 h, 13.30 h, 16.00 h). From day 12 to day 16 12 h a gradual change from weaning feed to piglet feed was introduced (16.3% crude protein, 8.6 MJ NE per kg), and from restrictive to ad libitum feeding was introduced. From day 16 onwards a commercial slaughter pig feed (16.5% crude protein, 9.3 MJ net energy (NE) per kg) four times a day (7.00 h, 10.00 h, 13.30 h, 16.00 h) was introduced. The pig pens were inspected daily and pigs with reduced health condition were registered and subjected to medical treatment with antibiotics.

2.3. Stress response to acute stress

Acute stress was induced in the focal animals by fixation in a nose sling (a synthetic rope (5 mm in diameters) twisted round the upper jaw) for 4 min in week 15. At the start and end of the stress test a blood sample was taken and the duration of blood sampling was registered in relation to the start of the stress test. The rectal temperature was measured by a thermometer and the heart rate was measured by a phonograph fitted on the pig during the stress test.

The plasma concentration of cortisol was determined by solid-phase radio immuno assay (Diagnostic Products Corporation, Los Angeles, USA) and the plasma concentration of ACTH was determined by radio immuno assay (Diagnostic Systems Laboratories, Texas, USA).

2.4. Hematological parameters

Blood samples for cell counting were collected from the focal animals at weeks 0, 1, 2, 4, 7, 10, 13, and 16 after weaning. The number of leucocytes, neutrophils, lymphocytes and erythrocytes, N/L-ratio and packed cell volume (PCV) were measured as described by Damgaard et al. (2006).

2.5. Statistical analysis

All variables were subjected to analysis of variance using the Restricted Maximum Likelihood method in the mixed model procedure with multiple error terms in the statistical package, SAS (SAS Institute Inc., 1996).

The model used for the number of blood cells and the PCV value included group composition (DYN or STA) and week, and interaction between these effects as general fixed effects. The residual variance was assumed to be different for each week. This was modelled using the repeated statement of PROC MIXED with week as a GROUP factor. The model used for the stress response in hormones, body temperature and heart rate further included the duration from the start of the test to the time of the blood sampling/measurements as covariates.

The results of the statistical analyses are presented by the F-value and the degree of freedom for the investigated effect (df) and for the error term in the denominator (df). A probability level (P) of 0.05 was chosen as the limit for statistical significance in all tests.

3. Results and discussion

Before the acute stress test there were no significant differences between the dynamic group and the static group in plasma concentration of cortisol and ACTH (Table 1).

The level of plasma cortisol and ACTH as a response to acute stress did not differ between the experimental groups (Table 1). However, there was significant interaction between treatment group and duration of blood sampling for the effects on plasma cortisol level (Table 1). Thus, the cortisol response to the stress test was increasing with the duration of the test in pigs from the dynamic group, while it was decreasing in the static group (Fig. 1). The body temperature was at corresponding levels in the dynamic group and in the static group before and after the acute stress test (Table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
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<tr>
<td>Plasma concentration of cortisol and ACTH, and body temperature before and after acute stress test, and heart rate during acute stress test in pigs in the static (n = 21) and the dynamic (n = 22) groups</td>
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<tr>
<td>Treatment group</td>
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<tr>
<td>Before Test</td>
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<tr>
<td>Cortisol, nmol/L</td>
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<td>ACTH, ng/L</td>
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<td>Body temperature, °C</td>
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<tr>
<td>After test</td>
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<tr>
<td>Cortisol, nmol/L</td>
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<td>ACTH, ng/L</td>
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<td>Body temperature, °C</td>
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<td>During the test</td>
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<td>Heart rate</td>
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<td>Values are least squares means and S.E.M.</td>
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Further, the heart rate was not different for the two treatment groups during the stress test (Table 1).

In pigs, the rate of the increase in cortisol in the very early state of responding to acute stress has been shown to be quicker in non-stressed pigs compared with pigs subjected to chronic intermittent noise in a comparable 2-min restraint test (Otten et al., 2004). In previous studies on comparable dynamic grouping of pigs a reduced stress level was found (Moore et al., 1994), whereas another study comparing the effect of static group formation with repeated regrouping of

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**Fig. 1.** Plasma cortisol concentration in relation to duration of stress test (mean time 285 s) after the acute stress test in the static (STA) and dynamic (DYN) groups. Values are least squares means and S.E.M.

**Fig. 2.** Number of leucocytes (A), neutrophils (B) and lymphocytes (C), N/L ratio (D), number of erythrocytes (E) and PCV value (F) in the static groups (STA) and the dynamic groups (DYN) at weeks 0, 1, 2, 4, 7, 10, 13, and 16 after weaning. Values are least squares means and S.E.M. *: P<0.05, **: P<0.01, ***: P<0.001 for differences between experimental groups.
pigs of the same age, consequently reducing the space allowance, did not show any benefits of dynamic grouping on plasma cortisol (Leek et al., 2004).

The growth performance was reduced in the dynamic group compared with the static group resulting in an average body weight (±std) of 51.6 kg (±12.2 kg) and 88.4 kg (±17.0 kg), respectively, at the end of the experiment 18 weeks after weaning (Jensen et al., 2008). Further, the total number of parenteral treatments in the dynamic group and static group was 153 and 63, respectively. The diseases were mainly intestinal disorders and the frequency of treatment for intestinal disorders was higher in the dynamic group than in the static group, 97.4% vs. 79.4%. In the dynamic group the treatments occurred throughout the experiment, whereas in the static group the treatment of the pigs occurred primarily in the first 7 weeks of the experiment. In groups of 12 pigs Moore et al. (1994) also found that dynamic grouping reduced the overall well-being compared with static grouping.

The bad performance in the dynamic group was suggested to be a result of problems with appropriate feeding in the dynamic group resulting in reduced performance of mainly the young pigs in this group. Appropriate feeding management may potentially improve the health condition and the growth performance of pigs in dynamic group housing.

All groups of leukocytes showed significant interactions between treatment group and week (total number of leukocytes: \( F_{1,30}=4.29, P=0.002 \); number of neutrophils: \( F_{7,45.7}=4.26, P=0.001 \); number of lymphocytes: \( F_{7,37}=2.35, P=0.04 \); and the N/L-ratio: \( F_{7,20.6}=2.69, P=0.04 \) (Fig. 2A–D)). The total number of neutrophils was increased in pigs in the dynamic group in week 7 (\( F_{1,44.0}=13.7, P=0.001 \)). Furthermore, the N/L-ratio was higher in pigs in the dynamic group than in pigs in the static group in weeks 7, 10 and 13 (\( F_{1,42.2}=15.1, P<0.001 \); \( F_{1,17.5}=5.6, P=0.03 \); \( F_{1,22.9}=5.1, P=0.03 \) in weeks 7, 10 and 13, respectively). The differences between the two groups in the number of lymphocytes in weeks 13 and 16 may be a response to a challenge with PPV vaccine that unfortunately was only performed in that group (\( F_{1,25.3}=0.05 \); \( F_{1,18.2}=6.0, P=0.02 \) in weeks 13 and 16, respectively). The increased number of neutrophils and an increased N/L-ratio in the dynamic group indicate an activation of the immune system that may be a response to the higher infection pressure and/or a stress response.

In addition, the number of erythrocytes (\( F_{7,46.3}=6.1, P<0.001 \)) and the PCV value (\( F_{7,45.7}=10.96, P<0.001 \)) were significantly affected by interactions between experimental group and week (Fig. 2E–F). The lower level of erythrocytes in week 7 (\( F_{1,24.7}=7.9, P=0.01 \)) and the lower PCV value in weeks 7 and 10 (\( F_{1,20.6}=22.3, P<0.001 \); \( F_{1,36.7}=17.5, P<0.001 \) for weeks 7 and 10, respectively) in the dynamic group compared with the static group may reflect the poorer health condition in the dynamic group as also indicated by the higher frequency of individual medical treatments in the dynamic group throughout the experiment.

In summary, the results showed limited differences in stress and haematological parameters between pigs in dynamic groups with a uniform space allowance compared with pigs in the static ‘all in-all-out’ groups. The cortisol response to the stress test was increasing with the duration of the stress test in pigs from the dynamic group while it was decreasing in the static group. The health condition and the growth performance were reduced in the dynamic groups compared with the static groups. In the dynamic groups the haematological parameters indicated an activation of the immune system characterised by an increased number of neutrophils and an increased N/L-ratio. However, more studies are required to estimate the consequences of dynamic grouping on stress level, immune competence, health condition and growth performance.

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References


