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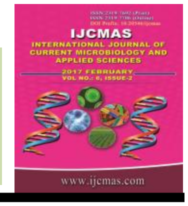

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Morphological and Certain Morphometrical Study of Humerus Bone of Indian Tiger

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Present study was conducted on the humerus bones of five adult Indian tigers. The shaft was a four sided structure upto the one third of its length, after which it became three sided because of merging of the anterior surface distally. Olecranon fossa was heart shaped and had several foramina. Greatest length of humerus was (33.62 cm) approximately three times than mid-shaft diameter of the humerus (10.88 cm). The humeral index was less (32.39), it means the humerus was elongated bone. To understand the ecology, biology of the animal and its role within the ecosystem the locomotion provides a key factor. The humerus is an important bone for locomotion, for transfer of weight and for propelling the body forward, by its position it also serves as a protective support for the thorax. The present study put on record the basic morphologic and morphometric anatomy of humerus in tiger which would fill the gap in the scientific literature, on the gross anatomy of humerus of tiger.

Introduction

Tiger, the pride of our country command the Asian landscape as the top predator, immense, magnificent, muscular animal armed with razored claws and massive canines. It has listed as an endangered species due to the humanization of nature and few accountable poaching activities (Robert *et al*., 2005). In the ecology of any animal, locomotion plays a crucial role. Animals move in their home ranges to forage for food resources, to search for the mating partner, to avoid the stressful environment, to pursue their prey or to escape from potential dangers like human being (Ewer, 1973; Biewener, 2003). Forelimb strength is part of an adaptive complex driven by the need to achieve the rapid immobilization of prey, thus decreasing the risk of injury and minimizing energy expenditure (Salesa *et al*., 2010). The humerus is a forelimb bone with a good muscular mass around it. As there is lack of systemic information regarding humerus of tiger, the current study was contemplated on the gross study of humerus which can enrich the anatomical knowledge on wild animals.

Materials and Methods

Gross anatomy of the humerus bones of five adult Indian tigers was studied. The bones were collected from the section of Veterinary Anatomy, Indian Veterinary Research Institute, Izatnagar, Bareilly, and Uttar Pradesh, India. The morphometrical data were recorded with the help of thread, scale and Vernier calipers. The gross morphology were included the curvature, elevation, depression present on the bones without any apparent skeletal disorders to understand the humerus of tiger. The following morphometric parameters of the humerus bone of Indian tiger were included in the present study

Greatest length of the humerus (GL): The distance between the most distal point of the trochlea to the most proximal point of the head (caput).

1. **Mid-shaft diameter of the humerus (MD):** It was taken at a point 35 percent back from the distal end of humerus.

2. **Proximal width of the humerus (PW):**The breadth of the proximal end of the humerus

3. **Distal width of the humerus (DW):** The breadth of the distal end of the humerus

4. **Humeral index (HI):** Mid shaft diameter of the humerus×100/ Greater length of humerus

The data generated from five animals were analysed to find mean ± SE for each parameter.

Results and Discussion

Humerus bone of tiger was long and slender. It had a shaft (body) and two extremities (proximal and distal).

Proximal extremity consisted of head, neck and two tuberosities i.e. lateral and medial. The bigger and most cranio-lateral proximal protuberance was the greater or lateral tuberosity. Lateral tuberosity was well developed whereas medial tuberosity was fused with the head. Large lateral and small medial tuberosity were separated by the bicipital groove, which was shallow in the present study. Several foramina were present at the fusion point of head with medial tuberosity (Fig. 1). Lateral tuberosity was grooved and several foramina were appreciated in the present investigation.

The shaft was a four sided structure upto the one third of its length, after which it became three sided because of merging of the anterior surface distally. Anterior surface was triangular, wide in front and narrow behind. A bony ridge, the humeral crest or tricipital line extended from the humeral head cranially and distally towards the deltoid tuberosity. Humeral crest divided the anterior and lateral surface and it fused with the antero-medial border. Deltoid tuberosity was less developed. Lateral surface was identified by the presence of musculospiral groove which was shallow (Fig. 2). Medial surface was flat, wide above and narrow behind. Teres tubercle was elongated. Nutrient foramen was present at the distal third of the shaft. Posterior surface was rough and narrow which widened distally. Onpostero-lateral surface there was supracondyloid crest.

The distal extremity of the humerus was characterized by the presence of two condyles, two epicondyles, two fossae i.e. coronoid and Olecranon fossa. The medial condyle (trochlea) articulated with the trochlear notch of the ulna. The smaller lateral condyle (capitulum) articulated with the radial head below. Coronoid fossa was shallower. Olecranon fossa was deep. Olecranon fossa was heart shaped and had several foramina. Margins of the Olecranon fossa were sharp and distinct in the lateral side whereas the margin was continuous along with medial epicondyle at the medial aspect (Fig. 3). Lateral epicondyle was grooved at the medial side. Medial epicondyle was prominent, well developed. Just above the medial epicondyle a large oval foramen was present known as supracodylar foramen and continued in the antibrachium and distal limb region (Fig. 3).

The results of different morphometrical parameters are depicted in table 1.

The slender characteristics of long bones has been usually interpreted as an adaptation to reduce the energetic costs of terrestrial locomotion by decreasing the moment of inertia of limbs and by increasing the stride length and enabling the animal to travel a longer distances on the ground and to run faster (Hildebrand, 1985; Janis and Wilhelm, 1993).

Table.1 Morphometrical parameters (Mean±S.E.) of humerus bones in adult Indian tiger

S.N.	Morphometrical Parameters	Mean±SE
1.	Greatest length of the humerus	33.62±0.87 (30.5-35.4)
2.	Mid-shaft diameter of the humerus	10.88±0.20 (10.1-11.2)
3.	Proximal width of the humerus	11.24±0.80 (9.6-14.2)
4.	Distal width of the humerus	6.28±0.14 (5.8-6.5)
5.	Humeral index	32.39±0.45 (31.07-33.63)

Fig.1 Photograph of humerus of adult Indian tiger (proximal extremity) showing lateral tuberosity (L), medial tuberosity (M), bicipital groove (B), several foramina at the fusion point of head with medial tuberosity (arrow) and head (H)

Fig.2 Photograph of humerus of adult Indian tiger (antero-lateral view) showing grooved lateral tuberosity (L), head (H), deltoid tuberosity (D), crest of humerus (arrow), musculo-spiral groove (MG), supra condyloid crest (SC), coronoid fossa (CF), lateral condyle (LC) and medial condyle (MC)

Fig.3 Photograph of humerus of adult Indian tiger (distal extremity) showing supracodylar foramen (SF) and heart shaped Olecranon fossa (O)

Martin- Serra *et al*., (2014) reported that the humerusis a 'S' shaped slender long bone comprising of proximal extremity, neck, shaft and distal extremity in carnivores.

In between postero-lateral surface there was supracondyloid crest reported as epicondyloid crest in horse by Sisson (1975). Change in the curvature of the shaft of humerus and the expansion of the distal epicondyles accounted for change in animal posture (adducted or abducted forelimb). Laterally curved humeral crest interpreted as an adducted position for the humerus (Martin- Serra *et al*., 2014).

Medial epicondyle was prominent, well developed. The expansion of the medial epicondyle is associated with an increased mechanical advantage of pronator teres muscle and the digital flexor muscles (Barone, 1986).

Just above the medial epicondyle a large oval foramen was present known as supracodylar foramen through which the median nerve and the brachial artery passes and continued in the antibrachium and distal limb region. This foramen gives an additional protection to the above said structures from the pressure exerted while these ferocious animals are embracing their prey. Presence of this foramen has been already reported in cat by Shivley and beaver (1985), Saxena and Saxena (2008).

The length of humerus in the tiger was 33.62 cm which was corroborated the finding of Lucy and Harshan (2010); Arora (2010) in the tiger. Mid shaft diameter was 10.88 cm. These findings were contrary with the study of Lucy and Harshan (2010); Arora (2010). They are found the mid shaft diameter to be 12 cm and 16.5 cm respectively. Greatest length of humerus was (33.62 cm) approximately three times than mid-shaft diameter of the humerus (10.88 cm); it means the humerus bone was long and slender. The proximal width of the humerus at the level of head was (11.24 cm) found to be more than distal width at the level of condyle (6.28 cm). The humeral index was less (32.39), it means the humerus was elongated bone.

To understand the ecology, biology of the animal and its role within the ecosystem the locomotion provides a key factor. The humerus is an important bone for locomotion, for transfer of weight and for propelling the body forward, by its position it also serves as a protective support for the thorax. Addition to this, a success fracture fixation depends largely on a sound knowledge of both skeletal and soft tissue anatomy around the affected region for the rehabilitation of the animal in the way of conservation. The present study put on record the basic morphologic and morphometric anatomy of humerus in tiger which would fill the gap in the scientific literature, on the gross anatomy of humerus of tiger.

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