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Original Research Article

Gross anatomical investigation on the fore limb skeleton of the adult helmeted Guinea fowl (*Numida meleagridis*)

Kigir, E.S., Omowumi, L.K., *Onwuama, K.T., Jaji A.Z. & Salami, S.O.

Department of Veterinary Anatomy, University of Ilorin, Ilorin, Nigeria

*Corresponding author: kenexcares@yahoo.com, +2348036425961

ABSTRACT

This study on the forelimb skeletal gross anatomy was conducted on the helmeted guinea fowl to document its distinctive morphological features. Eight (8) Helmeted guinea fowls (4 females and 4 males) with an average weight of 3.0kg were sacrificed via jugular vein severance with bone preparation achieved by use of insect larvae. The horizontally oriented scapula was an elongated flattened dorsoventrally curved bone having two extremities and a shaft but lacked the muscular tubercle on the cranial third of the ventral border present in other avian species. The obliquely oriented coracoid presented a thick bone with a hook-like acrocoracoid process that formed a shallow supracoracoid groove at its proximal extremity. It however, lacked the rough surface for muscular attachment and the pneumatic foramen on the dorsal surface. The proximal fossa was absent on the dorsal surface of the humerus while the ulna and radius were joined at their extremities creating an extensive interosseous space. The radius was the thinner of the two bones lying dorsal to the larger ulna in the folded wing. Two carpal bones were present on the wings while the carpometacarpal consisted of the 2nd (stub-like projection), 3rd (large straight long) and 4th (curved) metacarpals with the 3rd and 4th fusing at their extremities giving rise to an extensive D-shaped interosseous space. The digits were three in number (digits II, III and IV) that articulated proximally with carpometacarpals II, III and IV respectively. Digit III had two phalanges while digits II and IV had one. In conclusion, bones of the forelimb of the guinea fowl (*Numida meleagridis*) lacked some common features visible in its closest relative, the domestic fowl (*Gallus domesticus*).

Keywords: Avian species, bone, coracoid, carpometacarpal, helmeted guinea fowl, osteology.

INTRODUCTION

The Helmeted Guinea fowl (*Numidia meleagridis*), a native of sub-saharan Africa (Teye and Gyawu, 2001) is a member of the family Numididae and order Galliformes (Wanmi *et al.*, 2018). They are indigenous to Africa but have been introduced to various countries around the world and are among the oldest gallinaceous birds (Darre, 2007; Abdul-Rahman *et al.*, 2019). Guinea fowls are native to grasslands and woodlands in Africa and occupy all habitats except dense forest and treeless deserts (Moreki and Radikara, 2013). There are over 50 million semi-domesticated guinea fowls in Nigeria which constitute about 25 percent of the entire population of domestic poultry (Ikani and Dafwang, 2014). Their production has become commercially viable in places like Europe and America (Issaka and Yeboah, 2016).

Osteological researches which include phylogenic investigations, age to growth analysis and functional morphology are essential tools for evolutionary study, biomechanics, paleontology and archeology (Bemis *et* al., 2004). In avian species, the role of bones in the function and adaptation of life cannot be overemphasized. Bony structures of the body also known as the skeleton support, protect and forecast the body structure of an organism (Egwu *et al*., 2012). It can be defined as a hard framework 0of the body which supports soft structures (Abdulrahman and Yusuf 2021) and is responsible for the maintenance of the shape, flexibility as well as locomotion of the body (Hall, 2015). For the purpose of description, it is usually divided into Axial (Skull, vertebral column and thorax) and Appendicular skeleton (Fore and hind limb) (Ghosh, 2006). To this end, studies on the forelimb skeletal structure was

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conducted on the helmeted guinea fowl to document its distinctive morphological feature thereby uprooting their differences when compared with other species of the same order 'Galliformes'.

MATERIALS AND METHODS

ETHICAL APPROVAL

Ethical approval was obtained from the Animal ethics committee of the University of Ilorin, Nigeria with approval number FVERC/W0Q12/15.

STUDY DESIGN

Eight (8) Helmeted guinea fowl (*Numidia meleagridis*) 4 females and 4 males with an average weight of 3.0 kg were purchased in Ilorin, Kwara State, Nigeria and housed in the Department of Anatomy Laboratory, Faculty of Veterinary Medicine, University of Ilorin, Nigeria. They were fed with grains and water *ad libitum* prior to commencement of study. The birds were sacrificed via the jugular vein and dissected using a surgical blade to remove feathers, skin, thoracic, abdominal and pelvic contents while the muscles were teased away leaving the bones with minimal soft tissue attachments after which they were placed in a bowl (after being sprinkled with water) and allowed to stay outdoors for 3 days to allow for flies to lay their eggs. They were then kept indoors at room temperature for 5 months to allow for larva appearance, growth and feeding on the soft tissues. The recovered bones were then separated, washed, rinsed and sundried before photographs were taken using a digital camera (Nikon Coolpix 20.1 megapixel 4.6-23.00mm). Their general and specific morphological features were noted and described.

RESULTS

Forelimb bones of the helmeted guinea fowl consisted of the pectoral girdle (Scapula, coracoid and clavicle) and wings (Humerus, Ulna, Radius, carpal, metacarpal, and digits).

SCAPULA

The Scapula (Figure I) was a long plate-like horizontally oriented bone with two extremities (cranial and caudal), a shaft with two surfaces (medial and lateral) and two borders (dorsal and ventral). The cranial extremity bore dorsally; the furcular process with a facet for articulation with the clavicle and ventrally the glenoid cavity for articulation with the humerus. Between the furcular process and the glenoid cavity was a depression for articulation with the coracoid. A distinct neck was seen below the glenoid cavity. The surfaces were somewhat smooth and flat. The dorsal border was convex from its middle while the ventral border was slightly convex.

CORACOID

The Coracoid (Figure II) was a long obliquely oriented bone with two extremities (proximal and distal), a shaft having two surfaces (dorsal and ventral) and two borders (lateral and medial). The proximal extremity bore on its dorsal surface a hook-like acrocoracoid process which formed a shallow supracoracoid groove medially. Lateral to the groove on the dorsal surface of the bone is the humeral tubercle which continued distally to the scapular tubercle. The ventral surface of this extremity bore the acromial process. The distal extremity presented a concave articular surface for articulation with the sternum. The shaft was rod-like proximally before becoming flat distally.

CLAVICLE

The Clavicle (Figure III) presented a Y-shaped structure with two proximal extremities, two slender rod like shaft and a distal union of the bodies (furcula) which extended distally to form the flattened caudally directed vertical plate; the hypocleidum.

HUMERUS

The Humerus (Figure IV) presented a somewhat flattened long bone having a shaft with two surfaces (lateral and medial), two borders (dorsal and ventral) and two extremities (proximal and distal). The surfaces are smooth with a straight dorsal border and a concave ventral border. The proximal extremity presented an ellipsoidal head with the dorsal and ventral tubercle on both sides but distal to it. On its medial surface, the sulcus capitis separated the head from the raised ventral tubercle situated above the pneumatic foramen. On the lateral surface of the proximal extremity, a shallow transverse groove separated the head from the smooth ventral tubercle that merged with the bicipital crest while the dorsal tubercle continued as the delto-pectoral crest. Between the two tubercles was the shallow intertubercular fossa more associated with the delto-pectoral crest. The distal extremity presented medially, the dorsal and ventral epicondyle on the dorsal and ventral borders respectively separated by the olecranon fossa. Between the epicondyles are the dorsal (larger) and ventral condyles on its lateral surface.

ULNA AND RADIUS

The Ulna and Radius (Figure V) were two bones joined at their extremities creating an extensive interosseous space. The radius was the thinner of the two lying dorsal to the larger ulna in the folded wing.

The Ulna was a large long bone compared to the radius having a shaft with two surfaces (lateral and medial), and two extremities (proximal and distal). It presented a concave dorsal border and a convex ventral border. Another border divided the lateral surface into two unequal halves. The proximal extremity presented a relatively poorly developed olecranon as well as two articular surfaces, the dorsal and ventral cotyla for articulation with the condyles of the humerus. An articular facet for the radius, the radial

incisure, was etched into the bone, distal to the dorsal cotyla. The distal extremity presented a larger oblique lateral condyle and a smaller medial condyle with a prominent epicondyle. A small recess on the dorsal aspect, the *depressio radialis*, served as the site of articulation with the distal radius.

The Radius was a thin slender long bone with an articular surface for humerus articulation and a medial articular facet for ulna articulation on its proximal extremity. The shaft followed a relatively straight course to end in a slightly curved thickened distal extremity which bore surfaces for articulation caudally with the radial carpal bone and ventrally with the *depressio radialis* of the ulna.

CARPALS

Two carpal bones (Figure VI) were present on the wings; a compact *radial carpal* bone (bearing articular surfaces for the ulna, radius and carpometacarpus) and the larger angular *ulnar carpal* bone with long and short limbs separated by the metacarpal incisure.

CARPOMETACARPALS AND DIGITS

The Carpometacarpal consisted of three fused bones, the 2nd, 3rd and 4th metacarpals (Figure VII). The 2nd metacarpal was a stub-like projection from the dorsal surface of the 3rd metacarpus and bears the articular surface for the second digit. The 3rd metacarpal presented a straight smooth shaft while that of the 4th metacarpal was curved bearing a small muscular tubercle on its lateral surface. Both bones fused at their extremities giving rise to an extensive d-shaped interosseous space. The digits were three in number (digits II, III and IV) that articulated proximally with carpometacarpals II, III and IV respectively. Digit III had two phalanges while digits II and IV had one.

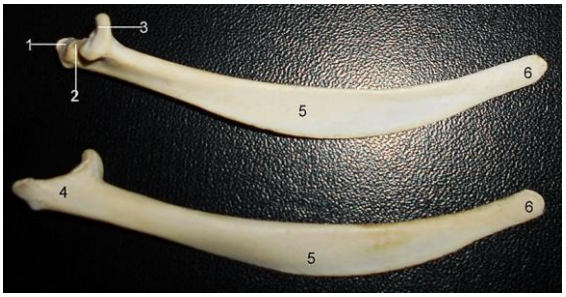

Figure I: Scapula of the Helmeted Guinea fowl (*Numida meleagridis)* Medial and lateral views.
1, Furcula process; 2, Articular fossa for coracoid articulation; 3, Glenoid cavity; 4, Cranial extremity; 5, Shaft; 6, Distal extremity.

Figure II: Coracoid of the Helmeted Guinea fowl (*Numida meleagridis*) Dorsal and ventral views.
1, Acrocoracoid process; 2, Acromion process; 3, Supracoracoid groove; 4, Scapula tubercle; 5, Humeral tubercle; 6, Shaft; 7, Distal extremity.

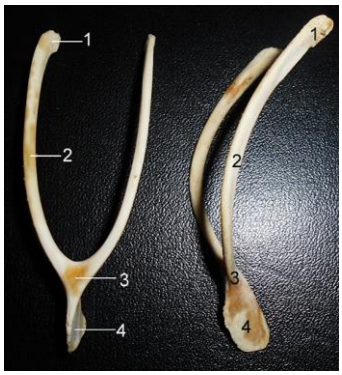

Figure III: Clavicle of the Helmeted Guinea fowl (*Numida meleagridis*) Cranial and Lateral views.
1, Proximal extremity; 2, Shaft; 3, Furcula; 4, Hypocleidum.

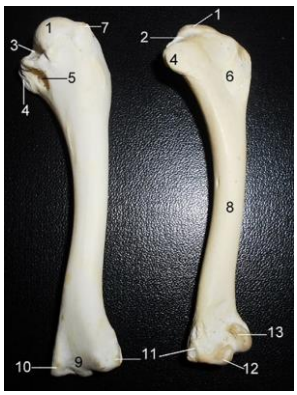

Figure IV: Humerus of the Helmeted Guinea fowl (*Numida meleagridis*) Medial and Lateral views. 1, Head; 2, Transverse groove; 3, Sulcus capitis; 4, Ventral tubercle; 5, Fossa; 6, Intertubercular fossa; 7, Dorsal tubercle; 8, Shaft; 9, Olecranon fossa; 10, Dorsal epicondyle; 11, Ventral epicondyle; 12, Ventral condyle; 13, Dorsal epicondyle.

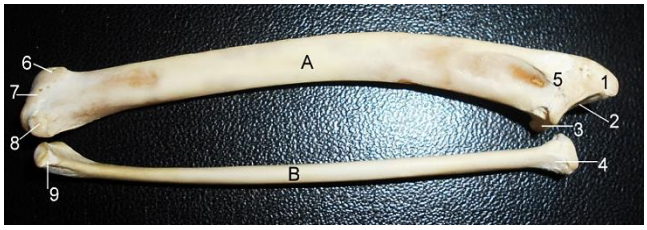

Figure V: Ulna (A) and Radius (B) of the Helmeted Guinea fowl (*Numida melegridis*) Lateral view.
1, Olecranon; 2, Cotyla; 3, Radial incisure; 4, Proximal extremity of Radius; 5, Proximal extremity of Ulna; 6,7, Condyle; 8, Epicondyle; 9, Distal extremity of Radius.

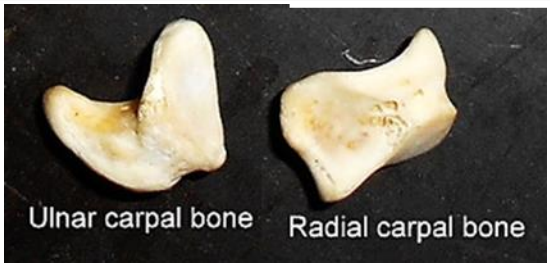

Figure VI: Carpal bones of the Helmeted Guinea fowl (*Numida melegridis*) Lateral view.

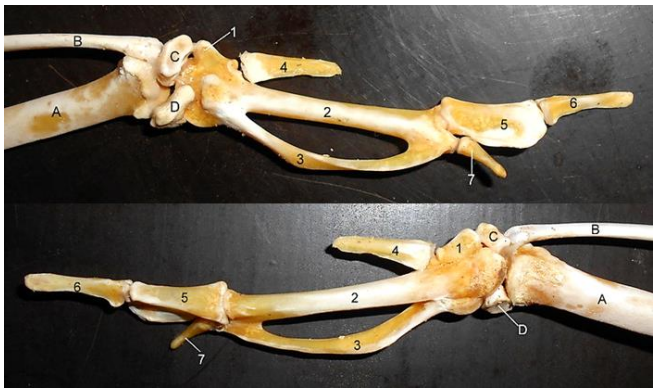

Figure VII: Some wing bones of the Helmeted Guinea fowl (*Numida meleagridis*) lateral and Ventral views.
A, Ulna; B, Radius; C, Radiocarpal; D, Ulnacarpal; 1, 2nd Carpometacarpal; 2, 3rd Carpometacarpal; 3, 4th Carpometacarpal; 4, Phalanx of 2nd digit; 5, 1st phalanx of 3rd digit; 6, 2nd phalanx of 3rd digit; 7, Phalanx of 4th digit.

DISCUSSION

Despite the guinea fowl (*Numida meleagridis*) being a member of the order "Galliformes" and a very close relative of the chicken (*Gallus domestica*), the gross anatomical features of its forelimb bones presented differences which were noticeable in the scapula, coracoid, humerus, carpometacarpal and digits. Similarities and differences were also noticed when compared with previously studied avian species such as the cattle egret and the barn owl.

The presentation of the scapula as an elongated flattened dorsoventrally curved bone was similar to findings by Dyce *et al*. (2010) and Tahon *et al.* (2013) in the chicken; Rezk, (2015) in the cattle egret and Usende *et al*. (2017) in the barn owl. However, the muscular tubercle seen on the cranial third of the ventral border of the scapula in chickens was absent in the guinea fowl.

Corroborating the findings of Dyce *et al.* (2010) in the chicken and Rezk, 2015 in the cattle egret, the coracoid was a thick bone with a hook-like acrocoracoid process that formed a shallow supracoracoid groove at its proximal extremity. However, it differed from the findings by Usende *et al*. (2017) on the barn owl who reported a Y-shaped groove on its cranial extremity. Also, the rough surface for muscular attachment and the pneumatic foramen seen on the dorsal surface of the coracoid of the Chicken (Koenig *et al*., 2016) was absent in the guinea fowl.

The presentation of the clavicle as a single Y-shaped bone with two proximal extremities and a distal furcula that extended the hypocleidum seemed to be a common feature of birds as it was similar to all literatures on avian species.

The humerus of this species had a slight difference from the chicken's presentation (Tahon *et al.*, 2013) in that it presented a shallow intertubercular fossa on its proximal lateral surface while the proximal fossa on the dorsal surface was absent.

The ulna was longer and larger than the radius which is in agreement with findings of Akers & Denbow (2008) and Tahon *et al*. (2013) in the chicken and in contrast to the

findings of Usende *et al*. (2017) in barn owl and Rezk, 2015 in cattle egret who reported equal sizes in these species.

The anatomical features of the of the carpometacarpal further show that the distal row of the carpus fused with the proximal extremities of the metacarpal. Its presentation of a stump-like metacarpal II, straight long metacarpal III and a curved metarcapal IV all fused at their extremities was in corroboration with findings of Akers and Denbow (2008) and Tahon *et al*., 2013 in chicken. However, only the lateral tubercle on metarcarpal IV was present in the guinea fowl. The medial tubercle (Intermetacarpal process) of metacarpal III was absent as reported by Rezk, 2015 in the cattle egret.

In this study, the digits were three in number (digits II, III and IV) that articulated proximally with carpometacarpals II, III and IV respectively. Digit III had two phalanges while digits II and IV had one. This is in accordance to reports of Muller and Alberch, (1990), Rezk (2015) in cattle egret, Akers and Denbow (2008) and Tahon *et al*., 2013 in chicken but differed from that of the barn owl (Usende *et al*., 2017).

CONFLICT OF INTEREST

Authors declare that no conflict of interest is associated with this work

ACKNOWLEDGEMENT

Nil.

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