

TRACE ELEMENTS IN CALVES PERSISTENTLY INFECTED WITH
BOVINE VIRUS DIARRHOEA VIRUS

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INTRODUCTION

Infections with bovine virus diarrhoea virus (BVDV) cause a wide spectrum of clinical syndromes throughout the world (1). The outcome of a transplacental infection includes foetal death, teratogenic effects and the birth of persistently infected (PI) calves (9) which are immunotolerant to the non-cytopathic strain of BVDV they harbour. Due to the tolerance such calves have no, or only a low level of, antibodies to BVDV.

Persistently infected cattle may perform normally but they are often recognized as being small at birth, having a poor growth rate and an unthrifty appearance. They also seem to have an increased susceptibility to other infections (2) and are the cattle population at risk of developing the fatal condition mucosal disease (11).

It is far from understood why PI cattle usually are small and have a retarded growth. Obviously, in some cases, this can be explained by the presence of chronic bacterial infections, which in turn may be attributed to a immunosuppressive state of the calves since BVDV infects the cells of the immune system. However, there are PI calves without signs of bacterial infections that are small. Since Srinivas et al (10) report that human patients with viral infections have altered concentrations of trace elements it is tempting to speculate that also a persistent BVDV infection can interfere with the body metabolism.

The aim of this study was to examine the serum concentrations of copper, zinc and iron during persistent infection with BVDV in calves. Further, the levels of these trace elements levels were related to the heart girth of the calves.

MATERIAL AND METHODS

Calves of both sexes and mostly of Swedish Red and White breed in 2 dairy herds (A and B) were used. Ten calves in herd A and 10 in herd B were considered to be persistently infected with BVDV since a non-cytopathic strain of this virus was isolated from the sera on two occasions, two months apart, and none of the calves seroconverted during this period. Ten non-PI and age-matched calves in each of the 2 herds served as controls. The calves were bled and their heart girth measured when they were about 3 months old (range; 75 to 117 days). Ringworm, coughing and/or diarrhoea were observed among both PI and non-PI calves in herd A, whereas all calves in herd B were apparently healthy when sampled.

The trace elements analyses were performed according routine methods of the Department of Clinical Chemistry, Swedish University of Agricultural Sciences, Uppsala. The concentrations of copper and zinc in serum were determined by atomic-absorption spectrometry and the level of iron by a commercial kit (Iron FZ test, Roche Diagnostica).

Virological techniques. An enzymed-linked immunosorbent assay was used to detect antibodies to BVDV in serum (SVANOVA, Biotech AB, Uppsala, Sweden). The presence of BVDV in sera was tested by inoculating sera on cultures of embryonic bovine turbinate cells. After incubation for 4 days the cultures were examined for cytopathic effect and the presence of BVDV was determined by an indirect immunoperoxidase test, using a polyclonal sera to BVDV.

Statistical analyses. Student's t-test was used for statistical analyses. Results are expressed as mean \pm standard deviation (S.D.), unless not otherwise indicated.

RESULTS

The mean serum concentrations of copper, zinc and iron in both PI calves and controls were within the laboratory reference limits. However, as shown in Table 1, the mean concentration of copper was significantly higher ($p < 0.01$) in the PI calves ($18.9 \pm 3.0 \mu\text{mol/l}$) than in the controls ($16.4 \pm 1.5 \mu\text{mol/l}$). In contrast, the mean serum concentrations of zinc ($18.2 \pm 3.3 \mu\text{mol/l}$, $p < 0.05$) and iron ($20.8 \pm$

Table 1. Age, heart girth and serum concentrations of copper, zinc and iron in calves persistently infected (PI) with BVDV in two dairy herds (A and B). Results are expressed as mean \pm S.D.

	Herd and calves					
	A		B		A and B	
	PI calves	Controls	PI calves	Controls	PI calves	Controls
No. of calves	10	10	10	10	20	20
Age (days)	94.1 ± 12.1	95.1 ± 11.6	92.7 ± 12.0	95.4 ± 11.5	93.4 ± 11.7	95.3 ± 11.2
Heart girth (cm)	96.3* ± 7.2	103.1 ± 6.5	96.5* ± 8.1	103.2 ± 4.7	96.4** ± 7.7	103.1 ± 5.5
Copper ($\mu\text{mol/l}$)	18.8* ± 3.6	16.0 ± 1.3	19.0* ± 2.5	16.8 ± 1.7	18.9** ± 3.0	16.4 ± 1.5
Zinc ($\mu\text{mol/l}$)	18.6* ± 2.9	22.5 ± 2.1	17.8 ± 3.8	18.9 ± 3.3	18.2* ± 3.3	20.7 ± 3.2
Iron ($\mu\text{mol/l}$)	21.9** ± 6.6	30.9 ± 6.2	19.8 ± 9.0	27.0 ± 7.8	20.8** ± 7.7	28.9 ± 7.1

* and ** indicate significantly different ($p < 0.05$ and $p < 0.01$) values than for control calves in the same herd.

7.7 $\mu\text{mol/l}$, $p < 0.01$) were lower in PI calves than in the controls (20.7 \pm 3.2 and 28.9 \pm 7.1 $\mu\text{mol/l}$, respectively).

In both herds A and B, the mean heart girth of the PI calves was significantly less ($p < 0.05$) than that of controls (Table 1). Among the PI calves there was a significant correlation between the heart girth and the levels zinc ($r = 0.65$, $p < 0.01$) and iron ($r = 0.53$, $p < 0.05$) but not between heart girth and copper ($r = -0.23$, $p > 0.05$). No significant correlation was observed between heart girth and levels of the examined trace elements among the controls.

DISCUSSION

Acute and chronic infections in human and animals can result in hypercupremia and decreased blood levels of zinc and iron (10). It has been suggested that interleukin-1 (Il-1) released by activated phagocytes is responsible for sequestering zinc in the liver (5) and that Il-1 induces a granulocyte release of lactoferrin which bind iron and induces hypoferraemia probably through increased hepatic uptake of lactoferrin-iron complex (6). The hypercupremia is considered to be owing to the stimulation of ceruloplasmin synthesis and its release from the liver (4).

In recent studies, we found persistently BVDV-infected cattle to have low serum concentrations of thyroid hormones (8) and to have altered concentrations of copper, zinc and iron but not of calcium, magnesium, phosphorus, selenium, retinol and α -tocopherol (7). The present study confirms the findings of an increased level of copper and decreased levels of zinc and iron in PI calves (Table 1). Notworthy, there was a significant correlation between the heart girth and the levels of zinc ($p < 0.01$) and iron ($p < 0.05$) among the PI calves. Both iron and zinc deficiency can lead to reduced feed intake and growth retardation (3). Therefore, it can not be excluded that low levels of iron and zinc contribute to the growth retardation in the under-sized PI calves.

In conclusion, PI calves have altered concentration of copper, zinc and iron which indicate a host response to the presence of virus. This study also confirms the clinical observation that PI calves are small in relation to their age.

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SUMMARY

A number of disease conditions including acute and chronic infections in human and animals can result in alterations of trace elements. To elucidate if a persistent infection with bovine virus diarrhoea virus (BVDV) influences the levels of copper, zinc and iron in serum, blood samples were taken from 10 persistently BVDV infected (PI) calves and 10 non-PI calves (controls) in each of 2 dairy herds. The heart girth of the calves was also measured and the age of the calves ranged from 75 to 117 days.

The mean heart girth of the 20 PI calves examined was less ($p < 0.01$) than that of the 20 controls. The PI calves had significantly higher ($p < 0.01$) serum level of copper ($18.9 \pm 3.0 \mu\text{mol/l}$) but lower levels of zinc ($18.2 \pm 3.3 \mu\text{mol/l}$, $p < 0.05$) and iron ($20.8 \pm 7.7 \mu\text{mol/l}$, $p < 0.01$) than the controls (16.4 ± 1.5 , 20.7 ± 3.2 and $28.9 \pm 7.1 \mu\text{mol/l}$). Among the PI calves, but not among the controls, there was a significant correlation between the heart girth and the levels of zinc ($r = 0.65$, $p < 0.01$) and iron ($r = 0.53$, $p < 0.05$). The altered serum concentration of copper, zinc and iron indicate a host response of the PI calves to the presence of virus.

ZUSAMMENFASSUNG

Eine Anzahl von Krankheiten, einschliesslich akuter und chronischer Infektionen, fuhren bei Menschen und Tieren zu Veränderungen der Spurenelemente. Um zu sehen, ob eine persistente Infektion mit das Virus der bovinen Virusdiarrhoe (BVDV) das Serumniveau von Kupfer, Zink und Eisen beeinflusst, wurden aus zwei Herden je zehn persistent BVDV infizierte (PI) und zehn nicht PI Kälber ausgewählt und Blutproben entnommen. Ebenso wurde der Brustumfang der Kälber gemessen. Das Alter der Kälber lag zwischen 75 und 117 Tagen.

Der mittlere Brustumfang der 20 PI-Kälber war kleiner ($p < 0.01$) als der Kontrollgruppe. Die PI-Kälber hatten ein signifikant ($p < 0.01$) höheres Serumniveau an Kupfer ($18.9 \pm 3.0 \mu\text{mol/l}$), hingegen niedrigeres Niveau an Zink ($18.2 \pm 3.3 \mu\text{mol/l}$, $p < 0.05$) und Eisen ($20.8 \pm 7.7 \mu\text{mol/l}$, $p < 0.01$) als die Kontrollgruppe (16.4 ± 1.5 , 20.7 ± 3.2 und $28.9 \pm 7.1 \mu\text{mol/l}$). Bei den PI Kälbern, jedoch nicht in der Kontrollgruppe, bestand eine bezeichnende Übereinstimmung zwischen Brustumfang den Serumwerten an Zink ($r = 0.65$, $p < 0.01$) und Eisen ($r = 0.53$, $p < 0.05$). Die Veränderungen der Serumkonzentrationen von Kupfer, Zink und Eisen deuten auf eine Reaktion der PI-Kälber auf die Gegenwart des Virus.

RESUMEN

En numerosos casos de enfermedad, incluyendo infecciones agudas y crónicas tanto de humanos como de animales, pueden presentarse alteraciones de los microelementos. Para dilucidar si una infección persistente a virus de la Diarrea Vérica Bovina (BVDV) influencia los niveles de cobre, zinc y hierro en el suero, se tomaron muestras de sangre de 10 terneros persistentemente infectados (PI) por BVDV y de 10 terneros no PI en cada uno de 2 rebaños lecheros. La circunferencia torácica de los terneros también fué medida; la edad de ellos fluctuaba entre 75 a 117 días.

La media de la circunferencia torácica de los terneros PI fué menor ($p < 0.01$) que de la 20 terneros controles. Los terneros PI tenían significativamente mayores ($p < 0.01$) niveles de cobre ($18.9 \pm 3.0 \mu\text{mol/l}$) pero menores niveles de zinc ($18.2 \pm 3.3 \mu\text{mol/l}$, $p < 0.05$) y hierro ($20.8 \pm 7.7 \mu\text{mol/l}$, $p < 0.01$) que los controles (16.4 ± 1.5 , 20.7 ± 3.2 y $28.9 \pm 7.1 \mu\text{mol/l}$). Entre los terneros PI, pero no entre los controles había una correlación significativa entre circunferencia torácica y los niveles de zinc ($r = 0.65$, $p < 0.01$) y hierro ($r = 0.53$, $p < 0.05$). Las concentraciones alteradas de cobre, zinc y hierro en el suero indican una respuesta del hospedero PI a la presencia del virus en los terneros PI.