Phosphorus Deficiency in Deer?: A Case Report

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1. INTRODUCTION

Phosphorus deficiency in grazing ruminants in New Zealand is not common. Rickets has been reported in young steers grazing a swede crop (Thompson and Cook, 1987). In cattle, phosphorus deficiency may manifest as retarded growth, poor reproductive performance, reduced milk yield, bone abnormalities, depraved appetite and stiffened gait (Winks, 1990). To the author's knowledge there are no reports of bone abnormalities associated phosphorus deficiency in deer.

This paper describes briefly two clinical cases involving osteoporosis, and rickets with osteoporosis, in grazing deer associated with low blood phosphorus levels which were possibly complicated by low copper levels.

2. GENERAL DESCRIPTION

2.1 Farm

The farm on which the cases reported here occurred is on flat, poor draining peat soil in the Manawatu. The farm contains approximately 400 deer with a number of pure-bred Wapiti, a predominance of Wapiti-cross red hybrid deer, and a small number of red deer. Pasture species include cocksfoot and fescue, along with ryegrass/clover pasture, and a range of supplementary feed is provided including hay, maize silage and occasionally brassica crops. The property has a prolonged history of copper deficiency and substantial supplementation is required. A number of "fading elk" have been attended on this property during the past few years.

2.2 CASE 1.

2.2.1 Clinical Description

One mature and one rising three-year-old pure Wapiti were presented on June 22. Both were in poor condition and the owner reported that during yarding the younger cow had a slightly abnormal gait. Body condition had been falling for many weeks and sometime earlier the owner observed submandibular oedema in the younger cow which disappeared after an anthelmintic drench.

A clinical examination revealed no significant abnormalities. Blood and faecal samples were collected. At that stage "Finaject" (2ml on two occasions 4 days apart) was prescribed along with a vitamin B12 injection.

2.2.2 Laboratory Results

The results of analyses conducted on the blood and faecal samples are

presented in Table 1. Major significant deviation from normal levels are indicated by arrows. The older hind (non-affected in terms of gait) presented a haematological and biochemical profile typical of hinds affected with "fading elk syndrome", but with a severely reduced phosphorus level. In addition there was a significant neutrophil left shift suggesting active inflammation.

Table 1. Results of blood and faecal analyses on two elk cows (*"Affected" animal was the rising 3-year-old with abnormal gait)

	"Affected"*	Non-Affected
Hb(g/dl)	11.9	9.9*↓
PCV (%)	32.6	28.8*↓
WBC (x 10^9/l)	7.6	6.2
N% Mat	43	20*↑
Band	20*↓	37*↓
E%	3	13*↓
L%	30	21
B%	-	
M%	5	9
BUN, Creat. CPK, γGT)		
Br, Na, Ca, Mg,)	Normal	Normal
Pepsinogen)		
Protein (g/l)	57.5*↓	57.9*↓
Alb. (g.l)	23.4	16.5*↓↓
K (mmol/l)	10.3↑	8.1↑
P (mmol/l)	0.61↓↓	0.69↓↓
Faecal Egg and larval counts	0	0
Blood Copper (μmol/l)	4.2↓	6.7↓

The animal affected with an abnormal gait showed a similar profile including a low blood phosphorus level. Blood potassium levels were elevated in both cows.

2.2.3 Follow-Up

On the basis of blood sample results, both cows were treated with "Tonophosphan" and "Streptopen" for seven and three days, respectively. In addition, six cohort Wapiti cows were yarded and blood samples collected for potassium and phosphorus levels.

Phosphorus levels were 1.88, 1.94, 2.09, 2.13, 2.16 and 2.31 mmol/l while potassium levels were in the normal range 3.4-4.7 mmol/l.

2.2.4 Initial Conclusion

It was not possible to make a clear diagnosis on the basis of the initial visit and tests carried out. It was suspected that the low phosphorus may be associated with the abnormal gait in one cow, but equally that could have been associated with weakness and poor condition. The low blood copper levels prompted the advice to further supplement. It was believed that the low P levels may have been the cause, or a contributory cause, of the loss of condition, given that a fall in bodyweight is a common sign of P deficiency. However, the fact that 6

cohorts had normal P levels suggested the low P in the affected deer may have been secondary to a fall in food intake.

2.2.5 Sequel

On June 24 the owner requested a further visit because the younger cow was having difficulty standing. The owner commented that during the previous two weeks while the animal was brought into the yard for phosphorus supplementation her gait was deteriorating and the time taken to reach the yards was quite protracted.

On examination the cow was distressed with eyes wide and pre-orbital gland wide open. When she attempted to stand there was crepitus noted, but flexion and movement of limbs failed to yield the origin of the crepitus. A further blood sample was collected and the owner advised to convey the deer to the yard for shelter and cover pending results. A tentative diagnosis of osteomalacia was made.

The following morning the farmer euthanased the deer because she had struggled severely after a leg had got caught under a gate and she was clearly severely distressed. Results from blood analyses showed a 92% neutrophilia and a phosphorus of 0.5 mmol/l, lower than at the original visits. The older cow was improving in condition and eventually recovered fully.

2.2.6 Post Mortem

There was substantial bruising to limbs and trunk, presumably associated with struggling after her leg became jammed under the door.

There were several pathological fractures, including avulsion of the major tubercles of the humerus and trochanters of the femur. Joints appeared soft to the knife and some areas of long bones were brittle. There was a medial luxation of both patella which had suffered multiple fractures. Cortical bone of the femur was 4mm which is considered very thin. Lesions were generally symmetrical.

Histopathological signs showed osteoclast activity, endosteal reabsorption and thin trabeculae consistent with a diagnosis of osteoporosis. In addition there was a mild inflammation of the gastro-intestinal tract and protozoal cysts and evidence of bacterial invasion were present. There was centralobular congestion in the liver. Liver copper was 55 umol/kg despite supplementation two weeks earlier.

A diagnosis of osteoporosis in the presence of low copper and low phosphorus indicated a clinical condition of complex aetiology.

2 2 7 Prophylaxis

Other hinds in the group were supplemented with dicalcium phosphate, administered to hay and silage supplementary feed.

2.3 CASE 2

2.2.1 Description

On August 29 an 8 month-old red x Wapiti stag was presented to the post mortem room after the farmer euthanased it after a spontaneous fracture of the hindleg occurred during mustering. The farmer noted that he had euthanased another weaner stag on August 22 because of limb fractures.

2.2 2 Post Mortem

The animal was in poor body condition. There was a mid-shaft fracture of the left tibia and fibular with two large bone fragments separated from the ends of the fractured bones. Numerous fresh and healing fractures of the ribs were observed as follows:- all but R3 on the left side, rib 7-11 on the right side. Some of these fractures had evidence of callus formation. Most fractures were mid-way along the rib.

Histologically there was cartilageous change close to the costochondral junctions, thick osteoid seams were evident around bony trabecula, numerous osteoblasts were present and there were areas of necrosis either side of bone fractures. Epiphyseal and metaphyseal trabeculae of the distal femur were thinner than normal. Mobilisation of marrow fat was evident and active osteoblasts lined most of the metaphyseal trabeculae of the proximal tibia. These changes were consistent with rickets in association with osteoporosis. The ricketic lesions were likely due to a phosphorus deficiency, while the osteoporotic lesions were more consistent with low copper levels.

Analysis of bone ash yielded a 53.4% dry matter, 15.5% calcium and 7% phosphorus. The Ca and P levels are below those considered normal for cattle (Ternouth, 1990). In that specics, demineralisation should be considered significant if levels are below 16% and 7.5% for Ca and P, respectively.

2.2 3 Follow-Up

On September 3, 12 rising one-year-old red x Wapiti hinds and stags were blood sampled for blood phosphorus analyses. Six had received copper supplementation previously, while six had not. Pasture and silage samples were collected for macro-element analysis.

The phosphorus levels in copper supplemented deer were 0.68, 1.91, 2.42, 2.65, 2.66, 2.75 mmol/l (mean 2.18). Phosphorus levels in deer not copper supplemented were 1.07, 1.48, 1.54, 1.57, 1.61, 2.42 mmol/l (mean 1.61). Thus, only one copper supplemented deer had low phosphorus while five of six not receiving copper supplementation had low phosphorus levels.

Pasture analyses showed phosphorus levels to be in the acceptable range (Table 2). Sulphur and molybdenum levels were high in some samples, whereas iron was substantially elevated in all samples. This pattern is consistent with previous monitoring undertaken on the property, indicating that low animal copper levels were probably induced by high iron, molybdenum and sulphur levels.

Table 2. **Pasture and silage analyses (Major variation from normal indicated by arrows)**

Element	Pasture 1	Pasture 2	Silage
P (%)	0.5	0.5	0.27
S (%)	0.46↑	0.37	0.26
Cu (ppm)	11	10	8
Fe (ppm)	929↑	519↑	448↑
Mo (ppm)	1.21	2.78↑	1.16
Ca (%)	0.47	0.44	0.52

2.2.4 Prophylaxis

Dicalcium phosphate was provided to cohort weaners and advice was given to treat all animals with copper needles.

3 DISCUSSION

The clinical pictures of osteoporosis and a combination of rickets and osteoporosis in the presence of the laboratory results given is confusing.

The rising 3-year-old with multiple pathological fractures clearly had an osteoporosis. This condition is more characteristic of copper deficiency than of primary phosphorus deficiency. The lesions observed were not fully consistent with osteomalacia which is the manifestation of long-standing dietary phosphorus deficiency in adult cattle (Ternouth, 1990). It may have been that the low phosphorus levels occurred because of a reduced appetite secondary to low copper levels. Ternouth (1990) noted that bone abnormalities exacerbate phosphorus deficiency as any bone disease reduces the ability of the animal to forage for food. This problem would become self-perpetuating, since in sheep low phosphorus levels have been shown to reduce food intake by as much as 50%. In the present case both clinically affected adult wapiti had low phosphorus and copper levels, but only one showed clinical signs of bone disease.

Normal phosphorus levels observed in 6 cohort deer also support the hypothesis that the low phosphorus level in the clinically affected deer were secondary to other factors. Phosphorus supplementation was provided as a safeguard.

The diagnosis of rickets with osteoporosis in an 8 month-old stag prompted further investigation. Rickets is uncommon in animals on pasture in New Zealand and is usually associated with low vitamin D. However, rickets can occur as a manifestation of long-standing dietary phosphorus deficiency in young animals (Ternouth, 1990). Data on phosphorus levels in 12 cohort weaners was very interesting in that the phosphorus level in 5 of 6 which had not received copper were below the normal range (1.8 mmol/l), whereas 5 of 6 which had received copper treatment had phosphorus levels in the normal range. Recent research (Grace and Lee 1988) has suggested a link between low copper levels and low phosphorus content of bone.

The reason for low phosphorus levels is not clear. In cattle phosphorus is considered to be a primary limiting nutrient when the dietary phosphorus is less

than 0.12 to 0.15% (Winks, 1990). In the present case dietary phosphorus levels were 0.27-0.5%.

CONCLUSION

This report presents evidence of bone abnormalities in adult and young deer associated with low blood phosphorus levels in the presence of low copper levels. There is a suggestion that the low phosphorus level may be linked with low copper. Investigation of the diet yielded no clue as to the reason for the reduction in phosphorus and it is tentatively concluded that the low phosphorus level was associated with a reduction in food intake, secondary to copper deficiency.

This case may alert practitioners to investigate the phosphorus status of copper deficiency deer so more knowledge of the significance of the findings of the present cases can accumulate.

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