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Anatomy

ARCHITECTURE OF SHOULDER MUSCLES OF SLOTH BEAR *(MELURSUS URSINUS)*

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ABSTRACT Sloth bear is one of the youngest carnivores occupying a wide range of habitats in Indian subcontinent. Carcass of sloth bears were studied from Bannerghatta Bear Rescue Centre, Bangalore. The study was undertaken to systematically establish the myological characteristics of shoulder region muscle which might help to carryout morphological assessments. In this study it was observed that well developed supraspinous fossa was filled by M. supraspinatus and infraspinous fossa was filled by M. infraspinatus. The powerful deltoideus muscle consisted of two bellies, arose from acromion process and from the fascia overlying M. infraspinatus. Subscapularis muscle was divided into five fascicular tracts and additional subscapularis minor muscle which was positioned medial to M. subscapularis proper. M. coracobrachialis consisted of two heads, short head inserted beneath the lesser tubercle and longus inserted on supracondylar crest. In sloth bear attachment of muscle was more proximally compared with other carnivore which may account for slow gait of bears and the muscle mass has reflected the quadrupedal walking of sloth bear.

KEYWORDS :

Introduction

Sloth bears (*Melursus ursinus)* are medium-sized nocturnal, insectivorous species currently seen only to southern Asia. They occupy a wide range of habitats on the Indian mainland including wet or dry tropical forests, savannas, scrublands and grasslands. They evolved from ancestral brown bears and have been classified as an ursid. Weighing 70-90kgs these adapt climbers subsist primarily on leaves and fruits. Two separate subspecies are recognized, the Sri Lankan sloth bear (*Melursus ursinus inornatus*) and the Indian sloth bear (*Melursus ursinus ursinus*). Sloth bear is classified as "Vulnerable" in the 1996 IUCN Red List of Threatened Animals and is listed on Appendix I of CITES. (IUCN Red List, Version 2014.2).A number of investigators studied the muscles of bears generally for phylogenetic analyses but the myology of Sloth Bear remains largely undocumented. This study augments the soft tissue data for sloth bear, including detailed description of the shoulder muscles.

Skeletal musculature constitutes the active part of the locomotor system. Skeletal muscles always attaching to bone or cartilage, provides force for locomotion and posture of individual parts of the body or the body as a whole. It also plays an important role in supporting the body weight and formation of abdominal wall (Konig and Liebich, 2004). Each movement of a body part is produced by the involvement of several muscles either simultaneously or one after another. The action of a muscle depends on its origin, course, insertion and point of rotation (Williams and Warwick, 2008).Locomotion and animal posture greatly influence the anatomy of a muscle due to the high frequency and high loads of forces involved.

Materials and methods

Dissections were conducted on the left and right forelimbs of three succumbed captive sloth bears. The bears lived at the Wildlife SOS, Bannerghatta Bear Rescue Centre of Bannerghatta Biological Park, Bangalore, Karnataka included two adult males of 15 and 13 years age, an adult female of 11 years. Following necropsy, the specimens were stored in 10 percent formalin and dissections were carried out. Digital photographs were taken at each level of the dissection. The shoulder region was photographed in medial and lateral views, the arm region in lateral, medial, cranial and caudal views. Muscle origins and insertions were recorded. Data from the forelimb dissections were compared with previous accounts of this species and other carnivores. The terminology in this report conforms to the standards of the Nomina Anatomica Veterinaria (Waibl *et al*. 2005).

Results

MUSCLES ON LATERAL ASPECT OF SHOULDER

M. Supraspinatus

M. supraspinatus took its origin from supraspinous fossa and from cranial aspects of scapular spine. It filled supraspinous fossa (Fig-1) and was covered by cervical part of M. trapezius. Distally its strong muscular belly curved far around neck of scapula (Fig-2) so that it also appeared on medial surface of shoulder joint. As the muscle crossed shoulder joint, M. supraspinatus inserted via a stout tendon onto the dorsal aspect of greater tubercle. M. supraspinatus extends and stabilizes the glenohumeral joint.

M. Infraspinatus

M. Infraspinatus was a triangular shaped muscle which occupied

infraspinous fossa and extended caudally beyond the fossa. M. infraspinatus arose from infraspinous fossa, scapular neck, caudal aspect of scapular spine and from the circular area on lateral aspect of lesser tubercle of humerus. M. infraspinatus was largely covered by the scapular part of M. Deltoideus (Fig-1). The muscle inserted via a stout tendon on lateral aspect of greater tubercle (Fig-2). M. infraspinatus stabilized gleno-humeral joint and laterally rotate the humerus. It may also assist in extension or flexion of gleno-humeral joint, depending on position of humeral head relative to glenoid cavity.

M. Deltoideus

M. deltoideus was a powerful bipennate muscle, consisting of two portions M. deltoideus pars acromialis and M. deltoideus pars scapularis (Fig-1). M. deltoideus par acromialis arose by fleshy fibres from posterior edge of acromion. M. deltoideus pars scapularis originated from fascia covering M. Infraspinatus. It was completely separable from M. deltoideus pars acromialis. It was inserted onto deltoid tuberosity by aponeurosis. Insertion of deltoideus muscle on humerus was via direct attachment of muscle fibres to humeral shaft through fibrous attachment. Deltoid tuberosity was found on lateral surface below the middle of shaft obliquely in the form of a thick ridge.

M. Teres minor

M. teres minor was a small but well-defined muscle observed distocaudally on the scapula (Fig-3). This muscle was wedged below M. infraspinatus. Some fibers of M. infraspinatus took origin from the surface of that tendon. It was inserted by a short, stout tendon onto small circular area present distal to the greater tubercle of humerus, just below the insertion of M. infraspinatus. M. teres minor will act as a flexor for shoulder joint.

MUSCLES ON MEDIAL ASPECT OF SHOULDER

M. Subscapularis

Subscapularis, a rectangular muscle, originated from subscapular fossa and caudal border of scapula. M. subscapularis wrapped around the cranial edge of scapula and also took origin from the surface of M. supraspinatus. M. subscapularis was divided into five tracts by fascial septa (Fig-4). In addition, a tract of parallel fibers which was separated from main mass of M. subscapularis by a fascial septum was noticed along the posterior border of scapula and formed M. subscapularis minor (Fig-5). Posterior half of subscapularis minor was completely covered by M. teres major, which took origin from this surface. Fibers of M. subscapularis minor maintained their identity from M. subscapularis proper down to their insertion, ventral part of lesser tubercle of humerus. M. subscapularis proper fibers passed over M. coracobrachialis tendon and inserted onto remaining part of lesser tubercle of humerus.

M. Teres major

M. teres major was a sheet like muscle which originated from the surface of M. subscapularis minor and from proximal half of caudal border of scapula (Fig-4). It had been displaced completely onto medial surface of the scapula by M. subscapularis minor. M. teres major terminated in a flat tendon, that united with the tendon of M. latissimus dorsi and inserted into roughened scar on the crest of humerus (Fig-6).

M. Coraco-brachialis

M. coracobrachialis was a strap like muscle arose from a rudimentary coracoid process. Tendon of origin of M. coraco-brachialis coursed deep to tendon of M. subscapularis and it passed over the head of humerus and divided into two bellies. First belly was coraco-brachialis brevis (Fig-4) which was a short muscular slip and was inserted onto inner side immediately below the lesser tuberosity of humerus. Second belly or main portion of the muscle was M. coraco-brachialis longus (Fig-4) which continued down on the inner side of the limb. M. coracobrachialis inserted via fleshy and tendinous fibers onto supra condylar crest.

Concluding remarks

Intraspecific variation with other bears and with other species

The origin of M. Supraspinatus is variable in red panda wherein muscle possessed an additional origin from the hamate process (Fischer *et al*., 2009). Hunt (1991) mentioned that deloideus muscle was larger in chimpanzee and may be an adaptation for vertical climbing. M. Teres minor was indistinguishable from M. infraspinatus in American black bear (Shepherd (1883). In present study, short head of biceps was absent in contrast to study made by Miller (1952), who suggested that in gibbons, short head was originating from the lesser tubercle of humerus whereas in monkey, it was from the coracoid process of scapula by common tendon with coracobrachial muscle (Ferreira *et al*., 2007). So in sloth bear this muscle might have less flexion capacity in shoulder level. Davis (1949) found that in carnivore muscle which were attached far away from joints are responsible for fast movement compared with the sloth bear.

Primitive retentions

Data from present study was matched with reports made in orangutans (Oishi *et al*., 2009). He proposed that size difference might reflect the functional specialization for their different positional and locomotor behaviour. Sloth bear posses large post scapular fossa. Davis (1949) revealed that degree of development of post scapular fossa had direct corelation with the size of animal.

Traits shared with family ursidae and carnivora

In bears infraspinatus muscle extended caudally beyond the fossa and similar findings were demonstrated by Evans and de Lahunta (2013) in dog. In sloth bear M. deltoideus par acromialis originated from acromion process of scapula. In other bears also similar findings were recorded by Shepherd (1883) and Fujino (1994). In present study M. teres minor was quite distinct running distocaudally on scapula and inserted to outer side of greater tubercle as in polar bear (Kelley, 1888), in red panda (Fischer *et al*., 2009) and in dogs (Evans and de Lahuta, 2013). Teres major muscle had been displaced completely on medial surface of scapula by M. subscapularis minor. This arrangement was well supported by distinct post scapular fossa in bears.

Conclusion

This study provides additional soft tissue features that can be incorporated in future phylogenetic studies of ursidae family. In addition, the shoulder muscles provide a unique resource for those analyzing the functional anatomy of fossil. The shoulder muscles of sloth bear are characterized by a number of primitive retentions of other bears. Features that are most likely to be derived in the forelimb of sloth bear include M. subscapularis was divided into five tracts by fascial septa and an addition M. subscapularis minor was there on posterior aspect. M. teres major had been displaced completely onto medial surface of scapula and terminated on the crest of lesser tubercle of humerus. So the animal exhibit more walking habit compared with that of other primates.

FIGURES

Fig 1- Figure showing Muscles of shoulder lateral

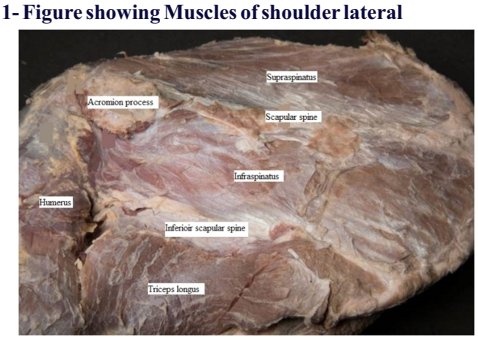

Fig 2- Figure showing M. Supraspinatus and M. Infraspinatus

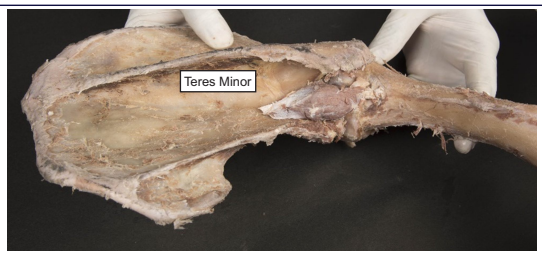

Fig 3- Figure showing M. Teres Minor

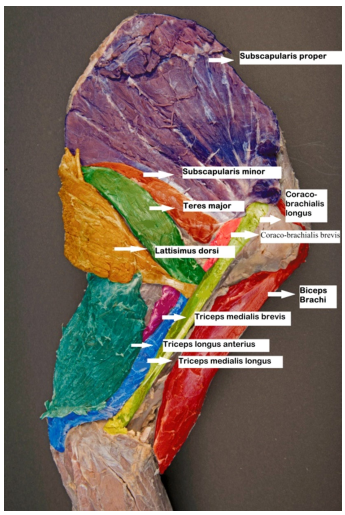

Fig 4 -Figure showing Muscles of shoulder medial aspect

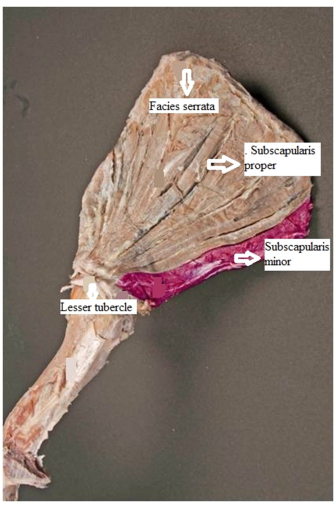

Fig 5 -Figure showing M. Subscapularis

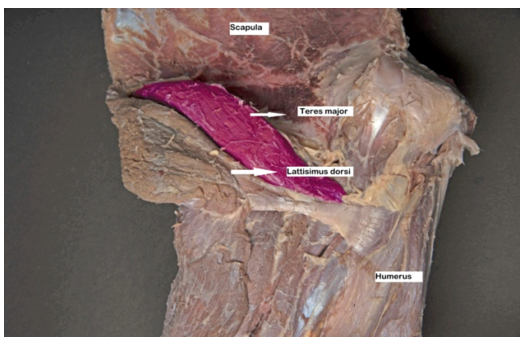

Fig 6- Figure showing M. Teres Major

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