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FAILURE OF PASSIVE IMMUNOGLOBULIN TRANSFER IN A BLACK RHINOCEROS (*DICEROS BICORNIS*) CALF

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Abstract: Serum protein electrophoresis from a 7-day-old black rhinoceros (*Diceros bicornis*) calf demonstrated failure of passive antibody transfer from the dam. The calf failed to thrive and died at 9 days of age. Mammary fluid samples taken 10 days prior to calving suggested that the dam was accumulating antibodies at a rate comparable to that of domestic species and further suggested that the failure to transfer this protection to the calf may be related to the lack of ingestion and/or absorption of normal colostrum.

Key words: Passive immunoglobulin transfer, black rhinoceros, *Diceros bicornis,* neonatal diseases, immunology.

CASE REPORT

A black rhinoceros (*Diceros bicornis*) calf was born on 3 October 1985 at the Detroit Zoo. The mother had borne previous offspring with cardiac anomalies. The calf was observed nursing three to four times during the first 12-hr period. Subsequent attempts to nurse were rejected by the dam. Approximately 6 days later, the calf became weak and dehydrated and would occasionally drink from a bottle. The animal was presented to the Michigan State University Veterinary Teaching Hospital at 7 days of age for evaluation for cardiac defects. Physical examination confirmed the dehydration and noted occasional ventricular dysrhythmias. No antemortem evidence of cardiac structural abnormality was found. Complete blood count and serum biochemical profile were performed. Data were comparable with published adult reference ranges[7] except for an azotemia, leukocytosis, neutrophilia, lymphopenia, and hypoglobulinemia producing a hypoproteinemia. Bacterial culture of the umbilical stump was also submitted and beta and alpha hemolytic *Streptococci, Staphylococcus epidermidis, S. faecalis, Citrobacter freundii,* and *Corynebacterium* sp. were isolated. The animal was treated with i.v. fluids, dextrose, and antibiotics and returned to the Detroit Zoo for further care. Maternal and calf serum were later submitted for protein electrophoresis to determine gamma globulin content (Table 1, Fig. 1). The animal failed to thrive and died 2 days later. Postmortem examination and histopathology failed to define a morphologic cause for failure to absorb maternal antibodies.

The serum protein electrophoretic tracings and quantitative evaluation indicated a severe deficiency of gamma globulin in the calf compared with the maternal serum data. (The mother was assumed to be a normal adult of the species.) Studies of normal foals have documented large increases in serum total protein after the ingestion of colostrum. Serum protein electrophoresis of samples from pre- and postsuckle foals demonstrated a mean increase of 1.38 g/dl (from a base of 0.26 g/dl) in the immunoglobulin-rich late beta and gamma fraction.[11] Data from this calf indicate failure to obtain maternal antibody from colostrum with a subsequent failure of passive transfer of immune protection.

Maternal milk samples taken 10 days prior to and 8 days after calving were also evaluated for total protein content and by protein electrophoresis (Table 2, Fig. 2). The

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Table 1. Serum protein values (g/dl) from a black rhinoceros 7-day-old calf and its dam. The protein fractions were separated by electrophoresis on cellulose acetate membrane.

Protein fraction	Calf	Dam
Total protein	4.3	8.1
Albumin	2.1	2.9
Alpha 1 globulin	0.2	0.1
Alpha 2 globulin	0.3	0.4
Beta globulin	0.9	1.6
Gamma globulin	0.2	3.0

milk samples had 1.4 g/dl of gamma globulin 10 days prior to calving and 0.3 g/dl of gamma globulin 8 days after calving. Equine colostrum collected within 3 hr of parturition had approximately twice the total protein of serum with 40% of the protein as IgG and IgG(T).[12] The sample taken from this dam prior to parturition did not exceed serum protein levels, but there was an increased proportion of gamma globulins, indicating appropriate selective accumulation of immunoglobulins.

DISCUSSION

The ungulate mother provides protection to neonates from infectious agents by colostral transfer of immunoglobulins. The significance of maternal protection has been documented for foals, calves, and lambs.[3,5,6] Failure to transfer protective antibodies has been related directly to morbidity and mortality in these domestic species.[8,9,14] Maternal immunoglobulins are delivered to the offspring by either placental transfer or ingestion and absorption of colostrum. The ungulate placenta is generally complex and does not allow the passage of large molecules. Therefore, in these species the colostral source of immunoglobulin is the only method of transfer of maternal antibodies to the neonate. The role of colostral transfer of immunoglobulins in zoo ungulates has also been established for many species.[4,10,13] Although young herbivores are generally immune competent at birth, maternal protection is essential because their immune

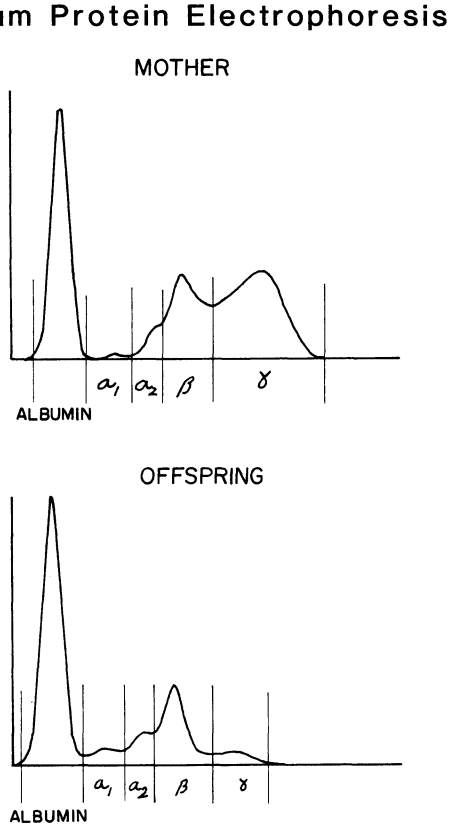

Figure 1. Densitometric scans of serum proteins from a female black rhinoceros and her offspring. Proteins were separated by electrophoresis. The sample from the adult female was assumed to represent a normal animal for the species. The sample from the offspring was taken at 7 days of age. Note the lack of gamma globulins.

system has not yet been stimulated in utero. Even with immediate stimulation, immunoglobulin production would not contribute protective levels of gamma globulin for several weeks.[15]

Several causes for failure of passive transfer have been identified and include failure to ingest colostrum, failure of the dam to produce adequate volume of colostrum or colostrum of sufficient immunoglobulin concentration, or failure of the calf to effectively use the available immunoglobulin.[15]

Evaluation of the initial milk sample in this study demonstrated that at 10 days prior to parturition the dam was beginning to

Table 2. Protein composition (g/dl) from milk samples from a black rhinoceros. Samples were taken 10 days prior to and 8 days after calving. Proteins were separated on cellulose acetate membranes.

Protein fraction	Precalving	Postcalving
Total protein	2.6	0.8
Albumin	0.7	0.3
Alpha globulin	0.1	0.0
Beta globulin	0.3	0.1
Gamma globulin	1.4	0.3
X fraction	0.1	0.1

concentrate gamma globulins in the mammary secretions (54% gamma globulins in mammary secretion 10 days prior to calving compared with 37% gamma globulins in the serum after calving). The exact rate of gamma globulin accumulation is not known, but data from cattle suggest that the greatest movement of immunoglobulins into the mammary gland occurs in the last 2 wk prior to parturition.[2] The data from this rhinoceros dam suggest that the interval for immunoglobulin accumulation is comparable to that of domestic species.[2]

The milk sample taken after calving demonstrated a marked decline in gamma globulin level. This sharp decrease in immunoglobulin content has also been documented in the horse, with a marked decline in total protein (almost 75%) and IgG levels (99%) by 6–33 days of lactation.[12] The data from this rhinoceros are consistent with these findings.

Data on the protein composition of the dam's mammary secretions suggest that immunoglobulins were probably adequate in the colostrum. The cause(s) of the failure of passive transfer in this calf are probably related to ingestion and/or absorption of the colostrum. Although the calf was reported to have nursed, it may not have actually ingested colostrum. This uncertainty is related to physical limitations in the observation process.

Electrophoresis of proteins separated from the rhinoceros milk samples showed a small band at the cathodal end of the separation.

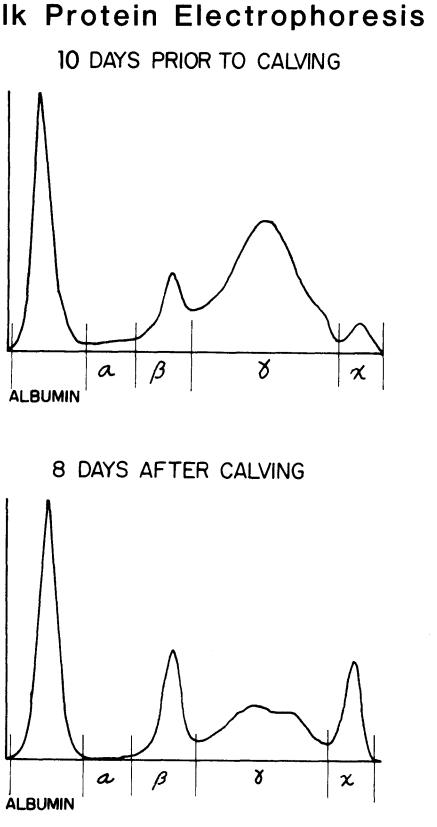

Figure 2. Densitometric scans of mammary secretion proteins from a black rhinoceros separated by electrophoresis. Samples were taken 10 days prior to and 8 days after calving. Lipids were removed by ultracentrifugation prior to electrophoresis.

The source or composition of this fraction was not determined but a similar band has been reported previously in milk samples from a black rhinoceros.[1]

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