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**Kamal Sarma**

Professor, Division of Veterinary Anatomy, F.V.Sc & A.H, SKUAST-J, R.S Pura, Jammu and Kashmir, India

**Jasvinder Singh Sasan**

Assistant Professor, Division of Veterinary Anatomy, F.V.Sc & A.H, SKUAST-J, R.S Pura, Jammu and Kashmir, India

**Shalini Suri**

Professor and Head, Division of Veterinary Anatomy, F.V.Sc & A.H, SKUAST-J, R.S Pura, Jammu and Kashmir, India

**Corresponding Author:**

**Jasvinder Singh Sasan**

Assistant Professor, Division of Veterinary Anatomy, F.V.Sc & A.H, SKUAST-J, R.S Pura, Jammu and Kashmir, India

## Gross and morphometrical studies on the humerus of Indian Barking deer (*Muntiacus muntjak*)

**Kamal Sarma, Jasvinder Singh Sasan and Shalini Suri**

### Abstract

The present study was conducted on the humerus of an adult Indian Barking deer. It was a long bone with spirally twisted shaft and two prominent extremities. The proximal third of the medial surface had a short teres tubercle. The proximal third of the lateral surface possessed at its middle a sharp deltoid tuberosity. The nutrient foramen was located on the distal third of the shaft on the postero-lateral aspect. The head was elliptical in outline with a very distinct neck. The cranial part or summit of lateral tuberosity was well developed and blunt whereas the caudal part was ill-developed. The medial surface of the summit of lateral tuberosity facing the bicipital groove had 2 spine-like structures, the distal of which was better developed than the proximal one. The area for the insertion of infra-spinatus muscle was roughly triangular in outline. The medial tuberosity was much smaller as compared to the lateral one. A distinct groove was observed caudal to the posterior division of the medial tuberosity. The bicipital or inter-tubercular groove was well developed and roughly U-shaped. The anterior parts of both the lateral and medial tuberosities curved over the bicipital groove. The distal extremity consisted of two condyles, two epicondyles and two fossae. The medial condyle and epicondyle were much larger than the lateral counterpart but the lateral epicondylar crest was more prominent than the medial one. The radial fossa was deep but the olecranon fossa was much deeper. Both the fossae were separated by a thin plate of bone. The width of the bone decreased from proximal to the middle of the shaft and then increased towards distal end.

**Keywords:** Barking deer, bicipital groove, deltoid tuberosity, epicondyle, humerus

### Introduction

The Indian muntjac (*Muntiacus muntjak*) is a common muntjac deer species of South and Southeast Asia. It is listed as Least Concern on the IUCN (International Union for Conservation of Nature) Red List. It has soft, short, brownish or greyish hair, sometimes with creamy markings. It gives calls similar to barking, usually upon sensing a predator (hence the common name for all muntjacs of "barking deer"). Muntjac is one of the smallest deer species and can be distinguished by its short antlers, the visible canines of males, and perhaps most notably the large postorbital scent glands they use to mark their territory. In literature, abundant information is available on gross anatomy of humerus of domestic animals [1]. Literature is available on the humerus of Black Bengal goat [2], Blue bull [3] and blackbuck [4]. Due to paucity of literature on the humerus of Indian barking deer, the present study has been planned. The outcome of this study will be useful to the field veterinarians, zoo veterinarians and wildlife experts.

### Materials and Methods

The present study was conducted on the right and left humeri of an adult barking deer. The bones were processed as per standard technique [1] and subsequently studied to record gross morphological features. The width of the humerus was taken from three sites; proximal extremity, middle of the shaft and distal extremity. The lengths of different segments of humerus were measured with help of thread, meter scale and Vernier Calipers as per Akman *et al.* [5] (Fig. 1a and 1b).

- Maximum length (cm): Distance between the most proximal point of the humerus to the most distal point of the trochlea (MLH).
- Distance between the most proximal point of the articular segment of the humeral head to the most proximal point of the greater tuberosity (H1).

- c. Distance between the most proximal point of the articular segment of the humeral head to the neck (H2).
- d. Distance between the most distal point and most proximal points along the edge of the olecranon fossa (H3).
- e. Distance between the most distal point of the olecranon fossa and trochlea (H4).
- f. Distance between proximal edge of the olecranon fossa and trochlea (H5).
- g. Circumference of the humeral head
- h. Depth of the bicipital groove

Few morphometric index measurements were also taken as per Phatsara *et al.* [6]. These included:

- a. Humeral robusticity index: The least circumference of humerus divided by the maximum length of humerus from proximal to distal ends of humerus.
- b. Distal humeral articular index: The width of distal articular surface of humerus divided by the epicondylar width of the bone.
- c. Humeral circumference index: The least circumference at the distal part of humeral shaft divided by the maximum circumference.
- d. Olecranon fossa index: The width of olecranon fossa divided by its height.
- e. Proximal humeral index: The width of humeral head divided by the length from the proximal end to proximal 1/3<sup>rd</sup> of the bone.

## Results and Discussion

Humerus was a long bone forming the arm region of the forelimb. It was a strong bone forming shoulder joint above with the glenoid cavity of the scapula and elbow joint below with the radius and ulna. It presented for description a shaft and two extremities.

The shaft of the humerus of barking deer was twisted as observed in Black Bengal goat earlier by Siddiqui *et al.* [2]. Shaft presented four surfaces. The medial surface was almost linear in outline as also observed by Bharti [3] in Blue bull. The proximal third of this surface bore a short teres tubercle (Fig. 3) as reported earlier in ox [1], in blackbuck [4] and in Blue bull [3]. Talukdar *et al.* [7] revealed a well-developed teres tubercle in Mithun. A distinct longitudinal ridge clearly demarcated this surface from the anterior surface. The proximal third of the lateral surface had a well developed deltoid ridge which bore at its middle a sharp deltoid tuberosity projected laterally (Fig. 2). Gudea and Stan [8] reported an indistinct deltoid tuberosity in roe deer. The ridge which proceeds from deltoid tuberosity proximally was very sharp and well developed and it joined the head near the neck of the bone.

The nutrient foramen (Fig. 5) was located on the distal third of the shaft on the postero-lateral aspect. In Black Bengal goat [2], it was located at the distal third of the lateral surface whereas in Blue bull [3], it was located on the distal third of the caudal surface. It was observed in the distal third at the junction between medial and caudal surface in spotted deer [9] and Indian muntjac [10].

The proximal extremity presented the head and two tuberosities (lateral and medial). The head was elliptical in outline with a very distinct neck. In ox [1], the head was rounded in outline whereas it was oval in Blackbuck [4]. Bharti [3] observed rounded head in Blue bull with ill-defined neck.

The lateral tuberosity (Fig. 4) was very well developed as also reported earlier by Talukdar *et al.* [7] in Mithun, Choudhary [4] in Black buck and Bharti [3] in Blue bull. The cranial part or summit was well developed whereas the caudal part was ill-developed. Similar observation was made by Bharti [3] in Blue bull. The summit was large and blunt as also reported earlier by Rajani *et al.* [10] in Indian muntjac. The medial surface of the summit of lateral tuberosity facing the bicipital groove bore 2 spine-like structures (Fig. 3), the distal of which was better developed than the proximal one. The area for the insertion of infra-spinatus muscle was roughly triangular in outline (Fig. 2) unlike ruminants where it is circular.

The medial tuberosity was much smaller as compared to lateral tuberosity. Its anterior and posterior parts were at the same level (Fig. 3). A distinct groove was observed caudal to the posterior division of the medial tuberosity.

The bicipital or inter-tubercular groove was present between lateral and medial tuberosities (Fig. 4). It was well developed, roughly U-shaped and was undivided. The anterior parts of both the lateral and medial tuberosities curved over the bicipital groove. Similar observations were recorded by Rajani *et al.* [10] in Indian muntjac.

The distal extremity consisted of two condyles, two epicondyles and two fossae. The medial condyle was much larger than the lateral condyle (Fig. 4). The lateral aspect of the lateral condyle presented a distinct fossa which was not seen over the medial condyle. The medial epicondyle was much more developed than the lateral epicondyle. The lateral epicondylar crest was more prominent than the medial one. Similar observations were made by Talukdar *et al.* [7] in Mithun and Bharti [3] in Blue bull. The radial fossa was deep but the olecranon fossa was much deeper (Fig. 4 & 5). Both the fossae were separated by a thin plate of bone.

The biometrical data regarding humerus of barking deer has been depicted in Table 1. The maximum length of right and left humeri was 14.5 cm and 14.4 cm, respectively. The width of the bone decreased from proximal to the middle of the shaft and then increased towards distal end. This pattern was seen in both the bones. The decrease in width from proximal to the middle of the shaft was 23.41 % for right and 27.09 % for left humerus. The increase in width from the middle of the shaft towards the distal end was 24.2 % for right and 31.76 % for left humerus. The overall decrease in width from proximal to the distal end of the shaft was negligible (4.88 % for right and 3.94 % for left humerus).

The measurements in regard to morphometric index of humerus gives an idea about shape and size [6]. Humeral robusticity index gives idea about the size of the humerus whereas humeral circumference index indicates the shape of the humeral shaft. Higher values of humeral circumference index recorded in the present study indicated that bone is more cylindrically in shape. The olecranon fossa index gives an idea about the shape of the olecranon fossa [6].

**Table 1:** Biometrical parameters of the humerus of barking deer

S. No.	Parameters	Right humerus	Left humerus
1	MLH	14.5 cm	14.4 cm
2	Width of humerus at proximal extremity	2.05 cm	2.03 cm
3	Width of humerus at middle of shaft	1.57 cm	1.48 cm
4	Width of humerus at distal extremity	1.95 cm	1.95 cm
5	H1	1.52 cm	1.62 cm
6	H2	1.81 cm	1.88 cm
7	H3	0.95 cm	0.93 cm
8	H4	1.24 cm	1.13 cm
9	H5	2.19 cm	2.06 cm
10	Circumference of head	8.1 cm	8.2 cm
11	Depth of bicipital groove	1.14 cm	1.15 cm
12	Width of bicipital groove	0.73 cm	0.77 cm
<b>Morphometric Index measurements</b>			
1	Humeral robusticity index	0.31	0.33
2	Distal humeral articular index	0.78	0.83
3	Humeral circumference index	0.45	0.48
4	Olecranon fossa index	1.11	1.02
5	Proximal humeral index	0.52	0.52



**Fig 1b:** Photograph showing lengths of different segments of humerus of Indian Barking deer (contd.)

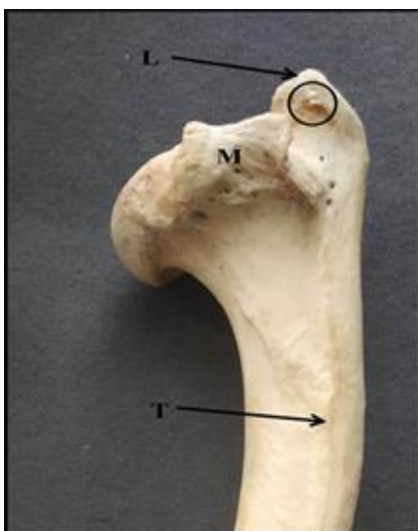
**Fig 1a:** Photograph showing lengths of different segments of humerus of Indian Barking deer



**Fig 2:** Photograph showing lateral surface of humerus of Indian Barking deer showing triangular shaped area for insertion of infra-spinatus muscle (\*), deltoideus ridge (R) and deltoideus tuberosity (T)



**Fig 4:** Photograph showing anterior surface of humerus of Indian Barking deer showing medial tuberosity (M) and lateral tuberosity (L) curving over the bicipital groove (B), radial fossa (R), medial condyle (C1) and lateral condyle (C2)



**Fig 3:** Photograph showing medial surface of humerus of Indian Barking deer showing teres tubercle (T), medial tuberosity (M), lateral tuberosity (L) and two spine-like structures on lateral tuberosity (encircled)



**Fig 5:** Photograph showing distal extremity of humerus of Indian Barking deer showing nutrient foramen (encircled) and deep olecranon fossa (O)

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