

Effects of Long-term Thyroparathyroidectomy on Antler Growth in Red Deer

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Abstract

Chronic thyroparathyroidectomy (TPTX), with thyroxine replacement, of a young red deer stag (*Cervus elaphus*) subsequently fed a high-calcium diet (15 g Ca/day) led to antlers of higher specific gravity which, from neutron activation analyses, appeared to result from an increase in the ratio of calcium to nitrogen. Similarly, histological examination showed that TPTX resulted in homogeneous, compact tissue with less remodelling activity than in antlers from a control animal.

The antlers lost their velvet and were cast on approximately the same dates in TPTX and control animals. It is concluded that when a diet high in calcium and phosphorus is fed, normal antler growth is maintained in the absence of parathyroid hormone and calcitonin.

Keywords: thyroparathyroidectomy, antlers, *Cervus elaphus*, calcium

Introduction

Mature hard antlers contain high concentrations of calcium (Ca) and phosphorus (P); this pilot study assesses the effects of removal of endogenous parathyroid hormone and calcitonin on the growth and composition of antlers, their histological appearance, and the timing of their maturation and casting (Hyvarinen *et al.* 1977) in red deer (*Cervus elaphus*).

Experimental

Two comparable yearling stags weighing approximately 60 kg were selected. After blood samples were taken from a jugular vein of each stag, 1 stag was anaesthetised with intravenous sodium pentobarbitone and both superior parathyroid glands removed, then both thyroid lobes with their inferior pair of parathyroid glands. Both animals were fed initially at the rate of 2 kg/day, increased to 3 kg/day 1 week after the thyroparathyroidectomy (TPTX), with a diet based on chopped lucerne and supplying 15 g Ca/kg dry weight and 2.2 g P/kg dry weight. This diet maintained a normal plasma Ca concentration 2 days after the TPTX, but there was a 17% reduction in plasma inorganic phosphate concentration. Reduction of the daily intake of Ca from 45 g to 33 g/day 10 weeks after the TPTX caused a sharp reduction in the plasma Ca

concentration of the TPTX stag of 64% of the pre-TPTX level (94 mg/l). There was also a rise in the plasma inorganic phosphate level. These changes indicated that parathyroidectomy had been achieved. Supplementation of a commercial diet for stags with 12 g CaHPO₄ weekly restored normocalcaemia in the TPTX stag.

Thyroxine replacement therapy was carried out weekly with 6 mg L-thyroxine, homogenised in 1 ml water:1 ml arachis oil, injected subcutaneously. This regime maintained the plasma thyroxine concentration (63 nmol/l) slightly below the normal range (65–92 nmol/l) shown by the intact stag. The dose rate was raised to 8 mg/week some 12 weeks after TPTX.

The plasma concentration of 1,25-dihydroxy vitamin D₃ (1,25 (OH)₂D₃) was measured by a radioimmunoassay following high pressure liquid chromatography of an extract of plasma using a modification of the method of Clemens *et al.* (1979). During the 2 days following TPTX it fell from 138 ng/l to 86/ngl, while the concentration of 1,25 (OH)₂D₃ in the intact stag remained unchanged (113 ng/l).

Results and Discussion

Antler growth proceeded in a comparable manner in the 2 stags and showed a good correlation with testicular growth, as assessed by the anterior –

Table 1: Comparison of antlers from 2 stags, 1 thyroparathyroidectomised (TPTX) with thyroxine replacement and the other intact

Stag	Specific gravity			Dry weight (g)	Volume (V,ml)	Ash (A,g)	Organic matter (OM,g)	Ratios	
	Before drying	After drying at 100°C						A/V	OM/V
TPTX 1	1.67	1.51	28.9	19.2	16.8	12.1	0.876	0.63	
2	1.74	1.58	18.0	11.4	10.7	7.3	0.943	0.64	
Intact 1	1.52	1.38	22.7	16.5	12.6	10.1	0.763	0.61	
2	1.53	1.39	23.5	16.9	13.1	10.3	0.776	0.61	

posterior dimension. Velvet shedding occurred over the same period in both stags and the antlers of both animals were recovered and flown to Leeds for examination. The TPTX stag produced antlers of higher specific gravity. The percentage dry matter (90.6) was not significantly different between the 2 stags nor was the weight of antler organic matter relative to antler volume. However, the weight of antler ash relative to antler volume was higher in the TPTX stag (Table 1).

Prior to ashing, the antlers were subjected to neutron activation analysis using a 14 MeV neutron generator which supplied 1×10^7 neutrons/cm²/sec for 10 min. Calcium was detected and measured by counting the 3.1 MeV gamma rays from the ⁴⁹Ca produced by the thermal neutron reaction ⁴⁸Ca(n,γ)⁴⁹Ca. Phosphorus was measured as the 1.78 MeV gamma rays from the ²⁸Al induced by the fast neutron reaction ³¹P(n,α)²⁸Al. At the end of the irradiation the antlers were rapidly (5.5 min) taken to a whole-body counter and counted for 30 min. The resultant gamma irradiation spectrum was analysed using a Nuclear Data 6620 computer controlled pulse height analyser. The radionuclide ¹³N was counted as a measure of the organic matter present in each antler. Table 2 shows that whereas there was no significant difference between the P/N ratio of the antlers from the TPTX and intact stags, the ratio of Ca/N was greater in the TPTX animal.

For histological examination, the antlers were sectioned longitudinally and examined, without prior decalcification, under the light microscope after staining with Goldner stain. Thyroparathyroidectomy was associated with distinct changes in the micro-anatomy of the tissue. In contrast to the heterogeneous character of the tissue from the intact stag which showed a central porous region of cancellous bone and allied sites of apposition, the sections from the TPTX stag showed homogeneous, compact tissue with little evidence of remodelling activity.

The 2 stags were kept for a further year during which the diet of the TPTX stag remained supplemented with CaHPO₄. Both stags remained in good health. The antlers were removed during the year and the residual "buttons" were cast by each animal at approximately the same time.

Conclusions

It is concluded that, as long as a nutritionally adequate diet is supplied which is high in both Ca and P, normal antler growth is maintained despite the absence of parathyroid hormone and calcitonin. However, in their absence the antlers are denser with little evidence of bone remodelling.

Table 2: Neutron activation analysis of antlers: phosphorus and calcium

Stag	²⁸ Al (P)	Counts/30 min			Ratios (×100)	
		⁴⁹ Ca	¹³ N	²⁸ Al (P)/ ¹³ N	⁴⁹ Ca/ ¹³ N	
TPTX 1	29337	2617	57094	51.4	4.58	
2	15672	1112	24412	64.2	4.56	
Intact 1	23340	1284	33988	68.7	3.78	
2	19170	344	52004	36.9	1.05	

References

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