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Original Research

Hematological and Blood Biochemical Characteristics of Newborn Heavy Draft Foals After Dystocia

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ABSTRACT

The negative impact of equine dystocia on hematological and serum biochemical profile of neonatal foals remains unknown, particularly in heavy draft horses that show high incidence of dystocia. This study aimed to reveal the hematological and serum biochemical profile of the foals born in normal delivery and examine the effect of dystocia on blood properties in heavy draft newborn foals. In the normal birth group (n = 23), stage II labor was <30 minutes, with spontaneous or assisted delivery with mild traction by one or two people. In the dystocia group (n = 13), stage II labor was ≥30 minutes, with strong traction by more than three people or mechanical tools with or without correcting fetal displacement. Blood samples were collected from the jugular vein at 0, 1, and 12 hours and 1 and 2 days after foaling. Red blood cells, hemoglobin concentration, and packed cell volume remained significantly lower in the dystocia group than in the normal birth group. The white blood cell count was significantly higher in dystocia foals (1 day: $P < .05$). Dystocia foals had significantly higher cortisol (1 hour: $P < .05$), urea nitrogen (1 hour: $P < .05$), and creatine kinase activities (1 hour: $P < .01$, 12 hours: $P < .05$). This study revealed that dystocia foals were more likely to be affected by anemia, physical stress, and muscle damage than normal birth foals.

1. Introduction

Dystocia is a difficult labor that can result in neonatal death without assistance by humans [1]. The incidence rate of dystocia has been found to be 4% to 10% in horses, and dystocia occurs more frequently in heavy draft horses than in light breed horses [2]. Most dystocia cases are caused by fetal displacement [3]. Parturition is divided into three stages: the first stage of parturition is associated with cervical dilation and uterine contractions, the second stage includes the time from the rupture of the chorioallantoic membrane to the end of fetal delivery, and the third stage is associated with discharge of the placental and fetal membranes [4]. The progression of equine parturition occurs more rapidly than that in other farm animals. Stage II lasts for only 20 to 30 minutes in mares [5]. A recent study reported that prolonged labor (stage II ≥ 30 minutes) is associated with a higher risk of stillbirth [6]. In other studies, the morbidity and mortality in dystocia foals have been found to be higher than those in normal birth foals [7,8]. The cortisol concentration in saliva [9] and blood [10] has been reported to be higher in dystocia calves, leading to metabolic changes such as increased blood glucose (Glu) and cholesterol levels [10]. The negative impact of equine dystocia on hematological and serum biochemical profile of neonatal foals remains unknown, particularly in heavy draft horses that show high incidence of dystocia. Understanding the effects of

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dystocia on neonatal foals would contribute to the development of nursing and treatment procedures. This study aimed to reveal the hematological and serum biochemical profile of foals born *via* normal delivery and examine the effect of dystocia on blood properties in heavy draft newborn foals.

2. Materials and Methods

2.1. Animals

Heavy draft foals (Percherons and crossbreeds between Percheron, Belgian, and Breton heavy draft horses) born from January 2013 to January 2015 at three stud farms (Tokachi, Hokkaido, Japan) were included in the study. Prepartum dams showing signs of foaling were monitored. Foaling events such as rupture of the chorioallantoic membrane, appearance of the fetal sac, and delivery of foals were recorded. Cases were excluded from the study if there was foaling in the absence of witnesses, abortion, premature birth, or cesarean section.

2.2. Definition of Normal Birth and Dystocia

In our study, dystocia was defined as prolonged labor with strong fetal traction with or without fetal displacement. If stage II was ≥30 minutes and the labor did not progress, traction was applied to the fetus. In the normal birth group (n = 23), stage II labor was <30 minutes, with spontaneous or assisted delivery with mild traction by one or two people. In the dystocia group (n = 13), stage II labor was ≥30 minutes, with strong traction by more than three people or mechanical equipment with or without correcting fetal displacement.

2.3. Physical Examination and Blood Sampling

Physical examination and blood sampling were conducted at 0 hour (within 5 minutes after birth), 1 hour (before suckling colostrum), 12 hours, and 1 (24 to 48 hours) and 2 days (48 to 72 hours) after birth. The foal's vitality was assessed immediately after birth using the advanced Apgar score (seven items, each two-point scale, a total of 0 to 14 points) [11]. Rectal temperature, heart rate, respiratory rate, and appearance of visible mucous membrane were recorded. Peripheral blood was collected into 7 mL vacuum tubes (VENOJECT II VP-P070K, Terumo Corp, Tokyo, Japan) and 5 mL vacuum tubes containing ethylenediaminetetraacetic acid (EDTA; VENOJECT II VP-NA050K, Terumo Corp) by jugular venipuncture using 21 gauge × 1½ inch needles (MN-2138MS, Terumo Corp). All blood samples were stored on ice until transfer to the laboratory and processed within 3 hours. The samples containing EDTA were used for complete blood counts. Tubes without EDTA were centrifuged for 12 minutes at 3,000 rpm after incubation (37°C, 90 minutes). Serum was withdrawn and frozen at −30°C for serum amyloid A (SAA), cortisol, and other biochemical analyses at a later date.

2.4. Hematological and Serum Biochemical Analysis

The numbers of white blood cells (WBCs) and red blood cells (RBCs), hemoglobin (Hb) concentration, packed cell volume (PCV), mean cell volume (MCV), mean cell Hb (MCH), MCH concentration (MCHC), and platelet count were determined using an automated hematology analyzer (Celltac α MEK-6358, Nihon Kohden Corp, Tokyo, Japan). In each sample, the levels of Glu, free fatty acid (FFA), total cholesterol, triglyceride (TG), total protein, albumin, urea nitrogen (UN), creatinine (Cre), aspartate aminotransferase, gamma-glutamyltransferase, alkaline phosphatase, creatine kinase (CK), lactate dehydrogenase, iron, calcium, inorganic phosphate, magnesium, sodium, potassium, and chlorine were measured using an automated clinical chemistry analyzer (TBA-120FR, Toshiba Medical Systems Corp., Otawara, Japan). The SAA level was measured using commercially available enzyme-linked immunosorbent assay kits (Tridelta Phase Range Kit, Tridelta Development Ltd, Kildare, Ireland) according to the manufacturer's instructions. The serum cortisol level was assessed by chemiluminescence enzyme immunoassay in a commercial clinical laboratory (Obihiro Clinical Laboratory Inc, Obihiro, Japan).

2.5. Statistical Analysis

The sequence of postnatal data was analyzed with the repeated measures analysis of variance (ANOVA). When significant differences or interactions between the two groups were observed, Student or Welch *t* test was used to identify differences between the groups at each sampling period. Results with a P value $< .05$ were considered significant, and those with $P < .1$ were considered to have a tendency (marginal difference). These statistical analyses were conducted using Statcel 3 (OMS Ltd, Saitama, Japan).

3. Results

There is a marginal difference ($P < .1$) in the Apgar score between the normal birth group (mean 10.6, SD 1.4, range 8–13) and the dystocia group (mean 9.4, SD 2.3, range 6–13). There were no significant differences in other physical examination findings between the two groups (Table 1). Significant differences or interactions between the two groups were observed for WBC and RBC counts; Hb concentration; PCV; and cortisol, UN, FFA, and CK levels by repeated measures ANOVA. Significant differences were not observed for the other parameters (Tables 2 and 3). Significant differences between the two groups in each sampling period were examined using Student or Welch *t* test, and the results are shown in Figs. 1 and 2. The RBC count (0 hour: $P < .1$, 1 hour: $P < .05$, 12 hours: $P < .05$, 1 day: $P < .01$, 2 days: $P < .05$), Hb concentration (12 hours: $P < .1$, 1 day: $P < .05$, 2 days: $P < .05$), and PCV (12 hours: $P < .05$, 1 day: $P < .01$, 2 days: $P < .01$) remained at significantly lower levels in the dystocia group than in the normal birth group. Serum cortisol ($P < .05$), UN ($P < .05$), and CK ($P < .01$) levels at 1 hour; CK ($P < .05$) and FFA ($P < .1$) levels at 12 hours; and the WBC count ($P < .05$) at 1 day were higher in dystocia foals than in foals in the normal