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COMPARATIVE MACRO ANATOMY OF FORELIMB BONES OF BLACK BENGAL GOAT AND INDIGENOUS DOG: AN OVER VIEW

Md. Abdullah-Al-Mahmud[1*], Md. Tareq Mussa[2]

ABSTRACT

A macro anatomic study was undertaken to compare the forelimb bones of predominant Black Bengal Goat (BBG) and Indigenous Dog in Bangladesh by means of visual observation. Twelve matured (6 BBGs and 6 dogs) male animals were sacrificed ethically to prepare the skeleton without any destruction. The observation revealed that the scapular spine unequally divided the lateral surface in BBG whereas it divided the lateral surface into two equal halves in dog. The tuber scapulae of dog was blunt but slender in BBG. On the other hand coracoid process was absent in dog. Acromion process was short, blunt and extended up to the level of glenoid cavity but in case of BBG it does not reach to the glenoid cavity. The humerus of dog was comparatively longer, less twisted, round head and more convex. A large supratrochlear foramen at the distal end of the humerus was present in dog but absent in BBG. Radius and ulna appeared as two separate bones in dog but fused in BBG where the interosseous space was narrow and extended throughout the length of the bones of dog. There were seven bones in the carpus of dog; three at the proximal and four at the distal row but six bones in BBG; three in proximal and two in distal row. On the other hand five metacarpal bones in dog but one bone in BBG were found. Only two digit where two sesamoid bones for each proximal digit and one for distal digit in case of BBG but five digits where nine proximal (two for each developed digit and one for first) and five distal sesamoid bones were found in dog. In conclusion, the present study suggests that the anatomy of the forelimbs bones of BBG were differed from indigenous dog in various point of view.

Key words: Macro anatomy, Forelimb, Black Bengal Goat, Indigenous dog

[1*]Department of Anatomy & Histology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh
Email: maamtuhin@yahoo.com
[2]Department of Anatomy & Histology, Jhenaidah Govt. Veterinary College, Jhenaidah, Bangladesh
**Corresponding Author*

INTRODUCTION

Black Bengal Goat (BBG) is the native and only recognized breed in Bangladesh which partially fulfil the national demands of meat, hides and skins (Siddiqui *et al.*, 2008). It is found throughout the Bangladesh and earn about 500 crore of foreign money every year by exporting hides and skins those are very famous in the world (FAO, 1998). On the other hand, the indigenous dog of Bangladesh are non-descriptive; most of these are free ranging street dog. Few dogs are reared for guarding the rural house hold and farm land in Bangladesh.

There are considerable number of morphological differences between the two species, the most simple and effective visual way of distinguishing goat from dog is the carriage of the tail (Dewey and Bhagat, 2002), variation in size, appearance and behavior. More differences between goat and dog are found in the limb. Some type of animals contain fibrous layer cover the distal part of phalanx called nail or hoof, this type of animals located under Digitigrades like dog (Donald and LAN, 2011). While another type of animals limb characteristic by the stronger feet for the tension and pressure, this type of animals located under Unguligrade like ruminant (Dyce *et al.*, 2010). On the other hand, the skeletal system stands out as one of the body structures that has been used and still being used for the characterization of different species of animals including humans (Watson, 1972; Guintard and Lallemand, 2003). This is because most of the parameters considered such as shape, height, length and size are easily accessible in the skeleton.

Long bones of the body are directly related with the muscular growth of goat and dog; so the anatomist and student as well as veterinary practitioners must possess clear conception about goat (Siddiqui *et al.*, 2008) and dog osteology. Differentiating the remains of the two animals during gross anatomy practical session in Veterinary schools, colleges and universities is difficult. There were some macro-anatomical investigations on the skeletal systems of large animals such as horse and cattle (Getty, 1975), small ruminants such as sheep (Getty, 1975), carnivores such as dog (Evans and Christensen, 1979), wild carnivores such as the mink and from the order of Rodentia such as guinea pig and rat; and from the order Lagomorpha such as rabbit (Özkan *et al*., 1997; Yalmaz , 1998) but comparative study of skeletal systems of BBG (Siddiqui *et al.*, 2008) and indigenous dog have not been investigated in details.

The aim of the present study was to investigate the comparative macro anatomy of forelimb bones of BBG and dog and to contribute to the present level of information.

MATERIALS AND METHODS

A total number of twelve matured (age 2-3 years), healthy and apparently disease free male animals were taken to prepare skeleton and observed the comparative structures of forelimb bones. The experimental BBGs were purchased from the local market and the dogs were collected from the local area of Jhenaidah sadar upazilla. The age of the experimental animals were determined by dentition method (Samad, 2008). The animals were kept in fasting condition for 24 hours and then were killed by killed by Saturated Magnesium Sulphate ($MgSO_4$) solution @ 2ml/kg body weight IV for small animals. These methods and procedures of killing is approved by the American Veterinary Medical Association (AVMA). After killing, the skin, adipose tissues, muscles and visceral organs were removed with the help of scalpel, scissors and forceps upto maximum extent to expose the bony structures. The forelimbs bones were boiled in 3% solution of soda water for 1 hour to digest the associated muscles. After cooling, the additional muscles and others tissues were removed from the bones. Finally, the bones were allowed to sundry for 10 hours. The skeleton of forelimbs were prepared without any destruction or damages by following the quick, economic and efficient methods (Gofur and Khan, 2010) in the Department of Anatomy & Histology, Jhenaidah Govt. Veterinary College, Bangladesh. After completing all the processes, the bones were studied by visual observation and photography was done for better illustration of the results.

RESULTS AND DISCUSSIONS

Scapula

The present study revealed that the scapula was a triangular flat bone but scapula of dog was less triangular than BBG's scapula which was situated at the cranio-lateral aspect of thorax that was directed downward and forward direction (Dyce *et al.*, 2009). The spine of the scapula of BBG extended up to the neck of the bone as like Siddiqui *et al.* (2008) findings. The scapular spine of BBG divided unequally (1:3) that means supra scapular fossa was three times smaller than the infra scapular fossa but in case of dog the spine was situated at the middle and divided the lateral surface into two equal halves (Ghosh, 2012). The scapula of BBG and dog in the present study has been represented three borders, three angles and two surfaces which were found to be similar to those of horse and sheep (Getty, 1975), cattle (McLeod, 1958) and dog (Millers, 1964). Typically cranial, caudal and distal angles were present in BBG but in case of dog the cranial angle practically absent (Ghosh, 2012). Dyce *et al.* (2009) and Ghosh (2012) agree with the findings that the caudal angle of scapula of dog was rough but depressed in middle and wider than the goat and distal angle was also wider in dog. The glenoid cavity was larger, shallow and incomplete in dog. There were three borders in both BBG and dog. The dorsal border of dog was more rough and thicker in dog than BBG.

Anterior border was thick and more curve in dog but thin and more or less straight in BBG. The posterior border was blended inward direction but less straight in BBG (Figure 1, 2, 3 & 4). Ghosh (2012) finding indicates that the tuber scapulae of dog were blunt but slender in goat. Coracoid process was absent in dog (Evans and Chirstensen, 1979) but present in BBG. On the other hand acromion process was short, blunt and extended to the level of glenoid cavity in dog but in case of BBG this structure could not reaches up to the glenoid cavity (Evans and Chirstensen, 1979; Siddiqui *et al.*, 2008; Ghosh, 2012).

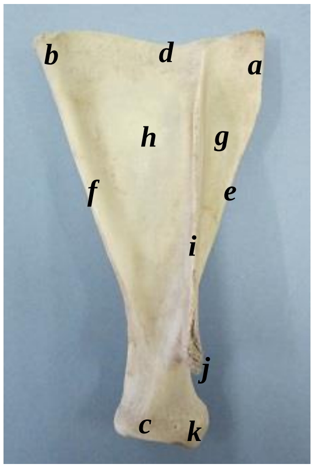

Figure 1: Right scapula of BBG (lateral view; *a* = anterior angle, *b* = posterior angle, *c* = distal angle, *d* = dorsal border, *e* = anterior border, *f* = posterior border, *g* = supra spinous fossa, *h* = infra spinous fossa, *I* = spine of scapula, *j* = acromion process, *k* = supra glenoid tubercle)

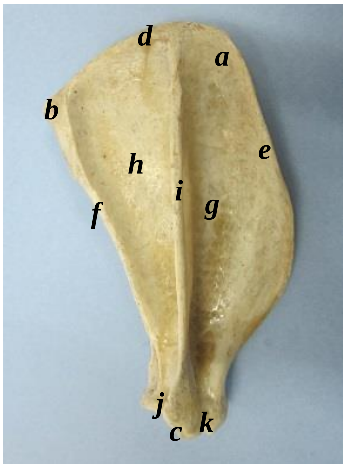

Figure 2: Right scapula of dog (lateral view; *a* = anterior angle, *b* = posterior angle, *c* = distal angle, *d* = dorsal border, *e* = anterior border, *f* = posterior border, *g* = supra spinous fossa, *h* = infra spinous fossa, *i* = spine of scapula, *j* = acromion process, *k* = supra glenoid tubercle)

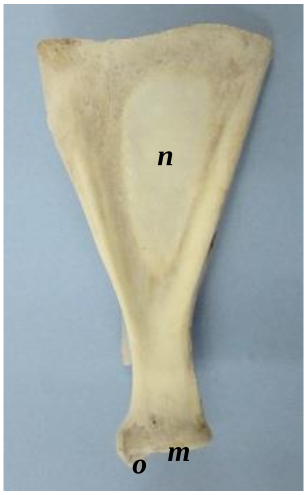

Figure 3: Right scapula of BBG (medial view; *m* = glenoid cavity, *n* =sub scapular fossa, *o* = coracoid process)

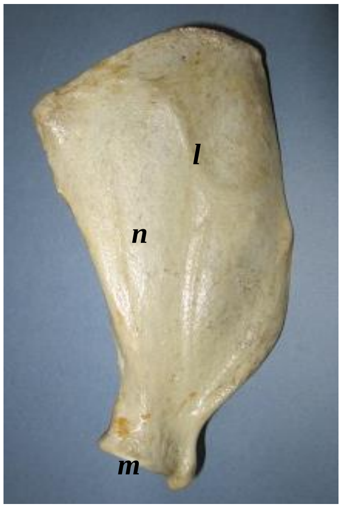

Figure 4: Right scapula of dog (medial view; *l* = sub scapular rough line, *m* = glenoid cavity, *n* = sub scapular fossa)

The glenoid cavity of BBG's scapula was mostly circular and deep but shallow in the dog (Evans and Chrisensen, 1979). Supra glenoid tubercle was small and close to the glenoid cavity which were dissimilar with dog. There was no glenoid cavity without any distinct glenoid notch which was dissimilar to dog (Evans and Chrisensen, 1979). In the present study the tuber spine in BBG was absent (Figure 1). The subscapular fossa in BBG was observed less extensive in contrast with the study of Siddiqui *et al.* (2008). The medial surface was more depressed and both anterior and posterior borders were elevated in dog than BBG but dorsal aspect of the medial border was more depressed, roughened and all the area of the subscapular fossa contained few rough lines which was absent in BBG (Figure 3 & 4). Those were supported by Dyce *et al.* (2009) and Ghosh (2012).

Humerus

The humerus was comparatively longer and less twisted with round and convex head in dog than BBG that was also found by Dyce *et al.* (2009) and Ghosh (2012). Both lateral and medial tuberosity, intertuberal and bicipital groove were larger in BBG than dog. The deltoid tuberosity of the BBG was found less prominent, similar observation was reported in cattle and sheep (Getty, 1975; Siddiqui *et al.*, 2008) but contrast to the present study where it was shown that deltoid tuberosity as ridge and not prominent in case of dog (Dyce *et al.*, 2009) but prominent crest in BBG (Figure 5, 6, 7 & 8).

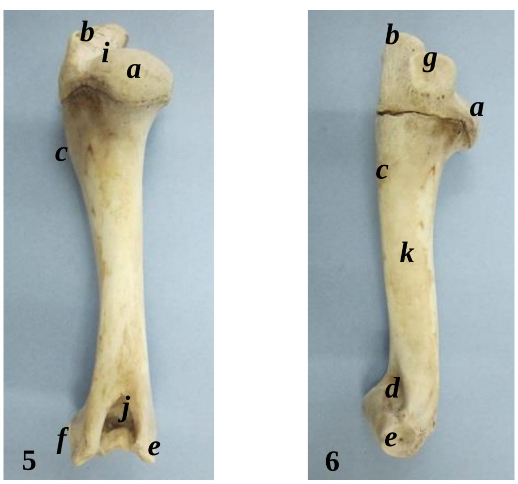

Figure 5 & 6: Left humerus of BBG (5 = posterior view, 6 = lateral view; *a* = head, *b* = lateral tuberosity, *c* = deltoid tuberosity, *d* = radial fossa, *e* = lateral condyle, *f* = medial condyle, *g* =medial tuberosity, *h* = intertuberal groove, *i* =bicipital groove, *j* =olecranon fossa *k* = musculospiral groove)

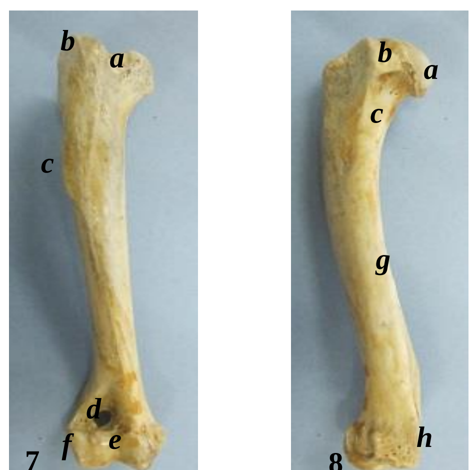

Figure 7 & 8: Left humerus of dog (7 = posterior view, 8 = medial view; *a* = head, *b* = lateral tuberosity, *c* = deltoid tuberosity, *d* = radial fossa with supra trochlear foramen, *e* = lateral condyle, *f* = medial condyle *g* = musculospiral groove, *h* = olecranon fossa)

The nutrient foramen was upper to the body in dog than BBG and all the condyles and epicondyles were larger in case of dog than BBG. Radial and olecranon fossa of dog were larger than BBG and communicated by a large supratrochlear foramen but this foramen was absent in BBG (Figure 7). Musculospiral groove was less prominent in dog. The radial and olecranon fossa of dog were deep but shallow in BBG which is agreed by Getty (1975) but disagreed by Siddiqui *et al.* (2008). Siddiqui *et al.* (2008) shown that the musculospiral groove of humerus of goat is shallow but present study observed that the musculospiral groove of the humerus of BBG was deep and prominent but in case of dog it was straighter (Figure 6 & 8).

Radius and ulna

These bones were larger but not same height and they were situated in vertical direction. These bones were completely separated in case of dog but in BBG these were in contact with each other by their ends but fused in most part and the interosseous space was narrow which extended throughout the length of the bones in dog (Getty, 1975; Ghosh, 2012). In the present study it was found that the radius of dog was larger and but more curved in case of BBG. The anterior surface was more convex but posterior surface was more concave in BBG than dog. All the surfaces were rough in case of dog but smooth in BBG (Figure 10 & 13). The proximal end of radius present only one articular facet for the lateral condyle of the humerus and the medial condyle of the humerus was articulated with the facet on the semilunar notch of ulna (Ghosh, 2012).

Figure 9, 10 & 11: Left radius and ulna of dog (9 = lateral view, 10 = anterior view, 11 = lateral view; *a* = radius, *b* = ulna, *c* = radial tuberosity lateral view; *d* = anconeous process, *e* = olecranon process, *f* = semilunar notch, *g* = styloid process)

Figure 12: Left radius and ulna of BBG (antero-medial view; *a* = olecranon process, *b* = anconeous process, *c* = semilunar notch, *d* = radial tuberosity, *e* = proximal interosseous space, *f* = distal interosseous space, *g* = styloid process, *h* = ulna, *i* = radius)

The medial, lateral and radial tuberosity were prominent in dog than BBG. The facets in the lower part of ulna were oblique in BBG but straight and round in dog. Medial surface of ulna of dog was more depressed than BBG but prominent ridge was found in BBG. Semilunar notch and anconeus process were larger in dog than BBG (Figure 9, 10, 11 & 12). Antero-lateral surface of olecranon process consisted a pair of small tubercles (Ghosh, 2012) that was absent in BBG which was an important differentiating point. Styloid process was thick in dog but thin in BBG. The epicondyloid crest of humerus was found prominent in BBG which was inconsistent with the report in cattle (McLeod, 1958) and sheep (Getty, 1975) but dissimilar in dog (Millers, 1964).

Carpal bones

In the present study, the carpal bones were short, six in number and arranged into two rows in between the radius-ulna and metacarpal bones in BBG. The proximal row consisted of radial carpal, intermediate carpal, ulnar carpal and accessory carpal; and in the distal row, there were second and third fused carpal and fourth carpal but the first one at the distal row was absent in BBG . This is also agreed by Getty (1975) in cattle and sheep but disagreed by Getty (1975) in horse. In horse, the proximal row consisted of radial, intermediate, ulnar, and accessory carpal; and the distal row consisted of first, second, third and fourth carpal. Millers (1964), Getty (1975) and Ghosh (2012) showed that seven bones were in the carpus of dog; three in the proximal and four in the distal row. In the proximal row; radical and intermediate as fused carpal, ulnar carpal and accessory carpal; and in the distal row there were four bones; first, second, third and fourth carpal that was agreed with the present result. The intermediate carpal was situated in between the radial and ulnar carpal bones. These observations are similar in case of cattle (Mcleod, 1958) and sheep (Getty, 1975) but differs in case of horse (Getty, 1975) and dog (Evans and Chrisensen, 1979).

Metacarpal bones

There was one metacarpal bone in BBG but five in dog for each forelimb (Figure 13). Siddiqui *et al*. (2008) observed that the large metacarpal bone was present which consists of third and fourth in BBG which is similar to the present study. Other metacarpal bones were absent. In case of BBG, the metacarpal fusion of the two bones was well marked by grooves externally and by the presence of double medullary cavities inside but no such structure was found in case of dog which are supported by the Getty (1975) and Ghosh (2012). The bones of both species have two surfaces like anterior and posterior where both the surfaces of metacarpal bone of BBG were present a vertical groove along the whole length and two foramina, one in proximal part and another in distal part of this groove those were absent in dog (Evans and Chrisensen, 1979; Ghosh, 2012). Metacarpal tuberosity and intercondylar cleft was absent in dog but present in BBG where the distal end was divided by a cleft into two condyles (Figure 14 & 15) and these condyles were divided into two parts by a ridge (Dyce *et al.*, 2009).

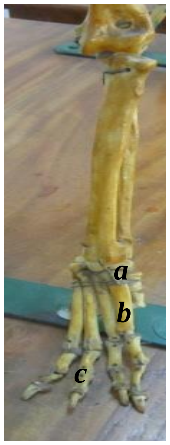

Figure 13: Left carpal, metacarpal and phalanges of dog (dorsal view; *a* = carpal bone, *b* = metacarpal bone, *c* = phalanges)

Figure 14: Right metacarpal of BBG (anterior view; *a* =lateral metacarpal tuberosity, *b* = lateral condyle, *c* = inter condyloid cleft)

Figure 15: Right metacarpal of BBG (posterior view; *a* = medial vertical groove, *b* = facets for sesamoid bone)

Present study indicated that the distal end of metacarpal bone of BBG had four depressions for four sesamoid bones but two depressions was present in case of dog for two sesamoid bones (Figure 13, 14 & 15). Ghosh (2012) described that the first metacarpal bone of dog is shortest but third and fourth bones are largest and the second and fifth are almost equal in length which were also observed in this study. The shafts were antero-posteriorly compressed. Ghosh (2012) also described that the distal ends bear a ridge at the middle and articulate with corresponding first phalanges where the proximal ends were articular and collectively form facets for the carpal bones.

Digits and phalanges

Two fully developed digits (third and fourth) were observed in each forelimb of BBG in which second and fifth were remaining as dewclaw and the first digit was absent. Each digit consisted of three phalanges (proximal, middle and distal). The proximal phalanx of each digit (third and fourth) appear four-sided and longer than the other phalanges. The present observations are consistence with those observations of Getty (1975); Siddiqui *et al.* (2008) and Al- Sharoot (2013). The study revealed that there were four proximal sesamoid bones in BBG; two for each digit (Al- Sharoot, 2013). The proximal sesamoid bones were encased within the elastic suspensory ligament proximally and the nonelastic distal sesamoidean ligaments distally on the palmer surface of the fetlock joint because that proximal sesamoid bones provide stability to the suspensory apparatus by acting as lever arm for the suspensory apparatus. This results were confirmed by the studies of Bukowieki *et al.* (1985) and Hubert *et al.* (2001) in horses; Siddiqui *et al*. (2008) in goat and Dyce *et al.* (2010) in cattle and sheep. Distal sesamoid bones in BBG were two in number, one for each digit which were shuttle-like in shape, situated palmer to the second interphalangeal joints. It increased the surface area of the coffin joint and reduced the impact loading of the deep digital flexor tendon away from the centre of the coffin joint. These study is agreed by Getty (1975); Loving and Johnston (1995); Dyce *et al*. (2010) and Ghosh (2012) in horse and cattle but disagreed with the Ral *et al*. (2004) who have presented that the distal sesamoid bone disappears in camels. On the other hand there were nine proximal (two for each developed digit and one for first) and five distal sesamoid bones were present in case of dog for each limb where the first digit was underdeveloped and possessed only two phalanges but other four digits had three phalanges each (Figure 13). Third and fourth digits have maximum length these observation was consistence with the study of Ghosh (2012).

CONCLUSION

In this study, the spine of scapula divided it's lateral surface unequally in BBG whereas it divided the lateral surface equally in case of dog. The humerus of dog was longer, less twisted with round and convex head. Supratrochlear foramen was present in dog. The radius and ulna was fused in BBG but it was separated in dog. There have also differences in carpal, metacarpal and digits of BBG and indigenous dog. In conclusion, this study has demonstrated a means of differentiating forelimb bones of BBG and indigenous dog of Bangladesh.

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