Tropical Animal Health and Production, 31 (1999) 397–404

Limb Deformities of Farmed Ostrich (*Struthio camelus*) Chicks in Botswana

E.Z. Mushi*, M.G. Binta, R.G. Chabo, J.F.W. Isa and M.S. Phuti
Animal Science and Production Department, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana
**Correspondence*

Mushi, E.Z., Binta, M.G., Chabo, R.G., Isa, J.F. and Phuti, M.S., 1999. Limb deformities of farmed ostrich (*Struthio camelus*) chicks in Botswana. *Tropical Animal Health and Production*, **31(6)**, 397–404

ABSTRACT

Limb deformities were detected in 135 out of 885 ostrich chicks, giving a prevalence of 15.3%. Tibiotarsal rotation affected 73% of the chicks with limb deformities, whereas rolled toes accounted for 36%. The right leg was more often affected than the left leg. The incidence of limb deformities was highest in 2- to 3-week-old ostrich chicks. The incidence of limb deformities was highest at the beginning of the breeding season and lowest towards the end, when it was relatively warmer. The mean serum manganese and zinc levels in deformed ostrich chicks were higher than the levels reported for normal chicks.

Keywords: deformity, limb, nutrition, ostrich, protein, season, temperature

INTRODUCTION

Ostriches have long leg bones, which results in problems with bone growth and development being relatively common (Deeming *et al.*, 1996). Limb deformities have been identified as a major constraint on farmed ostrich production and the main cause of chick wastage both in Australia (More, 1996) and South Africa (Bezuidenhout and Burger, 1993). Limb deformities in ostrich chicks include a rotated or twisted leg, perosis, slipped tendon, straddle leg, rolled toes, bowed leg and rickets (Foggin, 1992). In many of these conditions, the affected chick cannot use one or both legs and, since an ostrich cannot hop on one leg, the affected chicks are culled, resulting in considerable financial losses to ostrich farmers. Although a prevalence of 5% is normal, a prevalence of over 30% has been recorded from some ostrich farms in Zimbabwe (Foggin, 1992). The causes of limb deformity are considered to be multifactorial (Bruning and Dolensenk, 1986; Reece and Butler, 1984). Genetics, nutrition and excessive growth rates of young ratite chicks due to overfeeding with high-protein diets have been implicated. Excessive growth rate is thought to be due to the fact that, after the ostrich eggs have been artificially incubated and hatched, the chicks are put on a high-protein diet. This results in the development of osteodystrophy, whereby there is rotation of the distal tibia, which progresses to luxation of the gastrocnemius tendon. The chick is then unable to stand or walk (Reece and Butler, 1984). Management factors that were implicated included inadequate exercise and deficiencies of calcium, phosphorus, vitamin E and selenium (Bruning and Dolensenk, 1986) as well as deficiencies of manganese, zinc (Wallach, 1970), methionine or choline. Nutritional factors, particularly those leading to very rapid growth, are considered a principal factor (Gandini *et al.*, 1986; Huchzermeyer, 1994).

Limb deformities in ostrich chicks on a commercial ostrich farm in the Lobatse district of Botswana were investigated during the breeding season of June 1997 to February 1998.

MATERIALS AND METHODS

The walking behaviour of ostrich chicks was observed during weekly visits to the ostrich farm. Each affected chick was clinically examined to identify any specific skeletal abnormalities of the affected limb or limbs. The ostrich chicks were kept in concrete pens with a 33 m run. They were fed on commercial ostrich starter mash and chopped lucerne was added. The composition of the starter mash was plant protein (cottonseed cake 20.0%), crude fibre 7.0%, calcium 1.5%, phosphorus 0.9%, lysine 1.0%. Water, to which a commercial formulation (Phenix Stresspac, Phenix SA Pty, South Africa) containing vitamins and electrolytes was added at a dose rate of 100 g per 200 litres, was provided *ad libitum*.

Blood was taken from some of the chicks with limb deformities. Normal chicks were not available for bleeding as a comparison. The brachial vein, the preferred site for venepuncture in ostriches, was exposed and cleansed using a cotton swab moistened with an aqueous solution of chlorhexidine gluconate (Savlon, Johnson and Johnson, East London, South Africa) followed by one moistened with 70% alcohol. The blood was then collected into vacutainer tubes (Becton Dickinson, Vacutainer Systems, France) without anticoagulant at the same hour, 10:00 to 11:00, on each occasion, in order to reduce possible variations associated with diurnal changes. The blood was allowed to clot for 1 h at room temperature and the serum was immediately harvested to minimize the diffusion of potassium and phosphorus from the clot. The serum was kept in 1 ml aliquots at 4°C for a maximum of 4 h before being analysed. Sampling was completed within the course of 1 month in order to avoid seasonal effects that influence the diet and the physiology of the birds.

The serum samples were analsed colorimetrically for copper and zinc with a UV spectrophotometer (Shimadzu 1601, Tokyo, Japan) using commercial kits for copper (Boehringer Mannheim Diagnostics, Germany) and for zinc (Wako Chemicals GmbH, Germany). Serum copper was determined using diethyldithiocarbamate as the chromogen, the resulting golden yellow complex being read at 440 nm. Serum zinc levels were quantified using an *in vitro* colorimetric method involving deproteinization with trichloroacetic acid. Thereafter, the zinc that is released binds to the chromogenic component, 2-(5-bromo-2-pyridylazo)-5-(*N*-sulphopropylamino)phenol, forming a reddish violet chelate whose absorbance when measured at a wavelength of 560 nm was directly proportional to the amount of zinc in the serum. The detailed protocols for both copper and zinc were as stipulated by the manufacturers of the kits, who also provided the control serum samples for the tests.

The manganese (Mn) content of the serum samples was determined by atomic absorption spectrometry (Model-Varian Techtron, Mulgrave, Australia) using a hollow-cathode lamp current of 4 mA, a slit width of 0.5 nm and the wavelength optimized at 279.5 nm. The average absorption was determined over a period of 5 s. The concentration of manganese in the sample was determined using a linear calibration curve (Clinical Science Diagnostics, South Africa). The analytes phosphorus, calcium and magnesium were determined using the Vettest 8008 dry chemistry analyzer (Iddex Laboratories, Westbrook, ME, USA).

Means, standard deviations and reference ranges, including outlying figures, were determined. Spearman's rank correlation was used to analyse the relationship between the environmental temperature and the incidence of limb deformities. Student's *t*-test was used to analyse the differences in the concentrations of metal irons in the serum of affected and normal chicks.

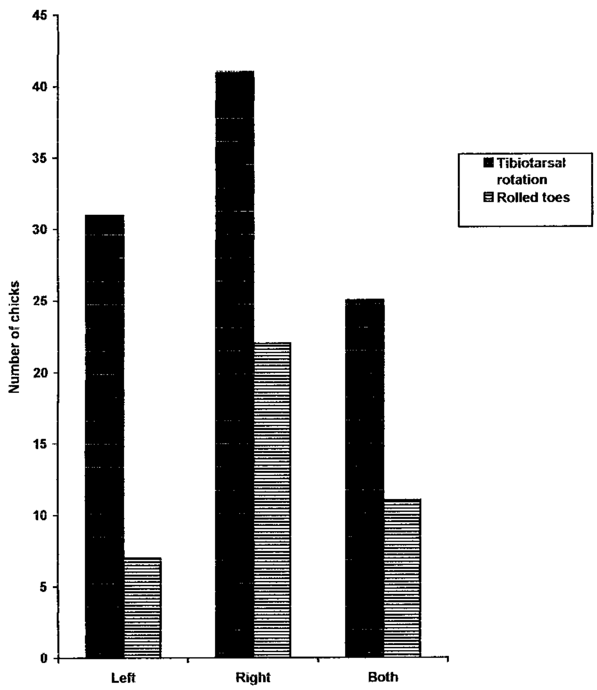

Figure 1. The side of the leg affected by deformity in ostrich chicks

RESULTS

In all, 135 out of 885 ostrich chicks (15.3%) had limb deformities. Two main types of limb deformities were encountered: tibiotarsal rotation and toe roll (Figure 1). In tibiotarsal rotation, the metatarsal bone had a lateral deviation, whereas in toe roll the toes pointed medially. Overall, tibiotarsal rotation affected 99 (73.3%) of the 135 chicks with limb deformities, while 36.3% had involvement of the toes. No cases of bowed leg or of rickets were observed. The right leg was most commonly affected by tibiotarsal rotation (Figure 1). There were some chicks in which both legs were affected, giving rise to splayed legs; such chicks constituted 25% of all those with limb deformities. Palpation of the affected limbs did not reveal any clinical signs of inflammation.

The incidence of tibiotarsal rotation reached peak levels at weeks 2 and 3 (Figure 2). The lowest incidence was recorded at 10 weeks of age, no cases being observed thereafter. A few chicks were hatched with deformed limbs, which was attributed to incubation problems since such chicks were among the weak hatchlings. Figure 3 shows that the incidence of leg deformities was highest at the beginning of the breeding season. About 44 of the 135 chicks with limb deformities were recorded in August, compared to only 5 each for January and February. With the onset of summer, as the

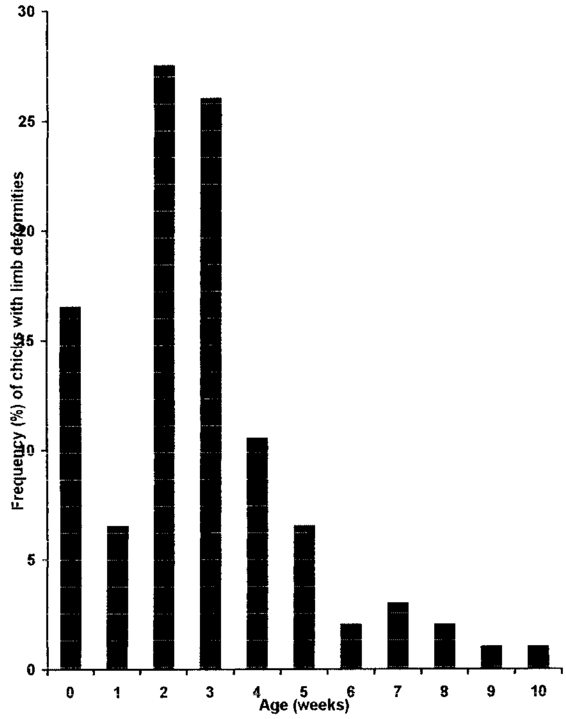

Figure 2. The distribution of the ages at which ostrich chicks developed signs of leg deformity

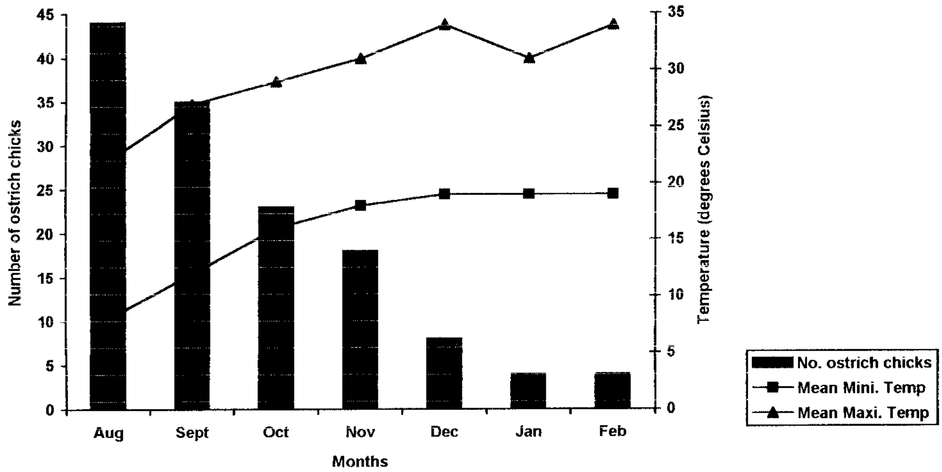

Figure 3. Relationship of leg deformities to maximum and minimum temperatures (August–February)

TABLE I
Mean and range of the serum mineral levels

Minerals	Affected chicks Mean ± SD	Range	Normal chicks Mean[a]	Range[a]
Ca (mmol/L)	2.310 ± 0.21	(1.19–2.99)	2.276	(1.60–2.28)
P (mmol/L)	2.125 ± 0.50	(1.20–3.38)	1.975	(1.47–3.42)
Mg (mmol/L)	1.031 ± 0.16	(0.80–1.31)	0.874	(0.61–0.99)
Mn (μmol/L)	0.60 ± 0.06	(0.56–1.28)	0.3672	(0.32–0.67)
Zn (μmol/L)	35.40 ± 4.30	(30.58–43.43)	10.608	(6.28–19.16)
Cu (μmol/L)	4.11 ± 0.09	(0.62–7.60)	4.236	(1.98–6.04)

[a]Source: Bezuidenhout *et al.* (1994)

minimum temperatures increased, the number of chicks with leg deformities declined. This correlation was expressed by Spearman's rank correlation, whose r values for minimum and maximum temperatures were –0.77 and –0.72, respectively. The respective p values were 0.05 and 0.09.

The concentrations of calcium, phosphorus, magnesium, manganese, zinc and copper in the serum of the affected chicks are shown in Table I, where they are compared with those previously reported for normal chicks.

DISCUSSION

The limb deformities in 15.3% of ostrich chicks raised during one ostrich breeding season were the single most important cause of chick losses, for such chicks were culled. A sporadic incidence of 5% has been reported from Zimbabwe (Foggin, 1992). In South Africa, Bezuidenhout and Burger (1993) reported an incidence of 6.3%, while More (1996) reported an incidence of 6.3% among ostrich chicks in Australia. Other workers have reported that the right leg was more commonly affected, Bezuidenhout and Burger (1993) finding that 85 out of 89 chicks had a right leg deformity. In chickens, Riddell and Stringer (1985) reported that 44% of broiler chicks had right leg deformities and 15% had both legs affected. The high rate of tibiotarsal rotation in the ostrich chicks at 2–3 weeks of age might be due to their rapid growth rate. In a previous study on the same ostrich farm, the metatarsal bone of ostrich chicks was shown to grow at the rapid rate of 2.5 cm per week in the first 10 weeks of life (Mushi *et al.*, 1998). Other workers have reported the peak incidence of limb deformities to be around 2 weeks of age (Bezuidenhout and Burger, 1993) and between 4 and 7 weeks of age (Foggin, 1992). This may have been related to the eggs laid at the beginning of the breeding season. However, there was also a significant negative correlation between the incidence per month and temperature. It was also found that the highest number of limb deformities was reported when the environmental temperature was relatively low at 6°C (minimum) and 21°C (maximum), thereafter declining with the onset of warm summer weather.

Trauma has been implicated as a possible cause of tibiotarsal rotation as the cartilaginous growth plate can easily be damaged (Deeming *et al.*, 1996). However, in this study there was no soft-tissue swelling in the affected limbs.

The levels of serum calcium, magnesium and phosphorus in chicks with deformities in this study were comparable to those obtained for normal chicks by several workers (Van Herdeen *et al.*, 1985; Levy *et al.*, 1989; Bezuidenhout *et al.*, 1994). The mean level of serum copper in the deformed chicks was slightly low though within the range reported for normal chicks, but the mean and the ranges for manganese and zinc were higher in chicks with limb deformities than in the normal chicks. Normal long bone development is characterized by endochondral, subperiosteal and endosteal ossification. Osteoid matrix is laid down by osteoblasts and subsequently mineralized to form bone. A deficiency in one or more of the above minerals may contribute to limb deformities as a result of poor mineralization (Squire and More, 1998). The elevated levels of these minerals in the serum of birds with leg deformities was a paradoxical finding. Kaneko (1989) reported that muscle catabolism due to muscular dystrophy may result in an increase in the levels of plasma zinc. Since levels of selenium and vitamin E were not determined, their possible involvement in these deformities could not be ruled out.

Although the exact cause of limb deformities in ostrich chicks was not conclusively determined, it is recommended that hatching of ostrich eggs should be carried out when the ambient temperatures are warm, as only a few cases of limb deformities were seen in chicks raised during the warmer months. This is in agreement with the observations of Kreibich and Sommer (1995), who also found that leg deformities depended on the season and that fewer leg problems were encountered in ostriches reared during the summer months than in those reared during the winter months.

ACKNOWLEDGEMENTS

This study was financially supported by the Research and Publications Committee of the Botswana College of Agriculture.

REFERENCES

Bezuidenhout, A. and Burger, W.P., 1993. The incidence of tibiotarsal rotation in the ostrich (*Struthio camelus*). *Journal of the South African Veterinary Association*, **64**, 159–161

Bezuidenhout, A.J., Burger, W.P., Reyers, F. and Soley, J.T., 1994. Serum and bone mineral status of ostriches with tibio tarsal rotation. *Onderstepoort Journal of Veterinary Research*, **61**, 203–206

Bruning, D.F. and Dolensenk, E.P., 1986. Ratites (Struthioformes, Casuariformes, Rheiformes, Tinaformes and Apterygiformes). In: M.E. Fowler (ed.), *Zoo and Wild Animal Medicine*, (WB Saunders, Philadelphia), 277–291

Deeming, D.C., Dick, C.K. and Ayres, L.L., 1996. Veterinary problems, diseases and chick mortality. In: D.C. Deeming, A.C.K. Dick and L.L. Ayres (eds), *Ostich Chick Rearing, A Stockman's Guide*, (Hangford Farm Ostriches Ltd and The Croft Veterinary Centre, Banbury, UK), 85–103

Foggin, C.M., 1992. Veterinary problems in ostriches. In: M.G. Hallam (ed.), *The Topaz Introduction to Practical Ostrich Farming*, (The Producers Association of Zimbabwe, Harare), 61–96

Gandini, G.C.M., Burroughs, R.E.J. and Ebedes, H., 1986. Preliminary investigation into the nutrition of ostrich chicks (*Struthio camelus*) under intensive conditions. *Journal of the South African Veterinary Association*, **57**, 39–42

Huchzermeyer, F.W., 1994. Nutritional diseases. In: F.W. Huchzermeyer (ed.), *Ostrich Diseases*, (Agricultural Research Council, Onderstepoort), 48–58

Kaneko, J.K., 1989. Trace elements. In: J.K. Kaneko (ed.), *Clinical Biochemistry of Domestic Animals*, 4th edn, (Academic Press, New York), 753–795

Kreibich, A. and Sommer, M., 1995. Miscellaneous. In: A Kreibich and M. Sommer (eds), *Ostrich Farm Management*, (Landwirtschaftsverg, GmbH, Munster-Hiltrup, Germany), 166–169

Levy, A., Perelman, B., Waner, T., Van Grevenbroek, M., Van Creveld, C. and Yagil, R., 1989. Reference blood chemical values in ostriches (*Struthio camelus*). *American Journal of Veterinary Research*, **50**, 1548–1550

More, S.J., 1996. The performance of farmed ostrich chicks in eastern Australia. *Preventive Veterinary Medicine*, **29**, 91–106

Mushi, E.Z., Isa, J.F.W., Chabo, R.G. and Segaise, T., 1998. Growth rate of ostrich (*Struthio camelus*) chicks under intensive management, Botswana. *Tropical Animal Health and Production*, **30**, 197–203

Reece, R. and Butler, R., 1984. Some observations of the development of long bones of ratite birds. *Australian Veterinary Journal*, **61**, 403–405

Riddell, C. and Stringer, R., 1985. An epizootiological study of acute death syndrome and leg weakness in broiler chickens in Western Canada. *Avian Disease*, **29**, 90–102

Squire, B.T. and More, S.J., 1998. Factors on farms in Eastern Australia associated with the development of tibiotarsal rotation of ostrich chicks. *Australian Veterinary Journal*, **76**, 110–117

Van Heerden, J., Dauth, J., Jarvis, M.J.F., Keffen, R.N., Denny, J.E.F.M., Dreyer, M.J. and Kriek, N.P.J., 1985. Blood chemical and electrolyte concentrations in the ostrich *Struthio camelus*. *Journal of the South African Veterinary Association*, **54**, 53–54

Wallach, J.D., 1970. Nutritional diseases of exotic animals. *Journal of the American Veterinary Medical Association*, **157**, 583–599

(Accepted: 21 February 1999)

Difformités des membres de jeunes autruches (*Struthio camelus*) elevées en ferme au Botswana

Résumé – Des difformités des membres furent observées chez 135 des 885 autruches étudiées donnant un pourcentage de 15,3%. La rotation tibia-tarse affecta 73% des jeunes, avec des retournements des doigts représentant 36% des difformités. La jambe droite fut plus souvent déformée que la gauche. Le pourcentage de difformités fut plus important pour les jeunes de 2 à 3 semaines. Les difformités furent plus importantes au début de la saison de reproduction qu'à la fin de celle-ci quand la température est plus élevée. Les moyennes en manganèse et zinc dans le sérum furent plus élevées chez les animaux ayant des difformités que chez ceux apparemment normaux.

Deformidades en las extremidades de polluelos de avestruces de granja (*Struthio camelus*) en Bostwana

Resumen – Se detectaron deformidades en las extremidades de 135 de un total de 885 polluelos de avestruz, con una prevalencia del 15,3%. La rotación tibiotarsal aparece en el 73% de los polluelos con deformidades en las extremidades, mientras que el enrollamiento de los dedos en el 36%. Las deformidades aparecen en mayor proporción en la pierna derecha que en la izquierda. La incidencia de deformidades en los miembros es mayor al principio de la época de reproducción y disminuye hacia el final, cuando el clima es relativamente más cálido. Los niveles medios de manganeso y zinc en los polluelos de avestruz deformes son mayores que en los animales normales.