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Morphological Changes in Hippocampus and Prefrontal Cortex of Confined Sows with Prolonged Pupillary Light Reflex

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Abstract: Human depression patients often show abnormal pupillary reflex with morphological changes in hippo campus and prefrontal cortex. This study aimed to find the relationship between the prolonged pupillary light reflex (PLR) which had been shown by confined sows with chronic stress or depression and morphological changes in brain, in order to provide theoretical basis for that the confined environment should lead to sows' depression. A total of 637 sows of Durac, Landrace and Large White breeds with various parities were observed, and the pupil light reflex (PLR) was measured and the actual pupillary light reflex time (PLRT) were recorded. All the PLRTs were grouped based on the results of confidence interval: t>10% as group A, 5%<t<10% as group B, 1%<t<5% as group C and t<1% as group D. Three individuals were randomly selected from each group (12 sows in total) and the white tissues of hippocampus and the prefrontal cortex were prepared for HS staining slices (three slices/per tissue) for observation on tissue structure and pathological changes with high magnification (400X) of electronic microscope. The results showed that in group A (t>10%) pathological change was found in hippocampus, however, as PLRT increased from group B to group D, pathological changes in hippocampus tissues tended to be deteriorated with the increase of inflammatory cells and nuclear pyknosis phenomena. The same as those shown in hippocampus as the increasing of PLRT from groups A to D, more inflammatory cells appeared in prefrontal cortex for groups B and D. The results suggested that the tissue lesions of hippocampus and prefrontal cortex of the confined sows with prolonged PLRT might be the results of chronic stress or depression.

Key words: sow, pupillary light reflex time, brain tissue, morphology, depression

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Introduction

Confinement is the feature of modern animal farming and recently it has been regarded as an aversive environmental condition for confined farm animals (Broom, 1991). Many evidences indicate that the confinement leads to chronic stress or depression of the farm animals (von Borell, 1995; Boissy *et al*., 2007). Depression is seen as a function of inadequate behavioural, psychological, socio-environmental and biological coping resources for managing one's individually appraised level of life distress (Mason *et al*., 2006). Many etho-anomalies are indicative of the distress underlying agitation, as demonstrated by vacuum activities, which are evident as repetitive body movement of the chronically confined animals (Fraser, 1988). A recent study reports that the

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pupillary light reflex (or pupillary contraction) of the stall-housed sows is prolonged in respone to light stimulation compared with the group-housed sows (Bao *et al*., 2013). The pupillary light reflex (PLR) is a physiological reflex of pupils and associated with psychological states (Bakes *et al*., 1990; Bitsios *et al*., 1996, 1998). This may imply that the depression will affect pupillary light reflex of sows. Hippocampus (HC) and prefrontal cortex are vulnerable to depression (Nestler *et al*., 2002). Especially hippocampus shows volume loss (Sheline *et al*., 1999; Campbell *et al*., 2004; Steffens *et al*., 2004) and abnormal structure changes (Frodl *et al*., 2002). Hippocampus has increasingly been the focus on animals, postmortem, and clinical examinations of the pathophysiological underpinnings of depression (Campbell and MacQueen, 2004). Bremner *et al*. (2000) has reported that volumetric reductions are the greatest in patients with a chronic course. Pigs are mammals and may show similar physiological or psychological response in relation to depression as humans. It could be hypothesized if the prolonged PLRT was related to depression, the abnormal changes in hippocampus or prefrontal cortex might occur. Thus, the tissue structure of hippocampus and prefrontal cortex of the confined sows with the prolonged pupillary light reflex time were observed, aiming to find the relationship between PLRT and the changes in hippocampus or prefrontal cortex. If the relationship was proved, it would provide a further evidence for the clinical method to test the psychological state of confined animals in a convenient, non-invasive and accurate way by examining PLR.

Materials and Methods

Animals and managements

A total of 637 pregnant sows (including 251 Landrace, 274 Large White and 109 Duroc breeds) were observed. All the sows were fed a commercial feed mixture with ME 3 000-3 100 kc·kg^{-1} and 14% CP under feeding restricting regime at 04:00 am and 14:00 pm a day. They had free access to water. The sows were individually housed in gestation stalls [214 cm(l)×70 cm(w)×110 cm(h)] throughout their pregnancy. After 105 days of pregnancy, the sows were moved to farrowing crates [214 cm (l)×120 cm (w)×110 cm (h). During the experiment, natural ventilation was adopted and ambient temperature and relative humanity was (27.5±5.8)℃ and (72±11.3)%, respectively.

Measurement of pulillary light reflex time

A total of 637 sows of Duroc, Landrace and Large White breeds with various parities were observed. The pupil light reflex (PLR) was measured and the actual pupillary light reflex time (PLRT) was recorded with the method described by Bao *et al* (2013). All the PLRTs were grouped based on the results of confidence interval: t>10% as group A, 5%<t<10% as group B, 1%<t<5% as group C and t<1% as group D. The numbers of the sows classified into each group are shown in Table 1.

Table 1 Distribution of all sampled sows based on confidential interval of PLRT

Group	Confidence interval	Number (n)	Critical PLRT (s)
A	t>10%	573	t<11.2s
B	5%<t<10%	32	11.2s<t<17.2s
C	1%<t<5%	28	17.2s<t<23.3s
D	t<1%	6	23.3s<t