IJAE
Vol. 118, n. 3: 298-302, 2013
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Research Article: Veterinary Anatomy Case Report

A case of polydactyly in the hind-limbs of a West African Dwarf goat in South-West Nigeria

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Submitted December 21, 2012; accepted revised March 12, 2013

Summary

This report describes a case of polydactyly in the hind-limb of a West African Dwarf goat kid in South West Africa. Physical examination revealed the presence of four digits in each of the hind limbs. Radiological examination and macerated bones of the animal showed a bifid shape of each metatarsal that was more prominent from the distal half of the diaphysis. This resulted in the presence of four articulating surfaces per limb at the distal extremity. Though this condition is rare in goats, we advise that continuous reporting by researchers can give a better prevalence statistics of these occurrences.

Key words

Congenital abnormalities, limb deformity, metatarsal

Introduction

Polydactyly is a condition where extra digits are formed in limb extremities of an animal. It is a rare condition in the ruminants (cattle, sheep and goat). Polydactyly is associated with musculoskeletal and several genetic syndromes (Farrell et al., 1996). Although some limb malformations are being attributed to genetic causes in domestic animals, the mechanisms by which genetic mutations are translated to limb developmental abnormalities are largely unknown (Hyttel et al ., 2010). The occurrence of polydactyly by itself has been associated with autosomal dominant mutation of single genes.

Goats usually possess a single metatarsal, formed from the embryonic metatarsal III and IV while metatarsal I, II and V regress. On either side, each of the two articular surfaces of the existing metatarsal bears a single phalange (phalange I); phalanges II continues from I and subsequently phalanges III continues from the latter (Dyce et al., 2002).

We report here the occurrence of polydactyly in the hind limbs of a goat resulting from a bifid expression in the distal extremity of the metatarsals.

Case history, necropsy and radiological findings

A young kid (4-6weeks) was found by the owner to have abnormal limb morphology and was subsequently brought to the Faculty of Veterinary Medicine, University

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Figure 1 – Hind limbs of a West African Dwarf kid goat showing four digits (arrows) per limb.

of Ibadan. Physical examinations revealed the presence of four digits in each of the hind limbs (Fig. 1).

Radiological examination of the animal showed a bifid shape of each metatarsal that was more prominent from the distal half of the diaphysis. This subsequently resulted in the presence of four articular surfaces per limb at the distal extremity. The four articular surfaces were occupied by four proximal phalanges to which four middle and four distal phalanges per limb followed (Fig. 2).

The animal later died, probably from septicemia, and was preserved by cryoprotection. Later, dissection was done to observe any organ anomalies, of which none was found. The bones of the hind limbs were then prepared using a modification of hot water maceration technique of Olopade et al (2011). The morphology of the metatarsal was consistent with that observed in the radiograph (Fig. 3).

Discussion

Polydactyly is reported to be a genetic defect of cattle and sheep amongst ruminants (Hyttel et al; 2010). It is a much rare occurrence in goats. The occurrence of

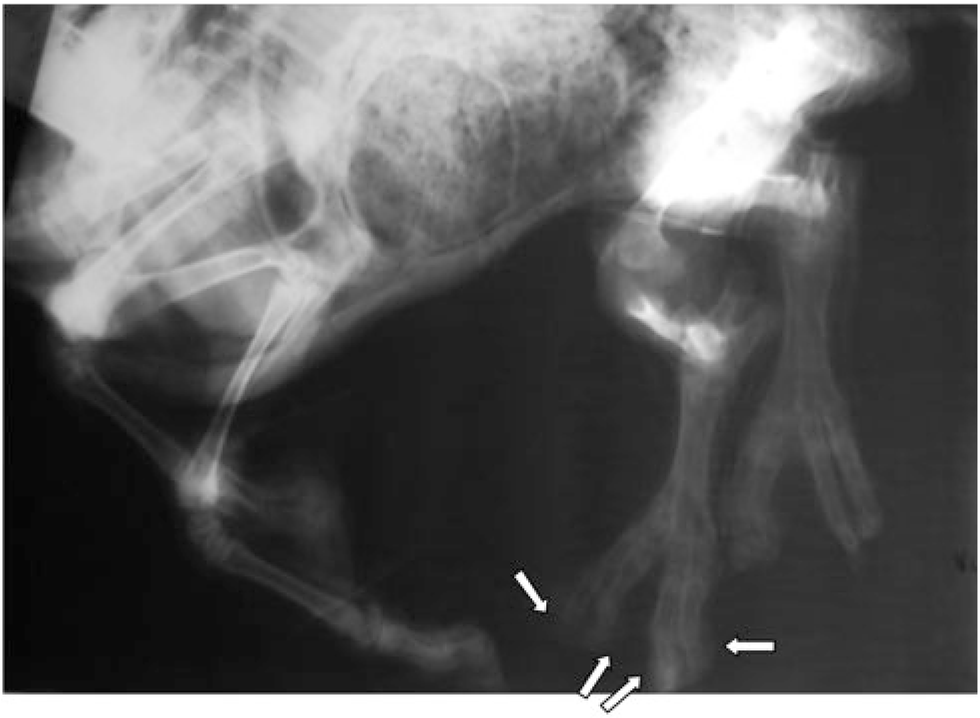

Figure 2 – Radiograph of the same West African Dwarf kid goat as figure 1, showing four digits (arrows) in each Hind limb.

this prodactyly in hind limb means that this limb dysmorphogenesis appeared later in development than when the forelimb metatarsal had formed, as hind limb development usually occurs 24-48 hours behind that of the forelimbs (Hyttel et al; 2010).

Limb formation starts from a restricted outgrowth of mesoderm in the embryo (the limb bud) which is covered by ectoderm. At the tip of this ectoderm is the thick apical ectodermal ridge (AER) (Hyttel et al., 2010). In the mesoderm, at the caudal border of the AER is an area called the zone of polarizing activity (ZPA). The cells of ZPA secrete retinoic acid which stimulates the expressions of sonic hedgehog (Shh) protein (Gilbert., 2010; Hyttel et al., 2010). Shh is responsible for specifying digit pattern (Riddle et al., 1993) and its knock-out results in the loss of all digits except the first (i.e, the thumb), which does not require Shh for its development (Chiang et al., 1996, Chiang et al., 2001). On the other hand, over expression of Shh is known to lead to mirror image duplication of the limb (Lopez-Martinera et al., 1995; Gilbert., 2010) as is reported in this case. In fact, it has recently been reported that the patterning activity of Shh may occur in the very early limb bud, with Shh responsible solely for driving cell proliferation during later limb development (Towers et al., 2008; Zhu et al., 2008).

Retinoic acid (RA) is another factor important for limb development (Mic et al., 2004). It is known to act as a ligand which controls the action of nuclear retinoic acid

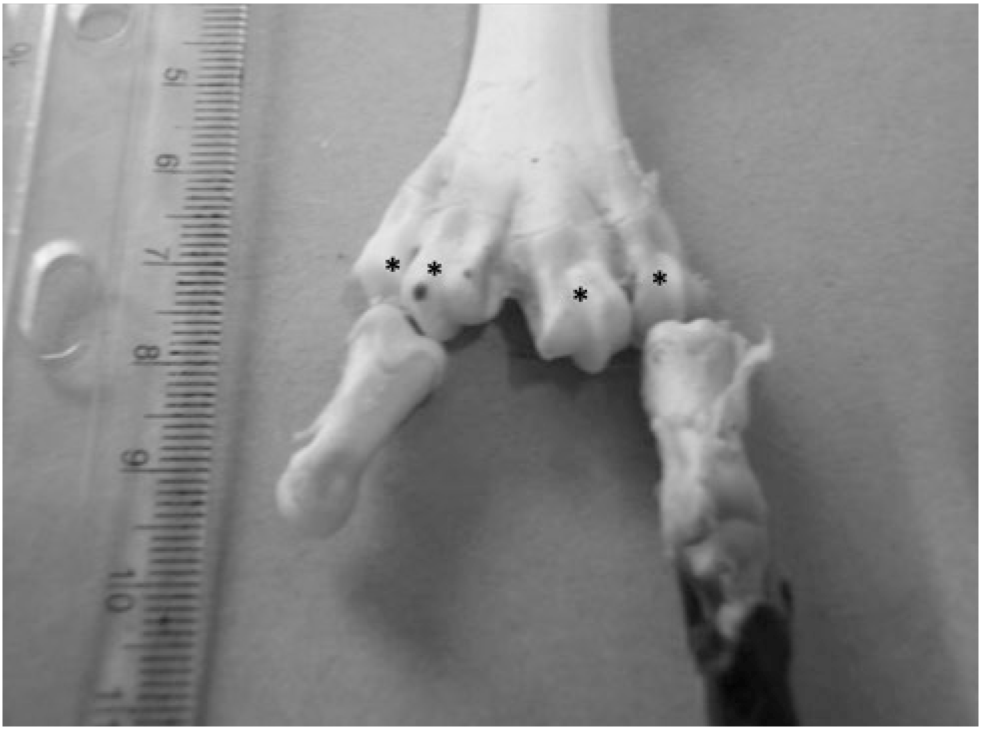

Figure 3 – Macerated metatarsal of the same West African Dwarf kid goat as figures 1 and 2, with polydactyly. Note presence of four condylar projections (asterisks) at the distal end of each radius.

receptors essential for vertebrate embryonic development (Zile, 2001; Clagett-Dame and DeLuca, 2002). A role for RA in limb bud development was proposed after it had been observed that exogenous RA generated proximodistal duplications when administered to the blastema of regenerating axolotl limbs (Maden, 1982) and also anteroposterior duplications when injected into the anterior region of chick limb buds (Tickle et al., 1982). In the latter, exogenous RA was found to induce Shh expression in the ZPA (Riddle et al 1993). More precisely, exogenous RA first induces the transcription factor dHand and then Shh; dHand is required for Shh induction in limb buds in the chick and mouse (Charité et al., 2000; Fernandez-Teran et al., 2000). These findings suggest that Shh activation by RA may be indirect (Mic et al., 2004).

The occurrence of mirror image duplication in goat is rarely reported. In most cases of polydactyly in ruminants, it is usually due to persistence of metatarsal II with its phalanges and not to a dew-claw. The presence of decubital sores on the plantar surface of the digits later in life of the kid is an indication that the duplication of the digits was probably inimical to its mobility. There is evidence that congenital abnormalities are under reported in Nigerian ruminants (Olopade et al., 2010) and continuous reporting by researchers can give a better statistics of the prevalence of these occurrences.

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