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Anatomy of the hind limb bones of wistar rat (*Rattus Norvegicus*)

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Abstract

The present study was conducted to study the skeletal anatomy of the bones of the pelvic limb of Wistar albino rat (*Rattus norvegicus*). The samples were collected from the animals used in the experimental procedures and were sacrificed during the study. The hind limb was composed of Os coxae, femur, tibia-fibula, tarsals, metatarsals and digits. Tibia-fibula was frequently studied for surgical interventions.

Keywords: Wistar rat, Os coxae, Femur, Tibia

1. Introduction

In the biomedical research, laboratory rats were always considered the model of choice for studies on physiology, behavior and complex human diseases. Rats belong to the family *Muridae*, order *Rodentia* and scientific name *Rattus norvegicus*. Rodents, especially rats were found to be good models for basic research involving skeleton and were considered reliable and affordable alternatives to dogs and non-human primates. Most of the skeletal research in laboratory animals was focused on metabolic bone diseases, such as osteoporosis (Maynard and Downes, 2019)^[7].

2. Materials and methods

Skeletal samples of the Wistar rat were collected from the animals used for other experimental purposes and were sacrificed after the study. The samples were prepared using water maceration technique (Couse and Connor, 2015)^[3].

3. Results and Discussion

The hind limb was larger compared to the forelimb in rodents as they were weight bearing (Maynard and Downes, 2019)^[7]. The pelvic limb of the rat consisted of the Os coxae, Femur, Tibia- fibula, Tarsals, Metatarsus and Digits.

3.1 Os coxae

Os coxae was composed of four different bones fused together to form a single unit. The two halves of the bones fused together in the ventral midline, pubic symphysis to form the pelvic floor.

The three parts were Ilium, Ischium, and Pubis

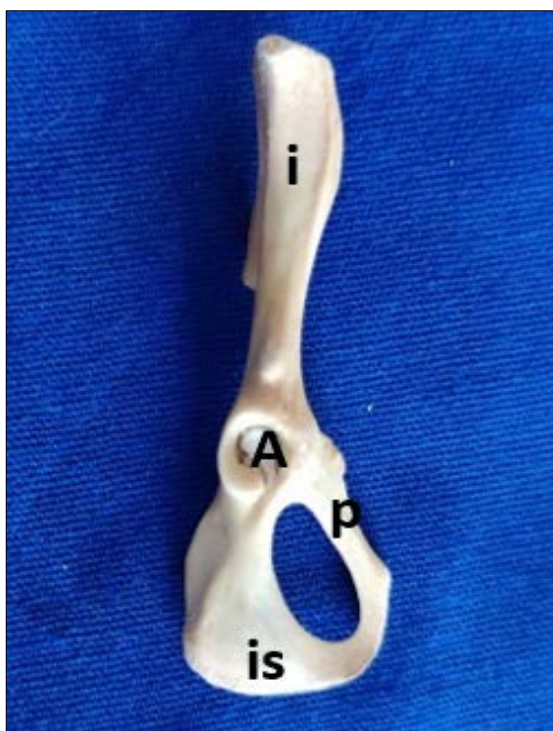
Ilium was the cranial most part of the bone and also the thickest among all. It was straight bone found elongated cranially. The tuber coxae were present on the medial surface as in African giant rat (Olude *et al.*, 2009)^[8]. The cranial tip of the ilium was extended laterally into the ventral iliac spine. Just above the iliosacral joint was a dorsal iliac spine. A tubercle was found cranial to the acetabulum at the neck of the ilium. The dorsal surface was concave.

Ischium formed the dorso-caudal portion of the os coxae. The dorsal edge emerged as ischiatic spine (Fig 1). The ischium and pubis were separated by the large obturator foramen. It was also described by Chiasson (1980)^[2] in rats.

The ventro-caudal portion of the os coxae was formed by pubis. At the pubic symphysis, the other part joined to form the floor of the pelvis. Iliopectineal eminence was found at the cranial border of the obturator foramen.

Acetabular bone or condyloid bone was found in the acetabulum. Acetabulum was a deep cotyloid cavity for the articulation of the femur.

A large oval obturator foramen was found in the posterior half of the Os coxae.

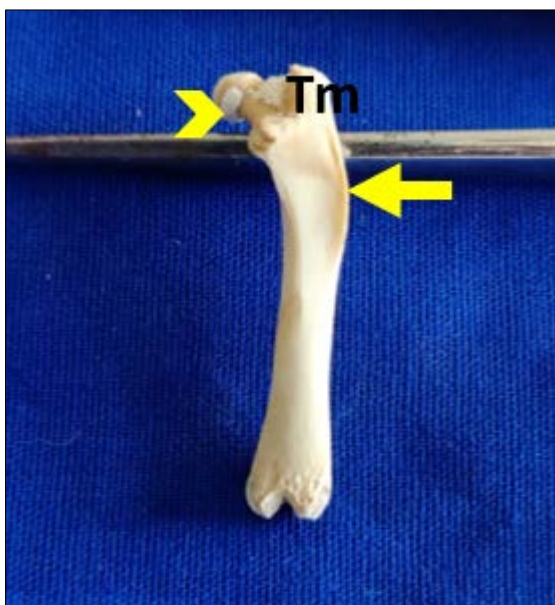


I – Ilium, IS- Ischium, P – Pubis, A - Acetabulum

Fig 1: Os coxae of rat

3.2. Femur

It was the large bone present in the thigh region. It had a shaft and two extremities.



Arrowhead – femur head
Tm – Trochanter major
Arrow – trochanter tertius

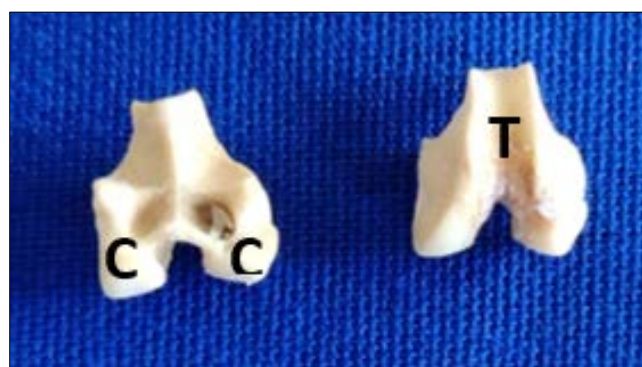
Fig 2: Femur of rat

The shaft was slightly rounded forming three surfaces. The medial surface was smooth and straight (Fig 2). The anterior surface was smooth and rounded. Posterior surface was proximally occupied by the three trochanters while the distal

end was rounded and straight.

The proximal extremity had a prominent head and neck. The lateral greater trochanter was prominent and a trochanteric ridge was found extending from the greater trochanter to the lesser trochanter. The lesser trochanter was present beneath the head of the femur. Maynard and Downes (2019) [7] described the morphology of head and trochanter major as a 'Y' shaped structure, in which the head of the femur and neck formed one arm of the Y while major trochanter formed the other arm. Chiasson (1980) [2] mentioned that the head was attached to the neck at an angle of 45°. A sharp ridge like trochanter tertius was present forming the lateral border. It was also reported by Salami *et al.* (2011) [9] in African giant pouched rats.

The distal extremity articulated with the tibial condyles by a large epiphysis (Fig 3). This epiphysis was not fused with the distal extremity of the femur. Maynard and Downes (2019) [7] mentioned the absence of fusion of these bones until old age. Without the epiphysis the distal extremity had four ridges resembling pyramids separated by deep grooves. The arrangement of the ridges was two anterior and two posterior. This was similar to the findings of Maynard and Downes (2019) [7].



C – Condyles T - Trochlea

Fig 3: Epiphysis of femur

The condyloid ridges were present on both internal and external surfaces as reported by Chiasson (1980) [2] in rats. A facet was found on the posterior aspect of the trochlea for the articulation of fabella in African giant rat (Salami *et al.*, 2011) [9].

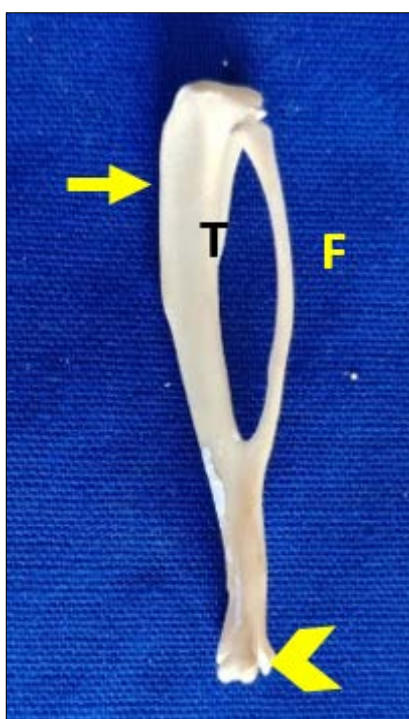
The anterior surface of the epiphysis had a trochlea, in between the condyles lied the facet for patella as described by Maynard and Downes (2019) [7].

Two menisci were found in the knee joint of rat similar to other mammals (Dyce *et al.*, 2009) [4].

3.3. Tibia-Fibula

The tibia was the large weight bearing bone present in the leg region, which was greatly reduced compared to man (Maynard and Downes, 2019) [7]. It was slightly curved in the proximal aspect and was made up of shaft and two extremities. The shaft had three surfaces medial, lateral and posterior. The medial surface was convex and smooth. The lateral surface was flat. The anterior tibial crest separated these two surfaces and extended distally to form the anterior border (Fig 4). The anterior tibial tuberosity was prominent for attachment of patellar ligament which was also reported by Maynard and Downes (2019) [7]. The posterior surface was flat with two prominent popliteal lines. While the medial

border was free, the lateral border of the tibia was fused distally with fibular bone.



T – Tibia F – Fibula Arrow – Tibial crest
Arrowhead – lateral malleolus

Fig 4: Tibia and Fibula of rat

Proximal extremity had two articular condyles for its articulation with femur. Posteriorly, a notch separated these condyles.

Distal extremity had longitudinal articular grooves for the tarsal bones. Postero- medial border extended beyond the distal extremity to form medial malleolus. The facets on the distal aspect along with medial malleolus articulated with the tibial tarsal. This was also reported by Salami *et al.* (2011) [9] in African giant pouched rats.

Fibula was a slender splint like bone articulating with femur in its distal one- third region similar to the findings of Olude *et al.* (2009) [8]. Contrast to this, Maynard and Downes (2019) [7] mentioned the presence of an articular facet beneath the lateral condyle of the tibia for fibular articulation. Similarly, Salami *et al.* (2011) [9] reported the articulation of proximal extremities of tibia and fibula in African giant pouched rat.

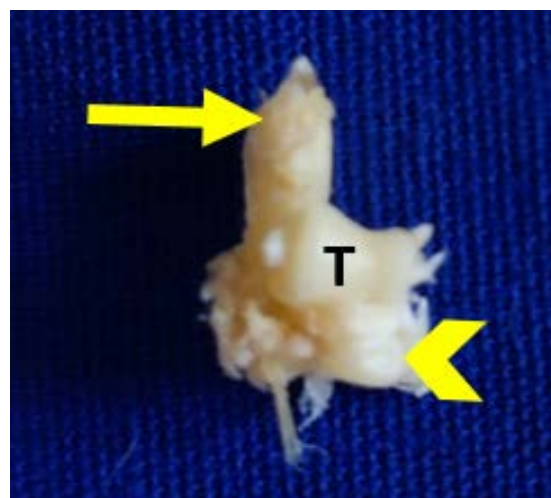
The fibula extended below to form lateral malleolus bearing a facet for the articulation with fibular tarsal. Similar findings were observed in African giant pouched rats (Salami *et al.*, 2011, Vickerton *et al.* (2014) [9, 11] illustrated the lateral malleolus as a part of the talus over which fibula rested.

3.4. Tarsals

Tarsals were composed of six bones arranged in three rows, proximal, middle and distal rows as in carpus. This followed the reports of Chiasson (1980) [2].

The proximal row was made up of tibial and fibular tarsal which was mentioned by Chiasson (1980) [2] in rats. While Maynard and Downes (2019) [7] opined that talus was the fusion of tibial and intermedia tarsals. Lewis (1964) [5] stated that there was no evidence of the fusion. The talus was present on the medial aspect of the sustentaculum tali which was well developed in rats as stated by Maynard and Downes

(2019) [7] (Fig 5). Its proximal end had trochlea for articulation with distal extremity of the tibia. The distal surface had an articular facet for central tarsal.



T – Tibial tarsal Arrowhead – middle row tarsus
Arrow – sustentaculum tali of fibular tarsal

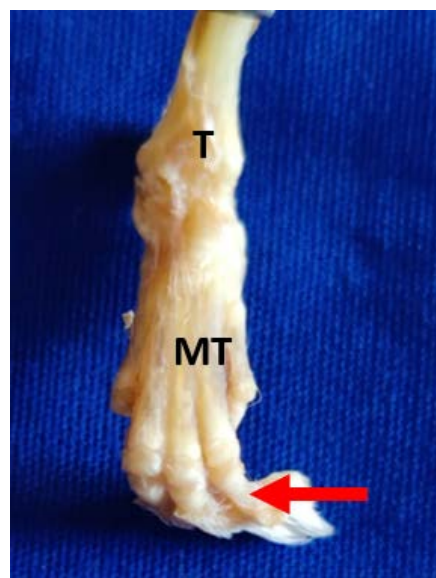
Fig 5: Tarsus

The fibular tarsal was cylindrical and as long as talus like rabbits (Lucy *et al.*, 2012) [6].

The distal row of tarsals had three bones second, third and fourth.

3.5. Metatarsus

Metatarsus in rats was composed of five bones of which the first was smaller and third was longest of all. It was also reported by Chiasson (1980) [2] in rats.



T – Tibia MT – Metatarsus
Arrow - Phalanges

Fig 6: Metatarsus

3.6. Pes

There were 5 digits of which the first one had two phalanges, while the rest of the digits had three phalanges each. The distal phalanx formed the claw. These were similar to that of African giant rat (Salami *et al.*, 2011) [9], rat forelimb (Oluden *et al.*, 2010), rats (Chiasson, 1980) [2].

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