Cortisol and Immune Measures in Boars Exposed to Three-day Administration of Exogenous Adrenocorticotropic Hormone

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ABSTRACT

The aim of the study was to evaluate the effect of adrenal stimulation by adrenocorticotropic hormone (ACTH) on blood cortisol concentration and on circulating total and differential leukocyte counts during and in the 16 days after ACTH administration. Swedish Landrace boars aged approximately 6–7 months were used. ACTH-treated animals (n = 7) were given ACTH intravenously at 10 μg/kg body mass for 3 days. A control group of animals (n = 7) received 1 ml of sterile 0.9% saline intramuscularly. ACTH induced a highly significant increase (p < 0.0001) in serum cortisol in treated boars. On the day after the last ACTH dose, the cortisol concentration was significantly higher, but the level of significance was lower than during ACTH administration (p < 0.05). During ACTH treatment, a significant increase was recorded in total leukocyte count and neutrophil percentage (p < 0.05 to p < 0.0001), along with the increase in blood cortisol concentration, whereas percentage lymphocyte count showed a significant decrease. Lymphopenia disappeared upon cessation of treatment, but neutropenia developed in the week after treatment. On all three days of ACTH challenge, the neutrophil-to-lymphocyte ratio was significantly increased. An increase in eosinophil percentage was recorded on treatment days 1 and 2, whereas ACTH treatment had no effect on basophil percentage. In conclusion, three-day administration of ACTH to young boars during restraint caused effects similar to acute stress situations, as suggested by disappearance of the effects on immune function after the last drug dosage.

Keywords: adrenocorticotropic hormone, boars, cortisol, immunity, leukocyte, stress

Abbreviations: ACTH, adrenocorticotropic hormone; HPA, hypothalamic–pituitary–adrenal axis; NL, neutrophil-to-lymphocyte ratio; WBC, white blood cell count (total leukocyte count)

INTRODUCTION

Various situations in modern farming are considered to be stressful to pigs, e.g. physical restraint and type of housing (Janssens et al., 1994; De Jong et al., 1998), social stress (Kunzl and Sachser, 2000; De Groot et al., 2001), shipping (McGlone et al., 1993; Perremans et al., 2001; Grandin, 2003), heat stress and electrical stimulation
(Becker et al., 1985; Hicks et al., 1998), mixing of unfamiliar pigs (Deguchi and Akuzawa, 1998) and restraint (Brown-Borg et al., 1993).

Stress is difficult to define and to evaluate. However, an animal’s response to stressful stimuli in its environment includes release of corticotropin-releasing factor from the hypothalamus, which in turn leads to the release of adrenocorticotropic hormone (ACTH) and other peptides from the anterior lobe of the pituitary gland. Elevated ACTH stimulates the release of glucocorticoids from the adrenal cortex into the circulation of stressed animals (Dantzer and Mormède, 1983).

It has been suggested that the duration and timing of exposure to a stressor may be a crucial factor for the immune outcome (Morrow-Tesch et al., 1994; Wallgren et al., 1994; Dhabhar et al., 1996; De Groot et al., 2001). There are not many studies systematically tackling the question whether acute and chronic exposure to stressors differentially impairs immune competence during and after stress situations.

Different experimental models have been used to examine the effects and consequences of stress on animal immune function. The aim of the present study was to assess the effects of three-day administration of ACTH on blood cortisol concentrations, and on circulating leukocyte count and differential leukocyte counts (neutrophils, lymphocytes, eosinophils and basophils) during treatment and in the 16 days after ACTH administration.

MATERIALS AND METHODS

Animals

Fourteen boars (Swedish Landrace) aged approximately 6–7 months and weighing between 105 and 135 kg were used in the experiment. The boars were housed in individual pens on farms. The stable temperature varied between 10°C and 17°C. Water was available ad libitum. The animals were given 3 kg of feed concentrate per day containing crude protein 16.99%, crude fibre 5.26%, crude fat 5.39%, starch 37.96%, sugar 3.02% and ash 5.65%.

The boars were randomly assigned to either control (n = 7) or ACTH-treated (n = 7) groups. On each of the three treatment days, ACTH/saline was administered at 10:00. The ACTH group of boars were injected with 10 μg/kg body mass of ACTH (1–39, from porcine pituitary, 80 IU/mg, Sigma-Aldrich, St Louis, MO, USA) into the ear vein. This dose of ACTH has been reported to induce a high cortisol response in treated animals (Janssens et al., 1994; Haussmann et al., 2000; Mwanza et al., 2000). The boars in the control group were administered 1 ml of sterile 0.9% saline intramuscularly with the purpose of simulation of a stressful condition similar to that in treated animals. Both group of animals were handled using restraint with a snare during administration of saline and of ACTH and also during blood collection.