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Serum- and bone-mineral status of ostriches with tibiotarsal rotation

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ABSTRACT

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Tibiotarsal rotation in ostrich chicks is a serious problem that accounts for considerable financial loss to ostrich farmers. Serum- and bone-mineral analyses of 20 ostrich chicks with tibiotarsal rotation were compared with serum- and bone-mineral analyses of eight normal ostrich chicks of comparable age, sex and body mass, and raised under identical conditions. The serum-zinc values were significantly higher and the bone-calcium and phosphorus values significantly lower in the affected group than in the group of normal ostrich chicks. The results indicated poor mineralization of bone with subsequent reactive osteoid formation.

INTRODUCTION

The twisted- or rotated-leg syndrome in ostrich chicks is well documented. Bezuidenhout & Burger (1993) reviewed the relevant literature and determined the incidence of proximal and distal tibiotarsal rotation in ostrich chicks raised at the Oudtshoorn Experimental Farm during the 1991–1992 and 1992–1993 breeding seasons.

The greatest incidence of the condition is seen in 4–8-week-old birds. The pathogenesis of the condition is not entirely understood. Aetiology indicates that nutrition, strain, housing, sex, exercise and growth rate are factors involved.

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There is, however, no evidence that the condition is congenital or that inflammation plays a role. Some blood-chemical and electrolyte concentrations in 1–3-year-old ostriches kept under semi-extensive conditions were determined by Van Heerden, Dauth, Jarvis, Keffen, Denny, Dreyer & Kriek (1985), while Levy, Perelman, Waner, Van Grevenbroek, Van Creveld & Yagil (1989) determined some reference blood-chemical values in 1–72-month-old ostriches kept under intensive conditions. Palomeque, Pinto & Viscor (1991) determined haematologic and blood-chemistry values of Masai ostriches at five and 17 months of age under zoo conditions.

Furthermore, Gandini, Burroughs & Ebedes (1986) raised ostrich chicks on four different dietary regimes to study body-mass gain and found that some of the chicks developed tibiotarsal rotation. Flieg (1973) studied nutritional problems in young ratites and, based on his findings, formulated the Falstaff diet for young ratites. The present study was undertaken to determine the serum- and bone-mineral status of ostrich chicks with tibiotarsal rotation and to compare the values with those of ostrich chicks without limb deformities, raised under identical conditions.

MATERIALS AND METHODS

All materials for the study were obtained from the Oudtshoorn Experimental Farm, Oudtshoorn. At hatching, all the ostrich chicks were identified and marked by means of a numbered wing tag. The chicks were kept in mixed groups and raised under identical conditions. Twenty chicks that developed tibiotarsal rotation between the ages of 4 and 8 weeks, were randomly selected for the study. Each ostrich chick was identified, its body mass was determined and a blood sample was collected. Five millilitres of serum were obtained by centrifuge separation of the blood, and the serum sample was identified by the wing-tag number. The bird was then culled, its sex was determined and both hind limbs were removed. All soft tissue was removed from the bones and the limbs were identified by means of the numbered wing tag. The serum and bones were subsequently frozen at −20 °C until such time as the mineral analyses could be done. Eight ostrich chicks from the same group as the affected chicks were selected as controls. Although the controls were of comparable age, body mass and sex, and had been raised together with the affected birds, sharing the same camp, feed and water, they did not develop tibiotarsal rotation. They were processed in the same way as the affected birds.

A 2 kg aliquot of the feed on which the chicks were raised was taken for mineral analysis.

The serum and bone samples of both groups were analyzed for calcium (Ca), phosphorus (P), magnesium (Mg), manganese (Mn), zinc (Zn), and copper (Cu), by the Allerton Regional Laboratory in Pietermaritzburg, Natal. The serum samples were analyzed in a Phillips PU 9100 Atomic Absorption Data Station, while the feed and bone analyses were done by incineration and spectrometry. The results of the analyses were statistically tested by one-way analysis of variance (ANOVA) and the "Statsgraphics" (Manugistics, Inc. 2115 East Jefferson St, Rockville, Maryland, 20852, USA) statistical analysis programme was used. The difference between the two groups was tested by the F-ratio test. A significance level of $P < 0,05$ was used to determine whether the result could be attributed to chance. Feed-mineral values were compared with the values suggested for ratites by Flieg (1973) and Gandini *et al.* (1986).

RESULTS

The mean value and range of the serum-mineral analyses for affected and normal ostrich chicks are represented in Table 1 and the mean value and range of the bone-mineral analysis for the two groups are given in Table 2. The mineral analysis of the feed is represented and compared with the values suggested by Flieg (1973) and Gandini *et al.* (1986) in

TABLE 1 Mean and range of the serum-mineral content

Minerals	Normal birds		Affected birds	
Ca mmol/ℓ	2,276	(1,60–2,86)	2,246	(1,90–2,80)
P mmol/ℓ	1,975	(1,47–3,42)	2,195	(1,13–3,56)
Mg mmol/ℓ	0,8744	(0,61–0,99)	0,8563	(0,72–1,33)
Mn µmol/ℓ	0,3672	(0,32–0,67)	0,4638	(0,05–0,87)
Zn µmol/ℓ	10,608	(6,28–19,16)	18,405	(7,98–36,13)
Cu µmol/ℓ	4,236	(1,98–6,04)	3,84	(1,79–9,39)

TABLE 2 Mean and range of the bone-mineral content expressed as percentage of bone

Minerals	Normal birds		Affected birds	
Ca	22,12	(20,029–23,977)	20,09	(17,823–22,463)
P	9,124	(8,384–9,991)	8,537	(7,567–9,488)
Mg	0,435	(0,383–0,509)	0,435	(0,370–0,489)
Mn	< 0,000	(0,000–0,001)	< 0,000	(< 0,000–0,001)
Zn	0,02147	(0,016–0,024)	0,0201	(0,018–0,024)
Cu	< 0,0000	(< 0,000–0,001)	< 0,000	(< 0,000–0,001)

TABLE 3 Comparison of the feed-mineral content of the Flagstaff ratite feed of Flieg (1973), the feed of Gandini *et al.* (1986) and the feed used at the Oudtshoorn Experimental Farm for the present study

Minerals	Flieg (1973)	Gandini *et al.* (1986)	Present study
Ca %	1,78	1,4	1,86
P %	0,67	0,7	0,8
Mg %	0,256	0,2–0,24	0,20
Mn ppm	120	90–91,5	20
Zn ppm	104	75,6–78	54
Cu ppm	17,3	10,7–11	7

TABLE 4 One-way analysis of variance (ANOVA)

Constituent	M.S. group	M.S. error	F-ratio	P
Blood				
Ca	0,00476	0,27253	0,017	0,8974
P	0,26806	0,29324	0,914	0,3587
Mg	0,00183	0,02076	0,088	0,7720
Mn	0,05161	0,03392	1,521	0,2294
Z	336,740	33,9400	9,923	0,0043
Cu	0,86901	4,49110	0,1930	0,6686
Bone				
Ca	21,1669	2,12770	9,948	0,0043
P	1,76140	0,36140	4,874	0,0371
Mg	0,0000001	0,00150	0,000	0,9953
Mn	0,00000	0,00000	1,198	0,2846
Z	0,00001	0,00001	1,731	0,2007

Table 3. The statistical analyses of the serum- and bone-mineral values are given in Table 4. The analysis indicated that serum-Zn levels were significantly (a significance-probability level of $P < 0,05$) elevated in the affected birds as compared with normal birds, and that their bone-Ca and -P levels were significantly ($P < 0,05$) lower as compared with normal ostrich chicks. Analysis of the feed indicated a P level slightly above that suggested for broilers and a Mn level of half the minimum suggested value for broilers.

No difference in the serum- or bone-mineral analysis of male and female chicks between and within groups could be demonstrated.

DISCUSSION

During normal long-bone development, which is characterized by endochondral, sub-periosteal and endosteal ossification, the osteoid matrix is laid down by osteoblasts and is subsequently mineralized to form bone. Various microminerals, including Zn, function as co-enzymes in the process of osteoid-matrix formation, while hormones, including those of the parathyroid gland, play an important role in the mineralization of the osteoid. Deficient formation or poor mineralization of the osteoid matrix will lead to deficient bone formation and subsequent bone abnormalities.

When the mineral content of the feed used in the present study was compared with the mineral content of the Falstaff ratite feed of Flieg (1973) and with the diets used by Gandini *et al.* (1986), it was found that the Ca, P and Mg levels were about the same. The Mn, Cu and Zn contents, however, were substantially lower.

Van Heerden *et al.* (1985) and Levy *et al.* (1989) established normal serum-P and -Ca levels for ostriches of various ages and under varying management systems. In the present study the serum-Ca and -P levels of both affected and normal birds were found to be within the normal range reported by the previous two groups of researchers. This was to be expected as blood-Ca and -P levels are maintained at the cost of other tissues. Gandini *et al.* (1986) raised 20 ostrich chicks on four different rations and found that five chicks developed enlarged hocks and bowing of the tarsometatarsus at 6–7 weeks of age. Radiographically, the chicks showed widening and poor mineralization of the metaphysis and epiphyseal plate. The birds improved and showed increased mineralization after the administration of calcium borogluconate. Dietary deficiency in Ca was thus shown to be the cause of the bone abnormalities. In the present study the Ca and P content of the feed was found to be within the range suggested by Flieg (1973) and Gandini *et al.* (1986) and the serum-Ca and -P levels of affected and normal birds were within the normal limits established by Van Heerden *et al.* (1985) and Levy *et al.* (1989). However, the bone Ca and P of chicks with tibiotarsal rotation was significantly ($P < 0,05$) lower, compared with the values in normal chicks, despite the fact that they were raised on the same diet and that their serum-Ca and -P levels were normal.

Normal bone contains a significant amount of Zn. In the present study, the serum-Zn levels of affected birds were significantly ($P < 0,05$) elevated when compared with those of unaffected birds, despite the fact that both groups received the same food and that the Zn content of the feed was low. There was, however, no difference between the bone-Zn content of affected and normal birds. This can possibly be explained as an attempt by the body to produce more bone (osteoid or bone matrix) in response to the bone abnormality (poor mineralization) in the affected birds.

These results would appear to indicate poor mineralization of bone in the affected birds. The factors responsible for promoting poor bone mineralization in the affected birds were not determined in the present investigation.

The results of the present study indicate that the problem of tibiotarsal rotation is very complex and needs to be investigated further. An essential part of future research must be the establishing of normal serum-, bone- and other tissue- (e.g. liver) -mineral values of ostriches at various ages and stages of growth. All minerals involved in normal bone development and growth should be investigated and baseline values should be determined for all the areas where ostrich farming is undertaken. Other possible fields of investigation are the effect of rapid growth, age, sex, internal parasites, breeding season and genetics on the absorption and metabolism of the various minerals involved in bone formation.

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