Gross morphological studies of the scapula and humerus of the Indian grey mongoose or Asian grey mongoose *(Herpestesedwardsii)*

ABSTRACT

The scapula of the Indian grey mongoose was a flat and trapezoid shaped bone with two surfaces, four borders and four angles.The scapular spine divided its lateral surface into two unequal fossae and terminated as a pointed hamate process, the latter presented a triangular suprahamate process whose apex was pointed and directed caudally. The glenoid cavity was shallow with a cranially projected supraglenoid tubercle that possessed medially a small indistinct coracoid process.The humerus was a long bone with a distinct spirally twisted shaft and twoextremities. Its proximal extremity had an ovoid head, lesser tuberosity placed medial to the head and a greater tuberosity lateral to the head. The bicipital groove was wide and shallow.The musculospiral groove was deep. The proximal half of the shaft had a medially located pectoral ridge and a laterallysituated prominent sharp deltoid crest. The distal end had two condyles, two epicondyles and two fossae, a cranially placed shallow coronoid fossa and caudally placed deep olecranon fossa. The two fossae communicated cranially through the supratrochlear foramen. A sharp prominent lateral epicondylar crest was present and above the medial epicondyle was the oval supracondyloid foramen.

Key words: Mongoose,scapula,hamate process, humerus, supratrochlear, supracondyloid foramen.

INTRODUCTION

Mongoose is a small terrestrial carnivorous mammal belonging to the family Herpestidae. The subfamily Herpestinae comprises23 living species that are native to southern Europe, Africa and Asia[1]. The Indian grey mongoose or Asian grey mongoose *(Herpestesedwardsii)*is a mongoose species native to the Indian subcontinent and West Asia. This is one of 5-6 species in the Indian subcontinent and is the state animal of Chandigargh. This species is considered as the least concern in IUCN red list[2]. It is a good climber and can also swim. They have short limbs and are known for their speed and agility with their short limbs and are capable of combating venemous snakes. Scientific studies on the anatomy and morphology of this animal has become the area of recent interest for wildlife biologist. Research studies on various organs and organ systems of the Indian Grey mongoose and related species in this Herpestinae family has begun to add up to the available pool of literature. This current study on the gross morphological and radiographic anatomy of the bones of the shoulder and arm region in Indian grey mongoose*(Herpestesedwardsii)* is not done yet and will certainly fill and enrich this knowledge gap.

MATERIALS AND METHODS

The cadaver of the Indian grey mongoose from the Puducherry region of India was utilized for the present study. All the animals suffered natural death and was referred by the Department of Forest and Wildlife, Puducherry for their post mortem examination in the Department of Veterinary Pathology, Rajiv Gandhi Institute of Veterinary Education and Research, (RIVER) Puducherry. These cadaverswere then subjected to radiographic inspection of the bones and joints in the radiology Unit, Teaching Veterinary Clinical complex, RIVER. After radiographic examination, they were carefully removed off their skin and muscles by careful dissection to the best possible extent and the bony remains were subjected to maceration without burying as recommended by [3]for smaller specimens and [4] for human cadavers. Necessary precautions were taken during processing with chemicals for this study. The bones were then brushed with a softbristled tooth brush to make them clean and to get rid of any adhering remnants. They were finally washed thoroughly with running tap water to get rid of the residual chemicals and then air driedas recommended by [5].These bones were used to study for their gross morphological features and to be photographed for their features.

RESULTS AND DISCUSSION

Scapula

The scapula of the mongoose was flat and almost trapezoid in shape (Fig 1). Such quadrangular shaped scapula was reported by [6] in civet cat;[7] in Indian wild cat; [8] in tiger and [9] in Himalayan mongoose. Whereas,[10] described a nearly triangular scapula in New Zealand rabbit and domestic cat.In leopard cat and fishing cat it was rounded and an almost triangular scapula was present in the small Indian civet cat [11].In Indian grey mongoose the scapula had 2 surfaces,4 borders and 4 angles.The surfaces were lateral and medial (Fig 1). The lateral surface presented a sharp edged spine which gradually increased in height and presented in the middle a tuberosity.The scapular spine in its distal one third, presented a notch. This spine terminated as the pointed acromion or the hamate process,which was at the level of the glenoid cavity (Fig 1a).

In lion, the acromion process hanged over the glenoid cavity [12]. Contrarily, [13] observed that the scapular spine diminished from the tuber spine and did not form the acromion process.The spine in this species divided the lateral surface into two unequal fossae; supraspinous and infraspinous fossae as reported by [9] in the Himalayan mongoose.In contrast, the scapula was divided into two equal fossae in lion [7], domestic cat [10],great Indian rhino [13], dog [14],Hedge hog[15],Indian wild cat[16].

According to [17] in sloth bear, the scapula had an additional spine that divided the supraspinous fossa into cranial and caudal parts. In the present study, the scapular spine was inclined towards the infraspinous fossa as reported by [11] in fishing cat and small Indian civet cat. The acromion or hamate process in this species presented a triangular suprahamate process with its base attached to the spine. It deviated from the spine at an acute angle(Fig 1a). Similar to the above finding, [12] described that suprahamate process was a thick triangular backwardly directed plate in lion and [6] termed it as metacromion process that was roughly triangular and caudally directedin civet cat.The apex of the suprahamate process was pointed caudally towards the infraspinous fossa as observed by [9] in the Himalayan mongoose and [11]in fishing cat. Thesuprahamate process was broad and semicircular in catand was an irregular L shaped process in the rabbit [10].In contrast, the metacromion process was found absent in dog [18].

In the present study, the cranial border of scapula was curved with a small indendation anteriorly, just below the cranial angle and a prominent notch distallyas reported by [9] in the Himalayan mongoose. The dorsal border curved from the cranial angle and terminated caudally as a thick blunt projection. The caudal border was thick. From this thick blunt projection, it curved slightly till the middle, forming a convexity and then dropped straight down. In lion, a pointed projection was seen from the caudal angle of the scapula [12]. The ventral border included the curve of the cranial border and the rim of the glenoid cavity (Fig 1a).The cranial angle was obtuse. Caudal angle was acute and the thickest. The cranio-ventral angle was right angled and the caudo-ventral angle was slightly obtuse. A nutrient foramen was noticed at the base of the spine, towards the glenoid angle which coincides with the observation of [14].The glenoid cavity in this species was in the shape of an oblong circle.But, it was rectangular in Indian elephants [6], oval to quadrangular in tiger [8] circular and deep in black Bengal goat [19], elongated in elephant [20]. In the present study, the rim of the glenoid cavity, near the posterior border of scapula was wide and round, while near the anterior border it was narrow. The glenoid cavity was shallow and a muscular process called the supraglenoid tubercle projected in front of the cavity that gave origin to the biceps brachii muscle (Fig 4a). These findings are similar to the dog [21]. This tubercle projected cranially and had a medial inclination as reported by [14] in dog. The glenoid notch was present along the ventromedial aspect of the rim of the glenoid cavity. Whereas, it was on the lateral aspect of the rim in the Himalayan mongoose[9] and on the anterolateral aspect of the rimin fishing cat [11].

The scapula of the Indian grey mongoose on its medial surface presented a relatively shallow subscapular fossa. Cranial and caudal to the fossa was a cranial and a caudal ridge as reportedin tiger by [8], whereas four ridges were seen in civet cat [6]. On the other hand, the subscapular fossa was distinct with two prominent ridges in hippopotamus [22]. The coracoid process in this species was small and indistinct situated on the medial aspect of the supraglenoid tubercle (Fig 4a). It was hook like in civet cat [6], tiger [8],rounded in Himalayan mongoose[9], beak like in rabbit [10] and in domestic cat [10, 23]. The coracoid process is a remanant of the coracoid bone that is still distinct in monotremes [14].

Humerus:

The humerus of the mongoose was a long bone of the arm. It was placed obliquely downward and backward and articulated proximally with the glenoid fossa of the scapula and distally with the radius and ulna (Fig 5). It had a spirally twisted shaft and two extremities proximal and distal. The shaft presented 4 surfaces namely anterior, posterior, medial and lateral as studiedin mongoose [24].The proximal extremity consisted of a posteromedially placed smooth, ovoid head and two tuberosities, medial and lateral(Fig 4b) as in dog[18] and cat [10, 25]. Whereas, it was spherical in civet cat [26] long and craniocaudally curved in lion [12].This ovoid head in mongoose would permit a high degree of extension and flexion in this species. Lateral to the humeral head was the greater or lateral tuberosity. The lesser or medial tuberosity was located just medial to the head. (Fig 4b). Anteriorly, between the two tuberosities was placed the wide and shallow bicipital groove, through which the tendon of biceps brachii passed (Fig 2b, 4b) as reported by [24] in mongoose. A distinct well defined neck was noticed in the present study. The lateral tuberosity presented on its posterolateral aspect, a deep depression. But a grooved lateral tuberosity was reported by [27] in the Indian tigerand was a deep notch in mongoose [24].

The shaft of the humerus in this species was distinctly twisted with a deep musculospiral groove (Fig 2a)as reported by [24]. The proximal half of the shaft presented a medially placed pectoral ridge (Fig 2b) and a lateral prominent deltoid crest. (Fig 2a). The pectoral ridge originated from the greater tuberosity and terminated in the well-developed teres tubercle. A prominent teres tubercle was also seen in domestic cat [25].The deltoid crest in the present study was prominent and sharp and was noticed on the lateral border as reported by [27] in tiger (Fig 2a). In contrast, [24] reported a sharp deltoid tuberosity in mongoose and a complete absence of it in domestic cat [10].

The medial surface of humerus was flat, wide above and narrow behind. The posterior surface was rough and narrow that widened distally.The distal end of the humerus had 2 condyles, 2 epicondyles and 2 fossae (Fig 4c, 4d). Of the 2 condyles the medial one was larger.The humeral condyles involved its articular area, together with the adjacent fossae. The radial or coronoid fossa was shallow and situated cranially above the trochlea. In dog coronoid fossa is absent [14].In this study in Indian grey mongoose the epicondyles above the condyles enclosed the olecranon fossa caudally. The coronoid and olecranon fossa communicated through the supratrochlear foramen which was present in the bony plate that separated the 2 fossae (Fig 4c, 4d).The olecranon fossa was deep and in addition to the supratrochlear foramenit also had several small foramina. This finding is in agreement with [10] who reported that supratrochlear foramen of different size perforated the bony lamina in rabbit. The margin of the olecranon fossa in the present study was sharp on the lateral aspect, while on the medial aspect, the margin continued onto the medial epicondyle as in tiger [27]. The supratrochlear foramen may be absent when the humerus is small in dog [14].The presence of supratrochlear foramem in mammals was variable and was linked to the range of mobility in the elbow joint [28].

A sharp prominent crest called the lateral epicondylar crest extended from the lateral epicondyle, on the posterior aspect, to end a little below the middle of the shaft (Fig 3,5) as reported by [10] in cat,[14] in dog, [24] in mongoose and [26] in civet cat. In the present study, the distal $1/3^{rd}$ or $1/4^{th}$ of the humeral shaft was flattened cranio-caudally. Above the medial epicondyle was noticed the oval supracondyloid foramen roofed by a thick bony ledge (Fig 4c, d) as reported by [10] in cat, [12] in Indian lion,[24] in mongoose,[26] in civet cat, domestic cat and[29] in cheetah. It was absent in dog [18]. The supracondylar foramen was an ancestral structure in mammals which was lost during mammalian evolution [30].In the African giant rats and cats,supracondyloid foramen is present and transmitted the median nerve and brachial artery [21]. Just above the lateral epicondylar crest, in mongoose on the posterior surface was present a nutrient foramen. It was on the caudal surface of the distal half in lion[12]. But, in civet cat it was on the medial surface [26]. In contrary, [24] reported the absence of nutrient foramen in mongoose. However, numerous nutrient foramina in both the diaphysis and epiphysis was observedin the humerus of cat [23].

CONCLUSION

The acromion or hamate process of scapula in Indian grey mongoose presented a distinct suprahamate process similar to that of cat. The glenoid cavity was shallow with a supraglenoid tubercle that projected cranially in front of the cavity as in dog and cat.The ovoid humeral headwas similar tocanine and feline species. The teres tubercle was prominent as in cat. The presence of lateral epicondylar crest resembled both dog and cat. The presence of supracondyloid foramen was similar to that in cat. The supratrochlear foramen was seen as in dog. Thus the bones of the shoulder and arm in mongoose presented features that resembled either of this two carnivores and some that was in common for both carnivores. These findings signifies that these morphological similarities in Indian grey mongoose are the adaptations of locomotion for predation by this carnivore.

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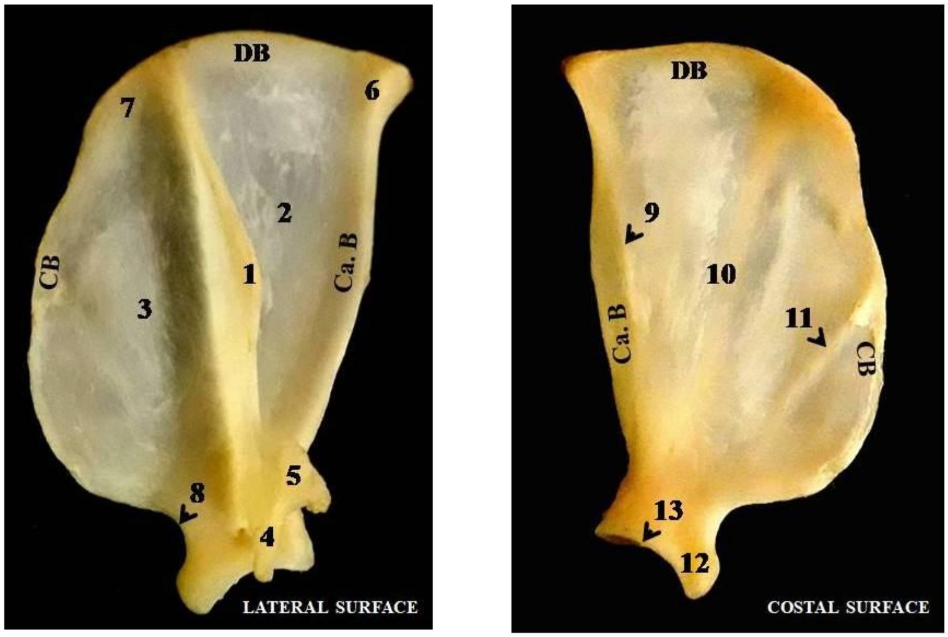
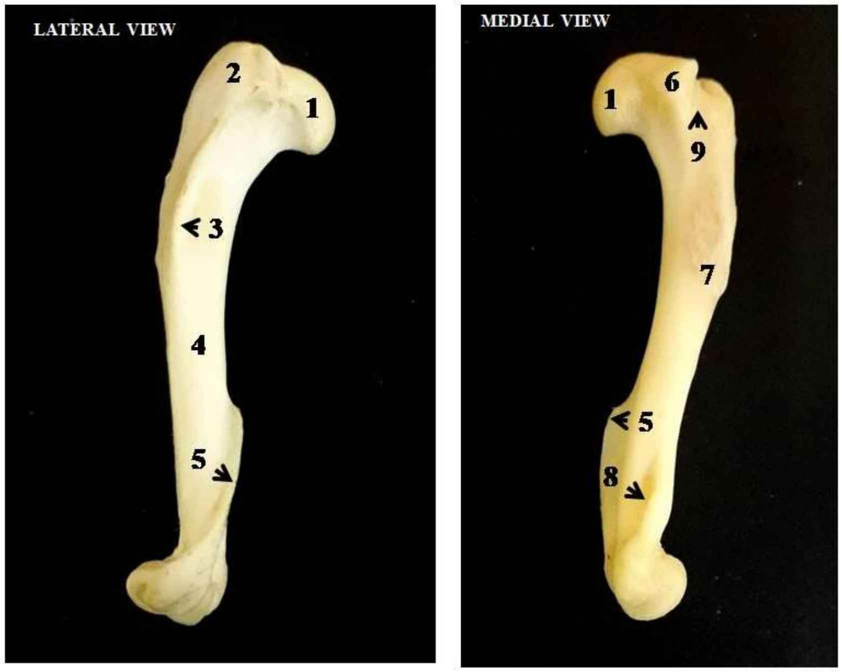
FIGURES:

Fig 1: Photograph of the left Scapula of mongoose showing its features in its lateral and costal surface.



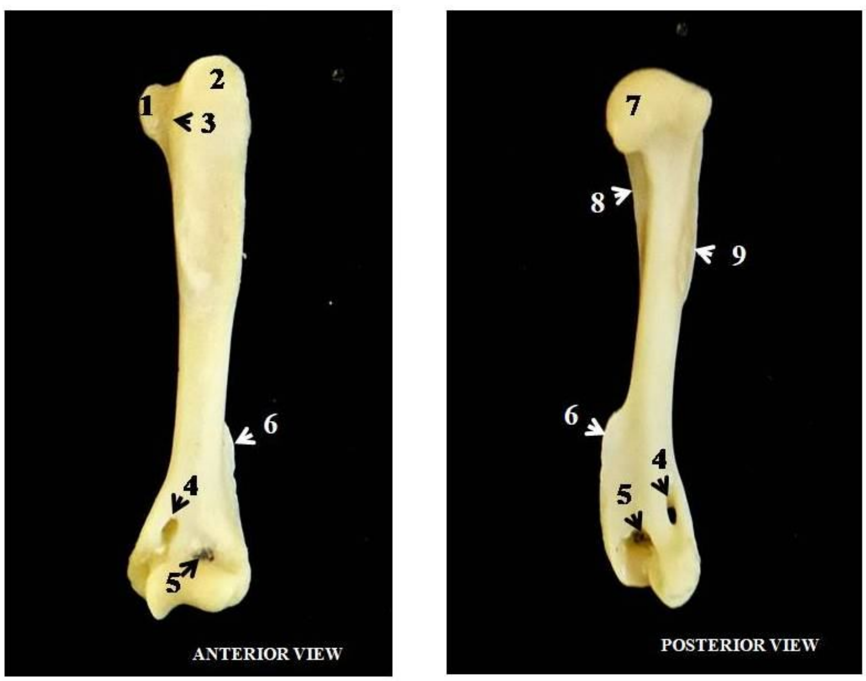
1- Scapular spine, 2- Infra spinous fossa, 3- Supra spinous fossa, 4- Acromion/hamate process, 5- Suprahamate .metacromion process, 6- Caudal angle, 7- Cranial angle, 8- Scapular notch, 9- Caudal ridge, 10- Sub scapular fossa, 11- Cranial ridge, 12-Supra glenoid tubercle, 13- Glenoid cavity

Fig 2: Photograph of the left Humerus of mongoose showing its features in its lateral and medial sides.



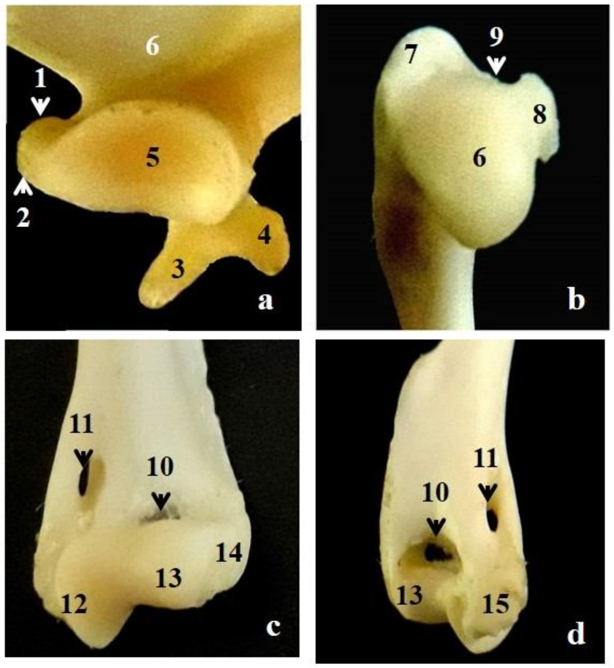
1-Head, 2-Lateral tuberosity, 3-Deltoid crest, 4-Musculospiral groove, 5-Lateral epicondylar crest, 6-Medial tuberosity, 7-Teres tubercle, 8-Supracondyloid foramen, 9-Bicipital groove

Fig 3: Photograph of the left Humerus of mongoose showing its features in its anterior and posterior sides.



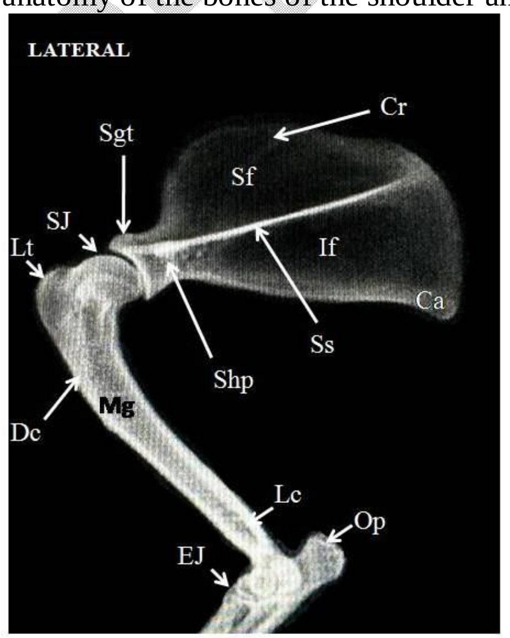
1-Medial tuberosity, 2-Lateral tuberosity, 3-Bicipital groove, 4-Supracondyloid foramen, 5-coronoid fossa, 6-Lateral epicondylar crest, 7-Head, 8-Deltoid crest, 9-Pectoral ridge

Fig 4:Photograph of the extremities of the scapula and Humerus of mongoose showing its features.



(a)- Distal extremity of scapula – 1- Coracoid process, 2- Supraglenoid tubercle, 3- Acromion process, 4- Suprahamate process, 5- Glenoid cavity. (b)- Proximal extremity of humerus – 6- Head, 7- Lateral tuberosity, 8- Medial tuberosity, 9- Bicipital groove. (c)-Distal extremity of humerus (anterior) & (d) (posterior)- 10- supratrochlear foramen, 11- Supra condylar foramen, 12- Medial condyle, 13- Lateral condyle, 14- Lateral epicondyle, 15- Medial epicondyle

Fig 5: Radiographic anatomy of the bones of the shoulder and arm in mongoose.



Cr- Cranial ridge, Sf-Supraspinous fossa, If- Infraspinous fossa, Ca- Caudal angle, Ss- Scapular spine, Sgt_ Supra glenoid tubercle, Shp- Suprahamate process, Sj- Shoulder joint, Lt- Lateral tuberosity, Dc- Deltoid crest, Mg- Musculo - spiral groove, Lc- Lateral epicondylar crest, Op- Olecranon process, Ej- Elbow joint.