Supernumerary ectopic limbs in Korean indigenous cattle: four case reports

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ABSTRACT: Four head of Korean indigenous cattle were presented to the Chonbuk Animal Medical Centre, Chonbuk National University, with the complaint of the presence of extra limb(s) since birth. The accessory limb(s) were underdeveloped in all the cases and attached to the lateral side of the withers craniodorsal to the right scapula in Case 1 and 2; in Case 3, right dorsally to the 4th cervical vertebra and in Case 4 it was ventrolateral to the thorax caudally to the right forelimb. In all the cases, the congenital anomaly was diagnosed as the presence of supernumerary ectopic limb(s) (SEL), which were removed by surgical excisions under general anaesthesia. In all the cases, the surgical corrections resulted in normal locomotion and better quality of life. No postoperative complications were observed during a 1-year follow up period. The SEL can be successfully removed by surgical excisions, which can result in normal locomotion and better aesthesis of the animal.

Keywords: supernumerary limbs; polydactyly; congenital anomaly; cattle

A number of different congenital anomalies are known to occur in domestic cattle (Newman et al., 1999; Noh et al., 2003). Congenital abnormalities may be multiple or may affect single parts of organ systems. Multiple congenital anomalies often occur because the malformation of one part of the body leads directly to the malformation of another part (Camon et al., 1990). These anomalies are associated with genetic factors (transgenes, chromosomes), environmental agents (infections, toxins, fertilization techniques, management) or a combination of factors (Keeler et al., 1981; Rousseaux and Ribble, 1988; Newman et al., 1999). Supernumerary ectopic limb(s) (SEL) is a congenital anomaly which is defined as the presence of accessory limb(s) attached to the various body regions (Hiraga et al., 1989; Fourie, 1990). Polymelia in symmetrical twins of cattle displays the presence of six or eight legs according to the degree of their attachment (Hossain et al., 1980; Singh et al., 1989; Kim et al.,

2001). In heterotopic polymelia there are one or two supernumerary legs attached to the various body regions and are classified as notomelia, cephalomelia, thoracomelia and pygomelia (Leipold et al., 1983; Rahman et al., 2006).

Congenital malformations of the limbs are among the most frequent congenital anomalies found in humans and animals, and they preferentially affect the distal part (Leipold and Dennis, 1987; Talamillo et al., 2005). The presence of extra digits or toes, a condition called polydactyly, is the most common limb deformity in humans and is the consequence of disturbances in the normal program of limb development. The anomalies in the number of digits can appear as an isolated condition or be a part of a systemic syndrome (Bahr et al., 2003; Talamillo et al., 2005). The frequency of individual defects varies with the species, breed, geographic location, season and other environmental factors. The incidence is reported to range from 2 percent to

3.5 percent of all births in calves, lambs and foals. Leipold et al. (1983) reported the occurrence of congenital defects in cattle involving the musculoskeletal system 24%, respiratory and alimentary tracts 13%, central nervous system 22%, abdominal wall 9%, urogenital system 4%, cardiovascular system 3%, skin 2%, and others 4%.The presence of SEL is rare in cattle and there are a few, if any, reports on such incidences in Korea. The purpose of this case report is to present the signalment, clinical signs, surgical management and prognosis of SEL in four head of Korean indigenous cattle.

Case presentation

Four head of Korean indigenous cattle were presented to the Chonbuk Animal Medical Centre, Chonbuk National University, with the complaint of the presence of extra limb(s) since birth. The accessory limb(s) were underdeveloped in all the cases. On physical examination the cattle were found quite normal except for the presence of the additional limb(s). Case 1 was a two weeks old male calf having an underdeveloped accessory limb attached to the lateral side of the withers craniodorsal to the right scapula (Figure 1). Case 2 was a 6 years old cow with an additional limb having 6 digit-like projections and attached to the lateral side of the withers craniodorsal to the right scapula (Figure 2). In Case 3 (4 years old cow), two accessory limbs were attached right dorsally to the 4th cervical vertebra (Figure 3). In Case 4 (5 months old female

calf) had an additional limb ventrolateral to the thorax caudally to the right forelimb (Figure 4). The pulse, respiration and rectal temperature were normal in all cases. The blood samples collected were subjected to complete blood count (CBC) and chemistry screening (CS) and the values were found within the reference range. In all the cases, the congenital anomaly was diagnosed as the presence of supernumerary ectopic limb(s). In all the cases, the SEL were removed by surgical excisions under general anaesthesia. The cattle were anesthetized administering atropine sulphate (Atropine Sulfate®, Huons Co. Ltd., Korea) 0.04 mg/kg, *s.c.*, and xylazine hydrochloride (Rompun®, Bayer Korea Ltd.) 0.06 mg/kg, *i.v.* The animals were then placed on lateral recumbency and the surgical areas (lateral side of the withers craniodorsal to the right scapula in Case 1 and 2; in Case 3, right dorsal neck and in Case 4 ventrolateral thorax) were cleaned, shaved and prepared with 7.5% povidone-iodine surgical scrub. Supportive fluid therapy was maintained throughout the procedure. A semicircular incision was made around the base of the accessory limb, the fascia and muscles were carefully dissected to reach up to the articulation. The larger blood vessels were double ligated and severed and the small bleeders were cauterized. Then the limb was detached (Figure 5) and the wound was closed in a routine manner.

Postoperatively amoxicillin (Augmex®, United Pharmaceutical Ltd., Korea) 10 mg/kg *i.m.* was administered every 8 hours for one week. The skin sutures were removed after one week.

Figure 1. The presence of an underdeveloped accessory limb craniodorsal to the right scapula in Case 1

Figure 2. The presence of a polydactylous (6 digits) ectopic supernumerary limb craniodorsal to the right scapula in Case 2

Figure 3. The presence of two under-developed accessory limbs right dorsal to the 4th cervical vertebra in Case 3

The recovery from anaesthesia was uneventful in all the cases. The healing of the surgical wounds was also normal. The physical examination of the animals was performed after one month and one year postoperatively and they were found quite normal. In all the cases, the surgical corrections resulted in normal locomotion and better quality of life. No postoperative complications were observed during a one -year follow up period.

DISCUSSION

The congenital anomalies of limb structure or function that are present at birth occur relatively frequently in cattle (Hossain et al., 1980; Leipold and Dennis, 1987; Singh et al., 1989). These defects can result from either defective genetics or from a genetic insult/agent that is associated with the foetal environment or from their interaction; these defects are classified as lethal, sub-lethal and non-lethal (Leipold et al., 1983). The susceptibility to an injurious environmental or to genetic agents varies with the stage of development and between species, and the susceptibility decreases with the advancement of foetal age. The signalment and clinical signs of the SEL and polydactyly in our cases are in full agreement with previous reports of similar cases in cattle (Hiraga et al., 1989; Fourie, 1990; Kim et al., 2001; Bahr et al., 2003; Rahman et al., 2006).

Figure 4. The presence of an additional limb ventrolateral to the thorax caudal to the right forelimb in Case 4

Figure 5. The amputated accessory limb in Case 4 revealed polydactylism (3 digits)

The first morphological evidence of a limb during embryonic development is the emergence of a bulge at the appropriate level in the lateral body wall. This bulge will rapidly form a bud consisting of mesenchymal cells of mesodermal origin that are covered by the ectoderm. The main source of the limb mesoderm is the somatopleura, but other contributions come from the migration of muscle precursors from the somites and from the progressive invasion of the limb bud by endothelial and nerve cells. This apparently simple bud will develop into a complete and patterned limb under the control of a few well-identified signalling centres. Signalling centres are specialized groups of cells that produce and secrete molecules to direct the developmental behaviour of neighbouring cells. The three main signalling centres identified in the growing limb bud are the apical ectodermal ridge (AER), the zone of polarizing activity (ZPA), and the non-ridge ectoderm, each being primarily responsible for directing the growth and patterning along one of the three orthogonal axes (Talamillo et al., 2005). Any alterations in the signalling centres due to genetic, toxic or environmental factors during limb development can cause congenital anomalies of the limb.

The digits are a novel evolutionary acquisition of the limb. The cellular and molecular mechanisms controlling the formation of the correct number of digital rays are not completely understood. During embryonic development, they arise as single chondrogenic condensations that later segment and grow. In the rounded digital plate (autopodium), the digits soon become demarcated and form the digital rays that are separated by the flattened interdigital tissue. The fate of the cells in these two regions is very different; while the digits form in the digital rays, the interdigital tissue will disappear through apoptosis. Interestingly, the cell death fate of the interdigit can be experimentally diverted to form a digit if the appropriate signals are provided. Indeed, the simple generation of a wound in the interdigital tissue is sufficient to activate the chondrogenic phenotype resulting in an extra digit. As indicated above, a polydactylous limb implies some kind of interference with normal development. Because the control of digit morphogenesis is complex and remains labile for a considerable time, the possibilities for interference are numerous. The number of digital rays that develop in the autopodium depends on the amount of the tissue available. Thus, the control of the size of the limb bud

is of decisive importance. Three factors strongly influence the size of the limb bud: (i) the number of progenitors that start up the bud, (ii) the rate of proliferation, and (iii) the amount of cell death. The deregulation of these factors results in a subsequent modification in the pattern of the autopodium and the number of digits (Talamillo et al., 2005).

Congenital malformation sometimes leads to perinatal mortality, and it may also decrease maternal productivity and reduce the value of defective neonates. Severe defects result in the abortion of the calf or a return to the service of the calf and cow (Rousseaux, 1994). Skeletal defects are common, and the skeletal system may be affected in its entirety or with single, isolated defects (Leipold et al., 1983; Leipold and Dennis, 1987). Congenital anomalies with accessory limbs and digits occur very rarely in cattle and there are few, if any, reports on such incidences in Korea. The animals with supernumerary ectopic limbs and supernumerary digits can survive successfully with normal locomotion and better aesthesis if the surgical excision is performed under proper aseptic conditions and appropriate postoperative care is taken (Hossain et al., 1980; Singh et al., 1989; Fourie, 1990; Rahman et al., 2006). The cases reported here describe the successful surgical excision of supernumerary limbs in four Korean indigenous calves. The surgical corrections resulted in normal locomotion and better quality of life.

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