

Comparative Morphology of the Humerus of Rabbit, Guinea Pig and Mongoose

Rajathi Shunmugam* , Muthukrishnan Sundaram

ABSTRACT

In this study, six animals of each rabbit, guinea pig and mongoose were used to compare the morphological features of the humerus. The biometrical parameters of the humerus, viz., mean length, width and circumference at the proximal extremity, distal extremity, and shaft were studied. In proximal extremity, anteriorly, the head of the rabbit humerus was comparatively thicker as compared to guinea pig and mongoose. The lateral tuberosity was large and less clearly divided in mongooses and the division was not visible in guinea pigs and rabbits. The lateral surface of the lateral tuberosity was found with a notch that was deep in mongooses and shallow in rabbit and guinea pig. The bicipital groove was very deep in guinea pig, less deep in rabbit and shallow in mongooses. The lateral surface of the shaft was spiral, smooth, and with musculo-spiral groove which was deep in mongooses, shallow in rabbit, and the groove was not visible in the guinea pig. On the lateral surface of the mongoose's proximal extremity of the humerus, the deltoid tuberosity was found sharp but in rabbit and guinea pig, it was blunt. The coronoid and olecranon fossa were deep in all the three species studied, but was found to be prominent in rabbit and guinea pig when compared to mongoose. Mongoose humerus was observed with an additional supracondylar foramen in the medial surface of distal one fourth of the shaft above the supratrochlear foramen.

Keywords: Biometry, Guinea pig, Humerus, Mongoose, Morphology, Rabbit.

Ind J Vet Sci and Biotech (2022): 10.48165/ijvsbt.18.4.13

INTRODUCTION

Rabbit is a laboratory animal used to experiment with new surgical techniques, study novel chemical and pharmaceutical substances, and produce vaccines and antibodies (Yanni, 2004). Among laboratory rodents, guinea pig (*Cavia porcellus*), belonging to Cavidae family is known as one of the most valuable models related to human (Kaiser *et al.*, 2010). Common grey mongoose (*Herpes tes edwardsi*) belongs to carnivore family and wild animal living close to human dwellings, they are mammals with long bodies and short legs and tapered snouts. They live in burrows and are nondiscriminatory predators feeding on small animals such as rodents, birds, reptiles, frogs, insects and worms.

The forelimb anatomy includes shoulder girdle, arm, forearm and manus. The massive bone in the forelimb is humerus. Research related to the macro-anatomy on the forelimb skeleton of wild carnivores like mink (Dursun and Tipidamaz, 1989), guinea pig and rat (Ozkan *et al.*, 1997), porcupine (Yilmaz *et al.*, 1998) and rabbit (Ozkan *et al.*, 2002) has been conducted. But the comparative anatomical study of the humerus of the animals belonging to the order Rodentia, Lagomorpha and Carnivora has not been done in detail earlier. The literature regarding the information about the humerus morphology in the above three animals is very scarce. Hence, this work was aimed at the comparative morphometry of rabbits, guinea pigs and mongoose humerus.

Department of Veterinary Anatomy, Veterinary College & Research Institute, Tirunelveli - 627 358, Tamilnadu Veterinary and Animal Sciences University, Tamilnadu, India.

Corresponding Author: Rajathi Shunmugam, Department of Veterinary Anatomy, Veterinary College & Research Institute, Tirunelveli - 627 358, Tamilnadu Veterinary and Animal Sciences University, Tamilnadu, India, e-mail:rajathis9936@gmail.com

How to cite this article: Shunmugam, R., & Sundaram, M. (2022). Comparative Morphology of the Humerus of Rabbit, Guinea Pig and Mongoose. *Ind J Vet Sci and Biotech*. 18(4), 59-63.

Source of support: Nil

Conflict of interest: None.

Submitted: 24/04/2022 **Accepted:** 25/08/2022 **Published:** 10/09/2022

MATERIALS AND METHODS

Six adult animals each of rabbits, guinea pigs and mongoose (irrespective of sex) were used to study the comparative morphology of humerus. Ethical committee approval of Tamilnadu Veterinary and Animal Sciences University for the study related to guinea pigs was obtained (Lr. No. 1467/DFAB/IAEC/2018 dated 13.07.2018). Rabbit and mongoose humerus were collected from freshly predated killed carcasses. After collection of the guinea pigs, they were euthanized as per the standard operating procedure by using the carbon dioxide asphyxiations as per CPCSEA (Committee for the purpose of control and supervision of experiments on animals) norms and they were subjected for the dissection. After carefully

dissecting the animals, the right and left arm bones of the above three species of animals were dissected with knife, removed muscles, tendons, ligaments and other soft tissues with the help of scalpel. Then, rinsed the arm bone (humerus) in tap water and then soaked in warm 10% potassium hydroxide solution at 35 to 37°C for 5 h in oven. Subsequently, the humerus of the above three animals were air-dried in the sunlight for a week as per the method of Thompson (2015). Samples of the right and left humerus of rabbits, guinea pigs and mongoose with no gross anatomical lesions were included for further studies. The humerus bones were photographed and gross anatomical details were recorded and compared. The biometrical observations namely length, width, the circumference of diaphysis, proximal and distal epiphyses of humerus were taken using thread and scale and recorded in centimeter (cm). One-way ANOVA with Arithmetic Mean and the Standard Deviation for the data were calculated as per Snedecor and Cochran, (1994) using MS Excel software.

RESULTS AND DISCUSSION

The humerus of the rabbits, guinea pigs and mongoose was a long bone situated obliquely downward and backward from the shoulder joint above with the scapula and elbow joint below with the radius and ulna. The humerus of all the three animals possessed shaft and two extremities (proximal and distal) and the shaft had four surfaces: anterior, posterior, medial and lateral.

In proximal extremity anteriorly, the head of the rabbit humerus was comparatively thick as compared to the guinea pig and mongoose humerus (Fig. 1). The proximal extremity had two tuberosities namely medial and lateral in all the animals. The medial tuberosity was smaller and attached to the head of the humerus in all the species studied. The lateral tuberosity was large and less clearly divided in mongoose and the division was not visible in guinea pig and rabbit humerus. The lateral surface of the lateral tuberosity had a notch which

was deep in mongoose and shallow in rabbits and guinea pigs. The humerus was short with prominent muscular attachment sites in rodents and long with less prominent muscular attachment sites in carnivores and lagomorphs (El-Ghazali and El-Behery, 2018). The bicipital groove was very deep in guinea pig, less deep in rabbit and shallow in mongoose (Fig. 2). Similar observation was also recorded in mole rats (Ozkan, 2002). The bicipital groove determined the development of biceps brachii muscles where the tendon of this muscle was passing in this groove (Nader *et al.*, 2010).

The shaft of the bone was clearly twisted in mongoose, less twisted in guinea pig and twisting of shaft was not prominent in the rabbit. The lateral surface of the shaft was spiral, smooth and had a musculospiral groove deep in mongoose, shallow in rabbits and not visible in the guinea pig. On lateral surface of the proximal extremity of humerus of mongoose, the deltoid tuberosity was sharp. However, in rabbits and guinea pigs it was blunt (Fig. 2). Yilmaz *et al.* (1998) reported well-developed deltoid tuberosity in porcupine, while Ozkan (2002) reported that the prominent deltoid tuberosity curved toward cranially as projection in mole rats. This may be due to species differences and adaptation. The teres tubercle was present on the medial surface of the proximal part of the shaft and was prominent in mongooses and not found prominent in rabbits and guinea pigs. El-Ghazali and El-Behery (2018) opined that the ill-developed deltoid tuberosity, teres tubercle and shallow musculospiral groove were responsible for adaptation for fast running in rabbit and cats. The deltoid ridge (Crsita tuberculi majoris) in the humerus was prominent in the Muridae family (Saunders and Manton, 1969), but less prominent in mole rats (Ozkan, 2002).

The distal extremity of the humerus had two condyles namely medial and lateral. The medial condyle was larger in all the three animals studied. The medial condyle was separated by a ridge which was prominently sharp in rabbit and less sharp in mongooses and blunt in guinea pig. The

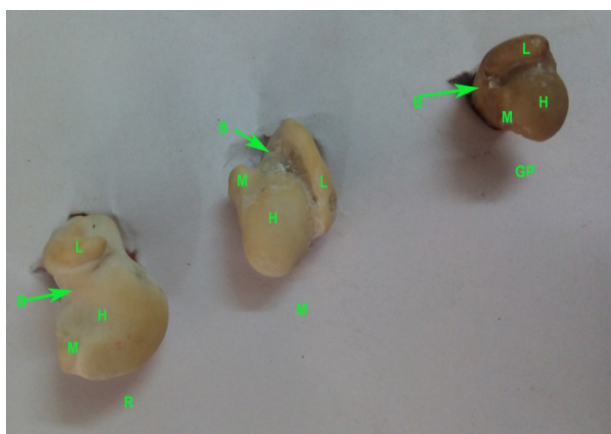


Fig. 1: Photograph showing the proximal extremity of humerus of rabbit (R), mongoose (M) and guinea pig (GP). H – Head, M – Medial tuberosity, L – Lateral tuberosity, B- Bicipital groove



Fig. 2: Photograph showing the lateral view of humerus of rabbit (R), mongoose (M) and guinea pig (GP). B – Bicipital groove, C – Crest G- Deltoid tuberosity



Fig. 3: Photograph showing the medial view of humerus of rabbit (R), mongoose (M) and guinea pig (GP). H – Head, N – Lateral tuberosity, Arrow - Supratrochlear foramen



Fig. 4: Photograph showing the posterior view of humerus of rabbit (R), mongoose (M) and guinea pig (GP) showing supracondylar foramen (SCF) in mongoose humerus.

animal captures the prey (Pathak *et al.*, 2017). Supracondylar foramen was not found in rabbit and guinea pig humerus. Similar observation regarding the absence of supracondylar foramen in guinea pig was observed by Witkowska *et al.* (2014). The supracondylar foramen was an ancestral structure in mammals and was lost during mammalian evolution (Polly, 2007). The lateral surface of the distal third of the shaft of the mongoose humerus had a prominent crest which was not found in rabbit and guinea pig humerus. The epicondyles were present above the condyles and enclosed the supratrochlear foramen. The epicondyloid crests were prominent in rabbit and mongoose and less prominent in guinea pig. The nutrient foramen was absent in the humerus in all the present study species. This might be due to the smaller size of the bones.

Biometry of the Humerus of Rabbit, Guinea Pig and Mongoose

Proximal extremity of the humerus

The biometrical observations namely the length of the

Table 1: Biometry (cm) of the proximal extremity of humerus in rabbit, guinea pig and mongoose (Mean ± SD)

Parameters	Rabbit	Guinea pig	Mongoose	F value
Total length of humerus	7.21 ± 0.73a	3.74 ± 0.83c	6.38 ± 0.50b	1009.0**
Width from head to lateral tuberosity	1.63 ± 0.06a	0.80 ± 0.52c	1.42 ± 0.35b	108.3**
Circumference at proximal extremity	4.89 ± 0.68a	2.37 ± 0.41b	3.91 ± 0.89ab	9.6*

**P≤0.01, * P≤0.05. Means within the row with different superscript differ significantly (P<0.05)

Table 2: Biometry (cm) of the distal extremity of humerus of rabbit, guinea pig and mongoose (Mean ± SD)

Parameters	Rabbit	Guinea pig	Mongoose	F value
Width from medial to lateral side	1.00 ± 0.03b	0.72 ± 0.22c	1.63 ± 0.54a	63.10**
Circumference	2.41 ± 0.71b	2.62 ± 0.63b	4.10 ± 0.72a	259.00**

** P≤0.01. Means within the row with different superscript differ significantly (P≤0.01).

Table 3: Biometry (cm) of the shaft of humerus in rabbit, guinea pig and mongoose (Mean ± SD)

Parameters	Rabbit	Guinea pig	Mongoose	F value
Width at middle of shaft	0.60 ± 0.42a	0.42 ± 0.22b	0.55 ± 0.45ab	7.22*
Circumference	2.00 ± 0.79a	1.10 ± 0.53c	1.73 ± 0.40ab	63.00**

**P≤0.01, *P≤0.05. Means within the row with different superscript differ significantly (P<0.05).

lateral condyle was small and had a clear articular surface in rabbits, whereas in guinea pig and mongoose humerus the articular surface was not clear and was round and irregular. The coronoid and olecranon fossa were deep in all the three species studied but were somewhat less deep in mongoose. Supratrochlear foramen was more prominent in rabbit and guinea pig, but was less prominent in mongooses (Fig. 3). Similar findings were also observed in porcupine humerus (Yilmaz *et al.*, 1998). Contrary to the present observation, supratrochlear foramen was absent in mole rat humerus (Ozkan, 2002). The presence of supratrochlear foramen in mammals was variable and was linked to the range of mobility in the elbow joint (Witkowska *et al.*, 2014).

Mongoose humerus had an additional supracondylar foramen in the medial surface of the distal one-fourth of the shaft above the supratrochlear foramen (Fig. 4). The presence of the supracondylar foramen was also reported in the African giant rats and cats which were found to transmit the median nerve and brachial artery (Dyce *et al.*, 2002). This foramen might have given additional protection to the median nerve and brachial artery from the pressure exerted when the

whole bone, and width and circumference at the proximal extremity of humerus in rabbits, guinea pigs, and mongooses are presented in Table 1. These measurements were found longest in rabbit, second largest in mongoose followed by guinea pig. Witkowska *et al.* (2014) reported the total length of humerus 3.5 to 4.0 cm in guinea pig, similar to the present observation. Pathak *et al.* (2017) and Bello and Wamakko (2021) reported the total length of humerus 10.88 cm and 20.0 cm in Indian tiger and dogs respectively which was higher than the present observation. This might be due to breed, species and food variation. Witkowska *et al.* (2014) and Dayan *et al.* (2019) reported the width of humerus 0.8–1.0 cm and 0.7–0.8 cm, respectively, in guinea pig, which coincides with the present finding (0.8 cm). These differences might be due to species variation. Bello and Wamakko (2021) reported the circumference at the proximal extremity of the humerus was 8.2 cm in dogs which was higher than the present finding. The total length of the humerus, width from head to lateral tuberosity and circumference showed highly significant differences among guinea pig, rabbit and mongoose ($p < 0.01$).

Distal Extremity of Humerus

The width from the medial to lateral side at the distal extremity of humerus was found to be largest in mongoose, followed by rabbit and guinea pig (Table 2). Similar observations regarding the width of the distal extremity of humerus were reported by Witkowska *et al.* (2014) and Dayan *et al.* (2019) in guinea pigs. On the contrary, Pathak *et al.* (2017) reported higher values for the width at distal extremity in Indian Tiger. The circumference at distal extremity was observed to be highest in mongooses, followed by guinea pig and rabbit. The circumference of distal extremity was reported 6.3 cm in dogs (Bello and Wamakko, 2021), which was higher than our observation. The difference might be due to species variation and animal adaptation. The width and circumference at the distal extremity of the humerus showed highly significant differences among rabbit, guinea pigs and mongoose ($p < 0.01$) (Table 2).

Shaft of Humerus

The width and circumference at the mid-shaft of the humerus of rabbit, guinea pig and mongoose are presented in Table 3. These were found largest in rabbit, followed by mongoose and guinea pig, possibly due to species differences. Dayan *et al.* (2019) reported a higher circumference of 2.5–3.5 cm in guinea pig compared to the present observation of 1.1 cm. The circumference at mid-shaft was reported as 5.9 cm in dogs (Bello and Wamakko, 2021) and 10.88 cm in Indian Tiger (Pathak 2017), which was higher than the present finding. This may be due to breed, species adaptation and food variation. The width and circumference at the middle of the shaft showed highly significant differences among guinea pigs, rabbits and mongooses ($p < 0.01$).

CONCLUSION

The humerus of digging carnivore mongoose possessed all the features like well-developed tuberosities and crest, deep fossa and an additional supracondylar foramen which showed that the species behavior played a role in the morphological determination of bone. Nutrient foramen was absent in all the species. Morphometric data compared between species showed significant differences. There are prominent differences in the morphology and morphometry of humerus in rabbits, guinea pigs, and mongooses.

ACKNOWLEDGEMENT

The authors sincerely acknowledge Veterinary College and Research Institute, Tirunelveli, Tamilnadu Veterinary and Animal Sciences University for supporting this research work financially.

REFERENCES

- Bello, A., & Wamakko, H.H. (2021). Comparative anatomy of selected bones of forelimb of local Mongrel Dog (*Canis lupus familiaris*) in Sokoto, Nigeria. *Insights in Veterinary Science*, 5, 26-31.
- Dayan, M.O., Besoluk, K., Eken, E., Aydogdu, S., & Turgut, N. (2019). Three-dimensional modeling of the femur and humerus in adult male guinea pigs with computed tomography and some biometric measurement values. *Folia Morphologica (Warsz)*, 78(3), 588-594.
- Dursun, N., & Tipirdamaz, S. (1989). Etudes macro-anatomiquement sur les os du squelette du vison (*Mustela vison*). *The Journal of the Faculty of Veterinary Medicine, University of Selcuk*, 5, 13-27.
- Dyce, K.M., Sack, W.O., & Wensing, C.J.G. (2002). *Textbook of Veterinary Anatomy*. Saunders-Elsevier Science, Philadelphia. 3rd ed. 840 pp.
- El-Ghazali, H.M., & El-Behery, E.I. (2018). Comparative macro-anatomical observations of the appendicular skeleton of New Zealand rabbit (*Oryctolagus cuniculus*) and domestic cat (*Felis domestica*) thoracic limb. *International Journal of Veterinary Science*, 7(3). 127-133.
- Kaiser, S., Kruger, C., & Sachser, N. (2010). The guinea pig. In: *The UFAW Handbook on the Care and Management of Laboratory and Other Research Animals*. Eds.: Hubrecht, R. and Kirkwood, J. Wiley-Blackwell, Chichester, West Sussex, England, UK, 8th edn, pp. 380-398.
- Nader, W., Santamaria, L.E.A., Vitor, L., Pereira, L.A., Ruiz, C.A., & Wafae, G. C. (2010). Morphometry of the human bicipital groove (sulcus intertubercularis). *Journal of Shoulder and Elbow Surgery*, 19(1), 65-68.
- Ozkan, Z.E. (2002). Macro-anatomical investigations on the forelimb skeleton of mole rat (*Spalax leucodon Nordmann*). *Veterinarski Arhiv*, 72, 91-99.
- Ozkan, Z.E., Dync, G., & Aydin, A. (1997). Investigations on the comparative gross anatomy of scapula, clavicle, skeleton brachii and skeleton antebrachii in rabbits (*Oryctolagus cuniculus*), guinea pigs (*Cavia porcellus*) and rats (*Rattus norvegicus*). *Firat University Journal of Health Sciences*, 11, 171-175.
- Pathak, S.K., Archana, M., Amarpal., & Pawde, A.M. (2017).



- Morphological and certain morphometrical study of humerus bone of Indian Tiger. *International Journal of Current Microbiology and Applied Science*, 6(2), 546-551.
- Polly, P.D. (2007). Limbs in mammalian evolution. In: Hall, B.K., ed. *Fins to Limbs: Evolution, Development and Transformation*. The University of Chicago Press. USA, pp. 245-268.
- Saunders, J.T., & Manton, S. M. (1969). *A Manual of Practical Vertebrate Morphology*. Clarendon Press, Oxford. 4th ed., Pp. 288.
- Snedecor, G.W., & Cochran, W.G. (1994). *Statistical methods*. Iowa State Univ. Press, Ames, Iowa, USA, 8th ed., pp. 524.
- Thompson, M.C. (2015). Preparing skeletons for research and teaching from preserved human specimens. *M.Sc., (Anthropology)* Thesis submitted to the California State University, East Bay.
- Witkowska, A., Alibhai, A., Hughes, C., Price, J., Klisch, K., Sturrock, C.J., & Rutland, C.S. (2014). Computed tomography analysis of guinea pig bone: Architecture, bone thickness and dimensions throughout development. *Peer Journal*, 2, 1-20.
- Yanni, A.E. (2004). The laboratory rabbit: an animal model of atherosclerosis research. *Laboratory Animal*, 38(3), 246-256.
- Yilmaz, S., Ozkan Z.E., & Ozdemyr, D. (1998) Macro-anatomical investigations on the skeletons of porcupine (*Hystrix cristata*). I. Ossa membri thoracici. *Turkish Journal of Veterinary and Animal Sciences*, 22, 389-392.