Occurrence of Polymelia in 9-Week-Old Male Broiler: Anatomical and Radiological Aspects

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With 4 figures

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Abstract

Polymelia was described in a 9-week-old broiler chicken macroscopically and radiographically. The external features showed two normal limbs and one undeveloped extra-limb. This extra-limb was attached to the caudal region of the pelvic bone and was surrounded by a mass of muscular tissue. The extra-limb was formed at a joint with the pelvis, presenting a characteristic incompletely duplicated femur and tibia. Radiographical examination showed that the right half of the pelvis had an extra femur which was attached to the acetabulum in addition to the normal femur. Two other femurs were observed to have articulated with the pelvis at a point caudal to the right acetabulum. This phenomenon is very rare in chickens. Our findings, therefore, document the first report on the occurrence of polymelia in broilers in the Federal Capital Territory of Nigeria.

Keywords

Polymelia, Poultry, Radiography, Anatomy, Occurrence

Introduction

Congenital malformations of the limbs are among the most frequent congenital anomalies found in animals and humans (Alam et al., 2007). They may be multiple or may affect single parts of organ systems. Congenital anomalies of the skeletal system are common in domestic animals and birds (Arunprasad et al., 2009). However, the precise mechanism that regulates their development is not yet clearly understood (Bahador et al., 2007). These anomalies are usually associated with genetic factors including transgenes, chromosomes, and environmental agents including infectious agents, toxins, techniques involved in fertilization and certain management factors or a combina-
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Polymelia is a congenital anomaly which is defined as the presence of accessory limb(s) attached to the various body regions and could be classified as cephalomelia (extra limb attached to the head), notomelia (extra limb attached to the back bone), thoracomelia (extra limb attached to the thorax) and pygomelia (extra limb attached to the pelvis) based on the region affected (Leipold et al., 1983; Arunprasad et al., 2009; Hiraga et al., 1989; Fourie, 1990). Polymelia has been reported in human, mouse, chicken, calf and lamb around the world (Anderson et al., 1985; Herec et al., 1986; Harinarayana, 1992; Bahador et al., 2007). To the best of our knowledge, this is the first report of a notable case of polymelia in chickens in Gwagwalada, FCT. As at present, there is no definitive etiologic knowledge of its origin. The understanding as to whether it is caused by genetic or environmental factors, or both, is not clearly known but it is confirmed that the susceptibility to an injurious environmental factors or to certain genetic agents varies with the various stages of bone development between species (Rahman et al., 2006). This could be a notable cause of this condition in chickens.

The aim of this article is to deduce the anatomic and radiologic facts of this case of polymelia in a fully grown broiler and to outline possible causes of the defect in birds with a view of preventing future occurrences.

Case Description

A nine week old broiler chicken was delivered to the Ambulatory unit of the Veterinary Teaching Hospital, University of Abuja, Nigeria, with the chief complaint of the presence of an extra limb in the caudal pelvic region. History revealed that the bird was raised with thirty others in a locally constructed wooden cage system and fed on broilers mash preparation. The bird grew and reached slaughter weight without any other problems. The aberration was presented with a request for its amputation.

Clinical examination revealed that the extra limb was attached to the
caudo-dorsal region of the pelvis on
the right side of the hip (Fig. 2). Its
cranio-caudal axis of development
was rotated in an angle of about 30
degrees in relation to the normal
limb. The proximal part of the limb
faced medial. The distal part of the
limb ended with two digits as seen
in Figure (3). Normal mass of mus-
cles and connective tissues were
palpated at the limb area especially
in its proximal aspect. No movement
and pain response was observed
during clinical examination. The an-
imal was in an apparently good
state and no other anomaly was ob-
served physically. Yet it was not
able to use the extra limb accord-
ingly.

Radiographic examination was used
to determine the degree of malfor-
mation in the limbs as well as the
type of articulation in both long
bones and digits. A radiograph was
taken in a ventrodorsal position with
exposure factors (50 Kv, 300 mA,
and 15 seconds). This was done
with the use of a fixed x-ray ma-
chine (SIEMENS, 83 75 040 G2107,
Made in Germany). Radiographic
and processing protocol was con-
ducted according to the method do-
cumented by Hassan and Hassan
(2003).

The radiographs revealed the pres-
ence of four femoral bones. The first
femural bone was normal with a
normal tibia attached to it. The
second femur had the same pelvic
articulation as the first. The third
and fourth femur bones had a
common point of articulation caudal
to the right acetabulum. However,
the fourth limb appeared to be the
most developed of the extra limbs
(Fig. 4). It articulated with a rud-
imentary tibia distally and protruded
externally. This externally visible
limb ended up with two digits as
seen in Fig (3).

Upon gross dissection of the normal
limb, muscles groups of the hip and
thigh including the coxocrural ex-
tensors, femorocrural extensors,
coxofemoral extensors, coxocrural
flexors, coxofemoral flexors and fe-
morocrural flexors appeared normal.
The extra limb ‘D’ (Fig. 4) was ex-
actly similar but not well developed.

Discussion

Limbs develop at definitive posi-
tions. Limb formation begins with
the activation of a group of mesen-
chymal cells in the somatic lateral
mesoderm. The Apical ectodermal
ridge produces fibroblast growth
factor, which interacts with the un-
derlying mesoderm to promote out-
growth of the limb by stimulating
mitosis (Sinowatz, 2010). As much
as the specific etiology of this tera-
tologic defect is not precisely
known, we suspect that some teratogens may be capable of stimulating mitosis at multiple sites.

Similar limb malformations have been linked to certain environmental and some genetic factors, teratogenic agents and drugs or to their combinations (Albarella et al., 2009). The occurrences of such defects in domestic birds such as broilers suggest that there are some widespread environmental factors that may be contributing to this problem. The increased concern and attention to these abnormalities by Veterinarians and field Biologists might assist in identifying their etiology. However, some common and seemingly overlooked environmental pollutants such as Polychlorinated Biphenyl Compounds (PCB) and mercury have also been incriminated in the cause of this congenital problem (Hays and Risebrough, 1972). PCBs for instance, are a class of organic compounds that are used as components of paints, cement, pesticides, cutting oils, hydraulic fluids, PCB-containing wooden floor finish and carbonless copy paper (Rudel et al., 2008). This class of organic compounds could generally acts by inhibiting estradiol, an effect capable of leading serious developmental problems including skeletal developmental issues (Rudel et al., 2008). However, to establish a relationship between defect and concentration of chemicals/extent of exposure, a large number of birds will have to be researched.

The exact cause of the deformity observed in our case study was not clear. In addition to the suspicion of environmental influence, genetic factors could also be considered. These could be from either defective genetics or from genetic agents that were associated with the foetal environment or from their interaction. It may have been transmitted vertically. This is because malformations represent an error that may have occurred early in development (Meteyer, 2000; Alam et al., 2007). However, in making this consideration, knowledge of normal developmental principles is necessary to design thoughtful investigations that will define the events involved in abnormal development in birds. This is because susceptibility to genetic agents varies with the stage of development and between species, and this susceptibility decreases with the advancement of foetal age (Alam et al., 2007; Rahman et al., 2006). In birds, development begins at the time an egg is fertilized and progresses by chemical communication between cells and cell layers. This communication is programmed through gene expression. Malforma-
tions, thereby, represent primary errors in development, errors in chemical communication or translation of genetic information (Meteyer, 2000). The defects could be lethal, sub-lethal and nonlethal (Leipold et al., 1983). In our case, it was nonlethal.

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. This apparently simple bud will develop into a complete and patterned limb under the control of a few well-identified signaling centers. The three main signaling centers 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). Alam et al., (2007) reported that any alterations in the signaling centers due to genetic, toxic or environmental factors during limb development can cause congenital anomalies of the limb. Congenital malformation sometimes leads to mortality, and it may also reduces the cost effectiveness and market value of defective birds. However, animals with supernumerary ectopic limbs can survive successfully with normal locomotion depending on the extent of the defect as indicated in this case study. We recommend the prompt reporting of similar cases as this will add knowledge to the distribution of defect, polymelia. It will also facilitate the search for offending compounds in the environment and the eventual establishment of their causal relationships. Poultry farmers are also advised to avoid uncontrolled or indiscriminate feeding of their birds as some of these pollutants which may be loitered in the environment may pose negative effects on the economics of poultry production.

Surgical amputation of the affected limb is a possible treatment of this deformity. However, this may not be routinely carried out in domestic birds bred for consumption, due to the negative balance of the of the surgery cost implication visa viz the monetary value of the bird.

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References


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Fig (1): Picture of the affected chicken standing on the two functional limbs.

Fig (2): Ventral view of the affected chicken with arrow showing the extra limb.

Fig (3): Picture showing the distal part of the extra limb ending with two digits.
Fig (4): X-ray radiograph of the entire pelvic region of the bird showing bones of the proximal pelvic limb, **A**- normal right femur, **B**- extra femur raising from the same point of articulation as the normal femur, **C**- femur articulating with the pelvis at a point caudal to the point of articulation of ‘A’ and ‘B’, **D**- femur raising from the same point of articulation as (C), **E**- extra tibia.