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Skeletal anatomy of the pectoral limb of *Rattus norvegicus*

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Abstract

The present study was conducted on *Rattus norvegicus*, Wistar rats. The samples were collected from the sacrificed animals used for experimental purpose*. The bones were collected after maceration in water. Pectoral limb of the rats had triangular bone scapula, clavicle, separate radius and ulna. The carpus consisted of eight distinct bones arranged in two rows. The metacarpus were four in number. The digits were made of three phalanges in each digit except the first one with two phalanges.

Keywords: Rat, forelimb, scapula, clavicle

1. Introduction

Laboratory rats were used in biomedical research and were always the model of choice for studies on physiology, behavior and complex human diseases. Rats belong to the family *Muridae* and order *Rodentia* with scientific name *Rattus norvegicus*. Wistar Institute in Philadelphia was a premier institute in development of rats as laboratory animals, where the rat strain Wistar was developed (Suckow *et al.*, 2005) [10].

2. Materials and Methods

Carcasses of healthy Wistar rats used for experimental purposes were collected and brought used for maceration. The bones were soaked in water until soft tissue was easily removed (Couse and Connor, 2015) [2]. Following this, the bones were cleaned with water and used for the study.

3. Results and Discussion

Pectoral limb of the rat composed of Scapula, Humerus, Radius, Ulna, Carpus, Metacarpus and Phalanges.

3.1 Scapula

Scapula was a flat bone present on the cranio- dorsal part of the thorax. It was a triangular plate like bone, wide above and narrow below similar to rabbits (Lucy *et al.*, 2012) [5], house and Wistar rats (Kazeem *et al.*, 2020) [3], African giant rats (Olude *et al.*, 2010) [7] and rats (Ozkan *et al.*, 1997) [8]. Lateral surface was divided into two fossae by scapular spine extended from the dorsal border to the neck of the scapula. The cranial smaller fossa was supraspinatus and the caudal larger one was infraspinatus fossa similar to rabbits (Lucy *et al.*, 2012) [5], house rat and Wistar rat (Kazeem *et al.*, 2020) [3].

The spine of scapula was slightly bent over the infraspinous fossa. The acromion process extended upto glenoid angle or the inferior angle as in rabbits (Lucy *et al.*, 2012) [5]. Tip of the acromion process also called as hamate process was flattened lateromedially for the attachment of the deltoideus muscle as in African giant rat (Olude *et al.*, 2010) [7], house rat and Wistar rat (Kazeem *et al.*, 2020) [3]. A roughly triangular medial surface with a single large depression, subscapular fossa was present. It was separated from the anterior rough surface by a shallow ridge (Fig 1).

Posterior border was straight with a prominent posterior angle that separated it from a thick dorsal border. Dorsal and anterior borders were continuous while a notch separated these borders. Dorsal border was slightly curved while in house rats it was almost straight (Kazeem *et al.*, 2020) [3].

Ventral angle had a glenoid cavity with a distinct glenoid notch similar to the reporting of Olude *et al.* (2010) [7] in African giant rat. Cranially tuber scapula was present which in turn had a corocoid process on its medial aspect as in rabbits (Lucy *et al.*, 2012) [5]. Free part of coracoid had a blunt hook like process which was also reported by Chiasson (1980) [1].

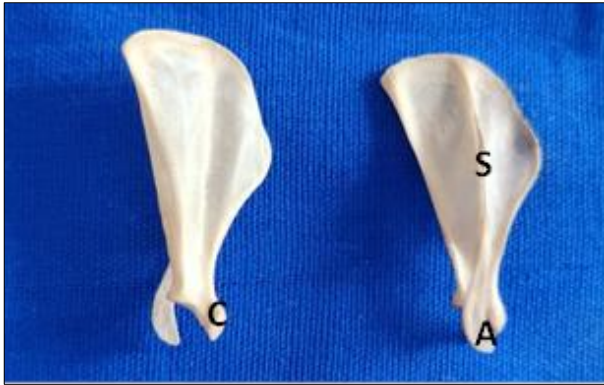


Fig 1: Scapula lateral medial and lateral surfaces.

C – Coracoid process, S – Scapular spine, A – Acromion Process

3.2 Clavicle

It was well developed curved bone in rats unlike rabbits where the bone was not completely developed (Lucy *et al.*, 2012) [5]. Rodents were found to be similar to humans regarding the usage of forelimbs. Hence, the clavicle was well developed compared to other animals that run (Maynard and Downes, 2019; Liska *et al.*, 2018) [6, 4]. The extremity articulated with humerus was rounded as in African giant rat (Olude *et al.*, 2010) [7] and the free end was curved and spoon shaped (Fig 2).



Fig 2: Clavicle of Wistar rat

3.3 Humerus

It had a shaft and two extremities. Shaft was four sided which was irregularly twisted as in rabbits (Lucy *et al.*, 2012) [5]. Lateral surface was smooth with proximal half forming deltoid tuberosity. Medial surface was straight and proximally it was rounded while distally it blended into the lateral condyle. Teres tubercle was indistinct as in rabbits (Lucy *et al.*, 2012) [5] and African giant rats (Olude *et al.*, 2010) [7]. Proximal extremity of the humerus bore head and tuberosities. The head of the humerus was on the medial aspect partially made of cartilage that was lost during maceration. The presented head had a concave facet (Fig 3). Distally it continued onto the shaft. The greater and lesser tuberosities were found divided by a groove which were following the description of Chiasson, (1980) [1] in rat. In African giant rat Olude *et al.* (2010) [7] described the proximal tuberosities as tubercles.

Distal extremity had shallow olecranon fossa on medial surface and coronoid fossa on lateral surface above the lateral articular area which was different from the African giant rat where a supratrochlear foramen was observed (Olude *et al.*, 2010) [7]. Lateral articular surface of the humerus, the capitulum was larger compared to medial surface of humerus which was also described by Chiasson (1980) [1] and Ozkan *et al.* (1997) [8].



Fig 3: Humerus of rat (Arrow Head – crest) H – Head, D – Deltoid tuberosity, O- Olecranon fossa

3.4 Radius

Radius and ulna were two distinct bones. Radius was shorter of the two bones, curved with two surfaces anterior and posterior, two borders medial and lateral. Proximal extremity had facets for the articulation with the humerus (Fig 4). Posteriorly there was a notch on the rim for ulnar articulation as reported by Chiasson (1980) [1] and Ozkan *et al.* (1997) [8]. Distal extremity had a facet for articulation of radial carpal. It was also extended below to from a styloid process on the lateral aspect as in African giant rat (Olude *et al.*, 2010) [7] and rats (Chiasson, 1980; Ozkan *et al.*, 1997) [1, 8]. Both radius and ulna were articulated at the extremities formed a narrow continuous interosseous space as in African giant rat (Olude *et al.*, 2010) [7].



Fig 4: Radius (R) and Ulna (U) of rat P- Olecranon Process

3.5 Ulna

The ulna was slightly curved and was ‘S’ shaped as in rabbits (Lucy *et al.*, 2012) [5] It had two surfaces, two borders and a prominent proximal extremity. Medial and lateral surfaces were present of which the medial surface was grooved. Lateral surface was smooth and convex (Fig 4). Proximal extremity had olecranon process with summit that was notched. Anteriorly the summit extended to form the coronoid process beneath which the semilunar notch was present. These were similar to the findings of Olude *et al.* (2010) [7]. Radius articulated with the facet on the anterior

aspect of the Ulna beneath semilunar notch (Maynard and Downes, 2019) [6].

Distal extremity of ulna presented a styloid process as in African giant rats (Olude *et al.*, 2010) [7], rats (Chiasson, 1980) [1], (Ozkan *et al.*, 1997) [8]. It was not completely fused as in rabbits (Lucy *et al.*, 2012) [5].

3.6 Carpus

The carpus was mainly composed of numerous smaller bones arranged in two rows. There were two bones in the proximal row, radial carpal being the medial bone while ulnar being lateral as in rats (Chiasson, 1980) [1], (Ozkan *et al.*, 1997) [8] and rabbits (Lucy *et al.*, 2012) [5]. In African giant rats Olude *et al.* (2010) [7] reported the fusion of radial and intermediate to form radiointermedial carpal. A pisiform carpal similar to accessory carpal was found behind the ulnar carpal as described by Chiasson (1980) [1], Ozkan *et al.* (1997) [8] in rats, Lucy *et al.*, (2012) [5] in rats. It was not reported in African giant rats (Olude *et al.*, 2010) [7].

In the distal row five small bones were found. From medial side Carpal I, Carpal II, a central Carpal, Carpal III and Carpal IV were present. It was similar to the findings of Olude *et al.* (2010) [7] in African giant rats, Lucy *et al.* (2012) [5] in rabbits and Chiasson (1980) [1], Ozkan *et al.* (1997) [8] in rats.

3.7 Manus

The manus was composed of five metacarpal bones and five digits. The shortest metacarpal bone was metacarpal I while metacarpal III was the longest of all which was also described by Smallwood (1992) in rats and mice.



Fig 5: Metacarpus (MC) and Phalanges (Ph) of rat

The digits were articulated with the distal extremities of the metacarpus. There were two phalanges on the first digit. Other four digits had three phalanges (Fig 5). Last phalanges of the digits formed the claws. These were similar to the African giant rat (Olude *et al.*, 2010) [7].

4. Conclusion

Wistar rats (*Rattus norvegicus*) are the laboratory animals used commonly used in the experimental research. The

knowledge on the skeletal anatomy of these animals will give firsthand information required for the study. The structure of the forelimb bones was mostly similar to other rodents such as African giant rat and rabbits. The minor changes in the scapula and clavicle were found owing to their natural habitat and other habits such as feeding. The morphology of radius-ulna, metacarpus and manus was similar to other rodents.

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