SHORT COMMUNICATION

Gross Anatomical and Morphometrical Studies on the Humerus of Indian Fox (*Vulpes bengalensis*, Shaw, 1800)

Supriya Botlagunta*, Karunasri Vaddi, Sai Urmila Talupuri, Prashanth Babu Ankem

Abstract

The Indian fox is the smallest wild canid and widely distributed fox species in southern India. The present investigation was performed on the humeri of four adult Indian foxes to observe their characteristic features. The humerus of the Indian fox was a long, cylindrical bone with indistinct musculo-spiral groove. The maximum average length of the humerus was 8.925 cm. The shaft had four surfaces. The anterior and lateral surfaces were separated by an anconeal line that descended from the space between the head and lateral tubercle and had a distinct teres minor tubercle. The deltoid tuberosity was like a low ridge. The proximal epiphysis consisted of a head caudally, a neck, a cranio-lateral greater tubercle, and a medial minor tubercle. The intertuberal groove was wide. One nutrient foramen was observed between the medial face of the lateral tubercle and the head. On the medial surface, the tubercle was absent. The distal extremity consisted of two condyles and two epicondyles. The lateral and the medial condyles are called capitulum humeri and trochleo humeri, respectively. The trochlea is articulated with the trochlear notch of the ulna to give more stability to the elbow joint. An oval supratrochlear foramen connected the coronoid and olecranon fossae. The supracondyloid foramen was absent.

Keywords: Anconeal line, Deltoid tuberosity, Humerus, Indian fox, Morphometry.

Ind J Vet Sci and Biotech (2025): 10.48165/ijvsbt.21.1.22

Introduction

Indian fox is endemic to the Indian subcontinent. Indian foxes belong to the family Canidae and it is an omnivore. Humerus of different species has been studied widely, *i.e.,* in dogs (Evans and de Lahunta., 2013), mongoose (Shanmugam and Sundaram, 2022), Indian wild cats (Palaniswamy *et al*., 2020), lions (Pathak *et al.,* 2017; Sohel *et al*., 2021), tigers (Tomar *et al*., 2014), leopards (Indu *et al*., 2007; Podhade *et al*., 2014), cheetah (Petronela *et al*., 2014) and Asiatic lion (Pandya *et al*., 2023). The morphological and morphometrical study of the bones of the forelimb of the Indian fox has not been studied in detail. Besides, in radiology and forensic studies, the osteo-morphometrical features of the humerus are important. Therefore, the present investigation on morphological and morphometrical features of the humerus of Indian fox was undertaken.

Materials And Methods

The present study was conducted on the humerii of four adult Indian foxes in the Department of Veterinary Anatomy, College of Veterinary Science, Proddatur (Andhra Pradesh, India). The bones were collected after maceration and observed for gross morphological features. The terminologies were adopted from Nomina Anatomica Veterinaria (2017). Different biometrical parameters, *viz*., Weight of left & right humerus, Maximum length of the humerus, Physiological length of the humerus, Circumference of the shaft in the upper part, Circumference of the shaft in the middle part, Circumference of the shaft in the lower part, Circumference of head, Circumference of proximal extremity, Width of proximal extremity, Circumference of distal extremity, Width of distal extremity, Humerus index (10 times the distal width ÷ maximum length) were measured with the help of a thread, meter scale, and Vernier callipers as follows:

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How to cite this article: Supriya, B., Karuna, V., Sai Urmila, T., & Prashanth Babu, A. (2025). Gross Anatomical and Morphometrical Studies on the Humerus of Indian Fox (*Vulpes bengalensis*, Shaw, 1800). Ind J Vet Sci and Biotech. 21(1), 110-113.

Source of support: Nil

Conflict of interest: None

Submitted 01/11/2024 **Accepted** 30/11/2024 **Published** 10/01/2025

Results and Discussion

The average weight of the right and the left humerus was 5.96 gm and 5.98 gm, respectively. The humerus is a bone of the brachium and the largest bone of the thoracic limb. The length of the right and left humeri in Indian foxes was 8.93 cm and 8.92 cm, respectively (Table 1), which was quite lower than that of Mudhol hound dogs (22.86 cm and 22.81 cm, respectively; Muthuraj *et al*., 2022). The average

length of the humerus reported in mongoose was 6.38 cm (Shanmugam and Sundaram, 2022) and in Asiatic lion 25.10 cm (Pandya *et al*., 2023). The humerus was directed downward and backward and proximally it articulated with the glenoid cavity of the scapula in forming the shoulder joint and distally forming the elbow joint with the radius and ulna bones. The bone consisted of a diaphysis, proximal epiphysis, and a distal epiphysis as described by Evans and de Lahunta (2013) in dogs.

Table 1: Morphometrical features of the humerus of Indian fox.

Parameter	Right (Av. cm)	Left (Av. cm)
The maximum length of the humerus	8.93	8.92
Physiological length of the humerus	8.55	8.56
Circumference of the shaft in the upper part	3.5	3.4
Circumference of the shaft in the middle part	2.6	2.5
Circumference of the shaft in the lower part	2.9	2.9
Circumference of head	4.5	4.4
Circumference of proximal extremity	5.5	5.5
Width of proximal extremity	1.85	1.85
Circumference of distal extremity	4.4	4.3
Width of distal extremity	1.54	1.53
Humerus index	1.724	1.715

The proximal epiphysis consisted of a head caudally, a neck, a cranio-lateral greater tubercle (lateral tuberosity), and a medial minor tubercle (medial tuberosity) (Fig. 1, Fig. 2). The head was round with almost similar sagittal and transverse diameters (1.51 cm and 1.35 cm, respectively) with a much flatter cranial part that continued into the bicipital groove. These observations corroborated with the findings of Uddin *et al*. (2022) in the royal Bengal tigers. The circumference of the head in the right and left humerus was 4.5 cm and 4.4 cm, respectively. The mean circumference of head of the humerus reported in Asiatic lion was 13.66 cm (Pandya *et al*., 2023). Sohel *et al.* (2021) observed the mean circumference of the head of right and left humerus in lions as 17.28 and 17.22 cm, while Podhade *et al*. (2014) reported it in leopard as 9.65 cm. The inter-tuberal groove was wide in Indian fox. The greater tubercle had a smooth, convex summit and was slightly higher in level than the head, but in badgers, the lateral tuberosity and the head were reported at the same level (Johnson, 2015). The greater tubercle in Indian foxes was undivided in line with the findings in other carnivores (Palanisamy *et al*., 2020). Evans and de Lahunta (2013) mentioned the presence of several small foramina between the head and greater tubercle in dogs, and Pandey *et al.* (2023) identified several foramina at the fusion point of the head with medial tuberosity in Asiatic lions. In the present study, one foramen was observed between the medial surface of the lateral tuberosity and the head. The flattened lesser tubercle (medial tuberosity) was placed craniomedially and close to the head (Fig. 2).

The diaphysis of the humerus was long, straight, cylindrical with a poorly defined musculo-spiral groove. The anterior surface was triangular. The tricipital line (anconeal line) descended from the space between the head and the lateral tuberosity, had a prominent teres minor tubercle (tuberositas teres minor) (Fig. 1). Similar findings were observed in dogs by Evans and de Lahunta (2013). The deltoid tuberosity was like a faint ridge in Indian foxes, whereas in Mudhole hound dogs the deltoid tuberosity was like a prominent ridge (Muthuraj *et al*., 2022). The medial surface of fox humerus was smooth. The medial face lacked the teres tuberosity (Fig. 4). The presence of crest-like teres tubercle was recorded on the medial surface of the humerus in dogs by Evans and de Lahunta (2013). The posterior surface started from the neck and was convex transversely, concave along the length in the proximal half, and straight in the distal (Fig. 5).

The distal extremity of the humerus showed two condyles and two epicondyles (Fig. 1, Fig. 3). The medial condyle was the larger of the two. The lateral condyle is called capitulum humeri. The medial condyle called trochleo humeri, consisted of a prominent trochlear ridge that articulated with the trochlear notch of the ulna and an oblique deep groove that led to the olecranon fossa posteriorly and the coronoid/radial fossa anteriorly. In the medial edge of the distal extremity supra-condyloid foramen was not observed in the present study, however, it was reported on the distal extremity of the humerus of several other species like cats and badgers (Johnson, 2015), Asiatic lions (Pandey *et al*., 2023), lions (Pathak *et al*., 2017; Sohel *et al.,* 2021), tiger (Tomar *et al.,* 2014), leopard (Podhade *et al*., 2014) and cheetah (Petronela *et al.,* 2014). The coronoid and olecranon fossae communicated through the supratrochlear foramen, whereas in Asiatic lion, the radial fossa and olecranon fossae did not communicate (Pandey *et al*., 2023). The medial aspect of the medial condyle beared prominence and the lateral of the lateral condyle had a depression for attachment of collateral ligaments of the elbow. The olecranon fossa was deeper and communicated through the coronoid fossa through the supra-trochlear foramen. The inner margins of the lateral and medial epicondyle bound the olecranon fossa (Fig. 5). The depth of the olecranon fossa was 0.51 cm. The medial epicondyle was the larger of the two. The lateral margin of the lateral epicondyle ascended on the posterior face to form the lateral epicondyloid crest of about 1.74 cm long. Similar observations were found in mongoose by Shanmugam and Sundaram (2022).

In conclusion, the present study provided the basic gross osteological details about the humerus of Indian fox which revealed no difference between the right and left humeri. The humerus has a prominent anconeal line with teres minor tubercle and ridge-like deltoid tuberosity. The medial surface of the shaft lacks teres tuberosity. The supratrochlear foramen is present, communicating the deep olecranon fossa with the radial fossa. The supracondyloid foramen is absent in fox.

Fig. 1: Photograph showing the lateral surface of the humerus. MSG: musculospiral groove, H: head, N: neck, GT: greater tubercle, AL: anconeal line, DT: deltoid tuberosity, TMT:teres minor tubercle, ME: medial epicondyle, LE: lateral epicondyle, STF: supratrochlear foramen, O:olecranon fossa, LSCC: lateral epiconyloid crest

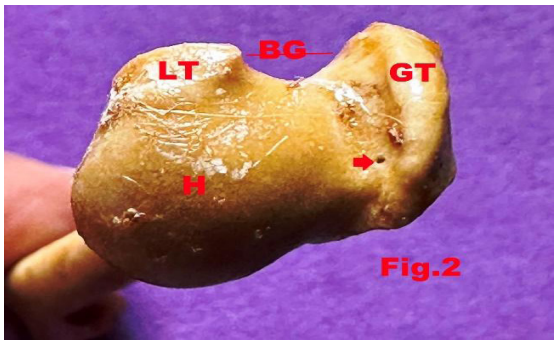

Fig. 2: Proximal extremity of humerus showing head (H), greater tubercle (GT), lateral tubercle (LT), wide bicipital groove (BG), and red arrow, the nutrient foramen

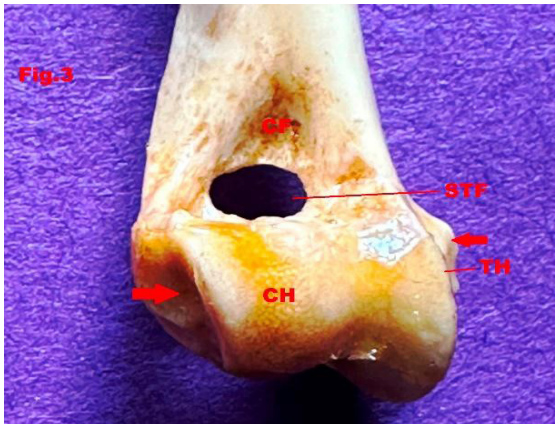

Fig. 3: photograph of the distal extremity of the humerus showing supratrochlear foramen (STF), trochlea humerii (TH), capitulum humerii (CH), red arrows present the depression and elevation on the lateral and medial aspect of distal extremity for attachment of the lateral and medial collateral ligaments of elbow.

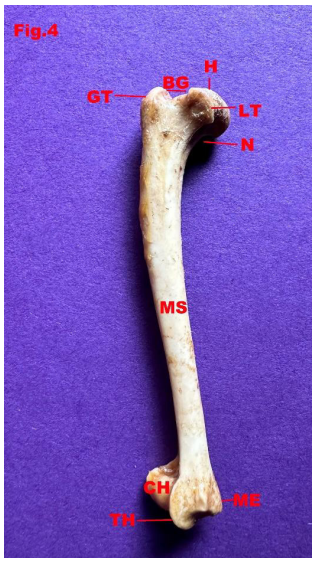

Fig. 4: Photograph showing smooth medial surface of the humerus (MS) H: head, N: neck, GT: greater tubercle, LT: lesser tubercle, ME: medial epicondyle, LE: lateral epicondyle, STF: supratrochlear foramen, O: olecranon fossa, LSCC: lateral epi condyloid crest

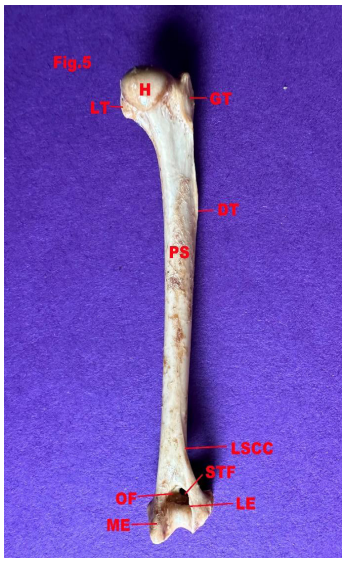

Fig. 5: Photograph of posterior surface (PS) of humerus showing head (H), GT: greater tubercle, LT: lesser tubercle, Dt: deltoid tuberosity, ME: medial epicondyle, LE: lateral epicondyle, STF: supratrochlear foramen, OF: olecranon fossa, LSCC: lateral epi condyloid crest

Acknowledgments

The authors are thankful to the Sri Venkateswara Veterinary University for providing the facilities for this work.

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