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Research Article

Comparative Macro-Anatomical Observations of the Appendicular Skeleton of New Zealand Rabbit (*Oryctolagus cuniculus*) and Domestic Cat (*Felis domestica*) Thoracic Limb

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ABSTRACT

On the topic of the manifestation of main differences between the thoracic limb of rabbit and cat, our research was carried out on ten adult New Zealand rabbits (*Oryctolagus cuniculus*) and domestic cats (*Felis domestica*) of both sexes. The animals were radiographically examined. Also, the bones were prepared, measured (length/cm), described and compared. The gross morphological study showed the presence of processus hamatus and suprahamatus of the scapula in both species. Supratrochlear foramen was observed in rabbit while in cat the supracondyloid foramen was present. The interosseous space of the forearm region was proximally located in rabbit but in cat, it was extended along the forearm region. The carpal bones were nine and seven in rabbit and cat respectively. In both species, Metacarpals and digits of the thoracic limbs were five in number. The distal phalanx was characterized by unguicular process and enclosed in the claw. The distal sesamoid was absent in cat. So, the major points of dissimilarity between the appendicular skeleton of rabbit and cat helped us to keep off the commercial fraud.

Key words: Acromion process, Interosseous space, Styloid process, Supratrochlear, Supracondyloid foramina, Unguicular process

INTRODUCTION

Rabbit is economically viable as a source of meat and fur production. It is used as a perfect laboratory animal because of its high fertility, short generation span, small size and low costs so, it is used in the manufacture of antibodies (Okerman, 1994). The rabbit is a good experimental clinic-anatomical copy for detection of some morphological anomalies and diseases in humans and animals (Abidu-Figueiredo, *et al*., 2008).

In the cat, the clavicle (collarbone) doesn't articulate with the sternum or shoulder region as it does in the humans (Hudson and Hamilton, 1993). In the rabbit, the scapula is more sharply triangular and has a pronounced hook-shaped suprahamate process on the acromion (Aspinall *et al*., 2015). Between the radial and olecranon fossae, the bone is reduced to a very thin lamina, which is sometimes pierced by an opening of very variable size, the supratrochlear foramen. In the rabbit, the carpus comprises nine small elements, the metacarpus comprises five elements, the phalanges are distributed according to the formula 2, 3, 3, 3, 3. The ungual phalanges are laterally compressed pointed, and cleft at their tips for the attachment of the claws (Craigie, 1948). While in the cat the carpus consists of seven bones and the metacarpals are five with five digits (Hudson and Hamilton, 1993). In the cat, the toes ended by strong, sharp, curved claws which were completely retractile (McCracken *et al*., 2008).

For the reason of the heavy coast of rabbit meat, the traders resort to exchange their carcasses by cat carcasses which can be easily confused in shopping market. So, our research intended to easily differentiate between the rabbit and cat carcasses by an anatomical illustration of the most points of difference between their bones to keep away from the commercial fraud.

MATERIALS AND METHODS

The present study was carried out on ten healthy adults New Zealand rabbits (*Oryctolagus cuniculus*) and domestic cats (*Felis domestica*) of both sexes, variable ages and weighed about 2.5-3.5 kg. The rabbits were collected from the animal laboratory house in Faculty of Veterinary Medicine, Zagazig University, Egypt. The cats were purchased from pet house in Zagazig city, Sharkia Governorate, Egypt.

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The sedation and anesthesia of rabbits occurred with 3 mg/kg xylazine IV followed by 3 mg/kg ketamine IV injection through the ear vein. But in cats, it anesthetized with 1 mg/kg of IM xylazine then followed by 5 mg/kg of IM ketamine (Hall, Clarke and Trim, 2001). The weight of animals obtained by using a digital scale. Two animals of both species were prepared for radiographical examination in Department of Surgery, Anesthesiology and Radiation. The exsanguinations of animals were performed through the common carotid artery under complete anesthesia. After evisceration and dissection of both limbs from the trunk and removal of the skin and muscles carefully, the bony preparations were carried out according to Onwuama *et al*. (2012). All animals used in this work were handled according to the Institutional Animal Care and the Research Ethics Committee of the Zagazig University, Egypt (ZU-IACUC/2/F/12/2018).

All obtained bones were used for comparative studies (gross morphology, length/cm and numbers). The measurements were estimated using graduated tape. The bones were photographed using a digital camera with resolution (16.1 megapixels, Sony DSC-W690, 36v and 10x optical zoom).

The measured data of the bones were statistically analyzed for the mean ± standard deviation (SD) by using the SPSS software program (version 16.0; Chicago, USA). The anatomical nomenclature used was based on NominaAnatomicaVeterinaria (2012) whenever possible.

RESULTS

The appendicular skeleton of both species included both thoracic and pelvic limbs. The thoracic limbs of rabbits and cats consisted of scapula, humerus, radius and ulna, carpal and metacarpal bones and digits. Also, it included the sesamoid bones and clavicle (Fig. 1A, B, C and D).

Clavicle

It was flattened long rod-like in rabbit (Fig. 1C) and curved short in the cat (Fig. 1D) with acromial and sternal ends. Its mean length was 2.170±.1160cm in rabbit and 1.570±.1160cm in the cat.

Scapula

The scapula of the rabbit and of the cat was a near triangle in outline with a mean length measured 5.700±1.0055 and 6.430±.3831 in rabbit and cat respectively. The lateral surface bore sharply edged scapular spine (Spina scapulae) which terminated ventrally by acromion process (Fig. 2A). In cat, the spine was increased in height gradually till its middle (Fig. 2B). In both animals, the acromion process ended by finger-like projection (processus hamatus) which reached to the level of the glenoid cavity and carried caudally processus suprahamatus. The latter process was sharped irregular L-shape in rabbit while a broad semicircular in the cat (Fig. 2A and B). The processus hamatus and processus suprahamatus of rabbit are highly breakable. The ratio between supraspinous (Fossa supraspinata) and infraspinous (Fossa infraspinata) fossae was 1:2 in rabbit and it was equal in the cat (1:1) with a protractor shape supraspinous fossa (Fig. 2A and B). The medial surface

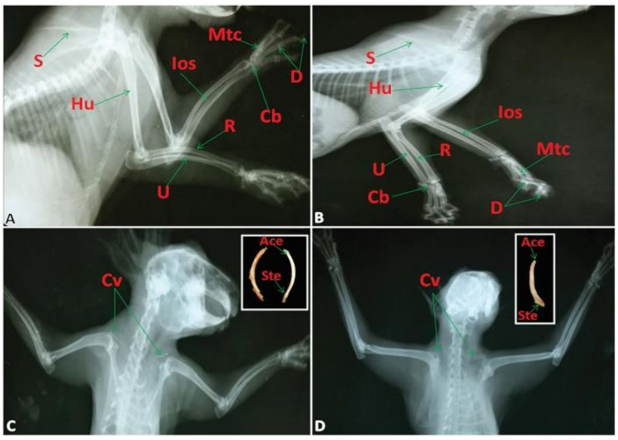

Fig. 1: radiographs of rabbit's (A) and cat's (B) thoracic limbs (lateral view) and rabbit's (C) and cat's (D) skeletons (ventrodorsal view) with the insert showing the clavicles of rabbit and cat (lateral view). Ace: Acromial end of the clavicle, Cb: Carpal bones, Cv: Clavicle, D: Digits, Hu: Humerus, Ios: Interosseous space, Mtc: Metacarpal bones, R: Radius, Ste: Sternal end of the clavicle, S: Scapula and U: Ulna.

had a flat subscapular fossa (Fossa subscapularis) in both animals with a deeply elongated area corresponding to the spine in rabbit (Fig. 2C and D). In both animals, the cranial angle (Angulus cranialis) was thin while the caudal one (Angulus caudalis) had a little thickening also in the cat the cranial angle was rounded (Fig. 2A and B). The articular angle carried a pear-shaped glenoid cavity (Cavitas glenoidalis) in rabbit and a circular one in cat which it extended cranially on the supraglenoid tubercle (Tuberculum supraglenoidale). The latter bore medially a coracoid process (Processus coracoideus) which was a beak-like projection. The cavity was notched caudally and cranio-medially in rabbit but the notches were absent in cat (Fig. 2C and D).

Humerus

In the rabbit, the body of the humerus (Corpus humeri) was three sided proximally while distally was flat but in the cat, it was cylindrical in shape along its length (Fig. 3A, B, C, D and E). The relative length of the humerus was 6.370±.8433cm in rabbit and 9.160±.6947cm in the cat. The surfaces in the rabbit were smooth and rounded from side to side (Fig. 3A and C). The cranial surface of the cat had a faint humeral crest (Crista humeri) and the deltoid tuberosity (Tuberositas deltoidea) was absent (Fig. 3B). In the rabbit, the humeral crest appeared on the cranial border at the proximal third and terminated as deltoid tuberosity (Fig. 3A). In the cat, on the lateral surface inbetween the lateral tuberosity and the head a rough projection is present. From the latter, a rough line was extended to the middle of the body (Fig. 3E). The proximal extremity carried caudo-medially semispherical head (Caput humeri) in rabbit and large ovoid one in the cat (Fig. 3F and G). The medial (Tuberculum minus) and lateral (Tuberculum majus) tuberosities were separated by intertuberal groove (Sulcus intertubercularis) which facies cranio-medially (Fig. 3F and G). The distal extremity in rabbit bore grooved articular surface, trochlea (Trochlea humeri) (Fig.3H).

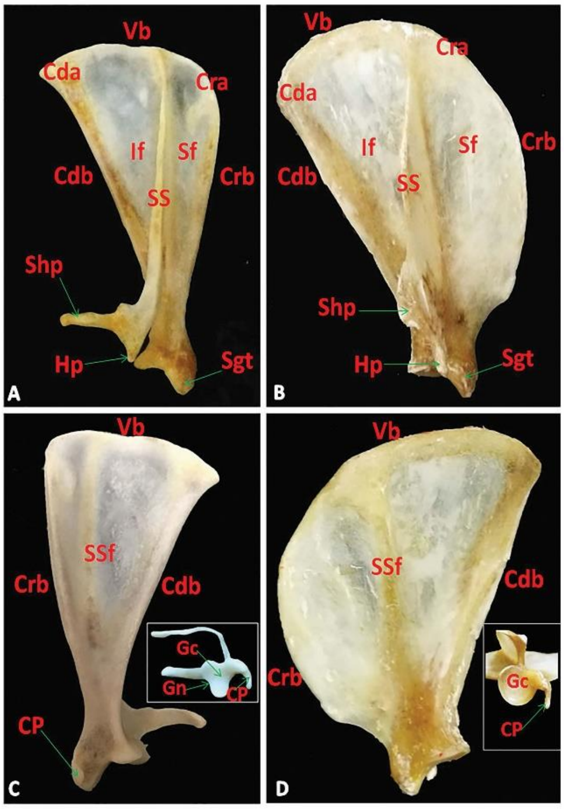

Fig. 2: photomacrographs of the scapula of rabbit (A) and cat (B) (lateral view), scapula of rabbit (C) and cat (D) (medial view)with the insert showing the articular angles of rabbit's and cat's scapulae (ventral view).Crb: Cranial border, Cdb: Caudal border, Vb: Vertebral border, SS: Scapular spine, Sf: Supraspinous fossa, If: Infraspinous fossa, Sgt: Supraglenoid tubercle, Hp: Hamate process, Shp: Suprahamate process, SSf: Subscapular fossa, Cp: Coracoid process, Gc: Glenoid cavity, Gn: Glenoid notch, Cra: Cranial angle and Cda: Caudal angle.

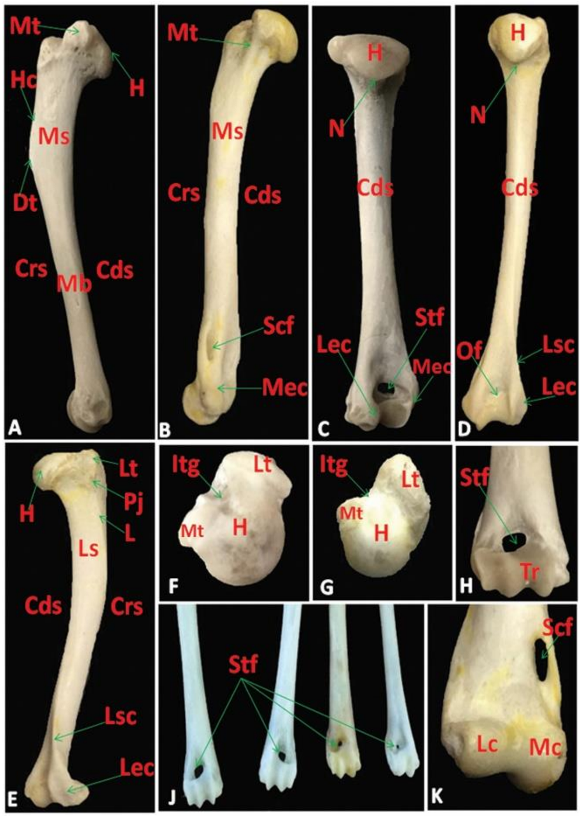

Fig. 3: photomacrographs of humerus of rabbit (A) and cat (B) (medial view), humerus of rabbit (C) and cat (D) (caudal view), humerus of cat (E) (lateral view), proximal extremity of humerus of rabbit (F) and cat (G) (dorsal view), distal extremity of humerus of rabbit (H) (cranial view), humerus of rabbit (J)(cranial view) showing variable sized supratrochlear foramen and distal extremity of humerus of cat (K) (cranial view). Ls: Lateral, Crs: Cranial, Cds: Caudal and Ms: Medial surfaces, Mb: Medial border, Lt: Lateral tuberosity, Mt: Medial tuberosity, Hc: Humeral crest, H: Head, N: Neck, Dt: Deltoid tuberosity, Scf: Supracondyloid foramen, Mc and Lc: Medial and Lateral condyles, Mec and Lec: Medial and Lateral epicondyles, Lsc: Lateral Supracondyloid crest, Of: Olecranon fossa, Stf: Supratrochlear foramen, Itg: Intertuberal groove, Tr: Trochlea, Pj: Projection between Lt and H and L: Line extended from Pj. to the middle of the body.

The radial fossa (Fossa radialis) was present cranially above the trochlea while between the two epicondyles caudally the olecranon fossa (Fossa olecrani) was present (Fig. 3D). The two fossae separated by very thin bony lamina which perforates to form different sized supratrochlear foramen (Foramen supratrochleare) (Fig. 3C, H and J). In the cat, the humerus carried two condyles (Condylus humeri) distally, the medial one was larger and the radial fossa was unclear (Fig. 3K). From the lateral epicondyle (Epicondylus lateralis) extended the lateral supracondyloid crest (Crista supracondylaris lateralis) (Fig. 3D and E). Just above the medial epicondyle (Epicondylus medialis) present an elongated oval supracondyloid foramen (Foramen supracondylare) (Fig. 3B and K).

Radius and ulna

They were completely long bones, curved along its length in the rabbit while the two bones were straight in the cat (Fig. 4A). The relative length of the radius measured about 6.270±.9166cm in rabbit while in cat it was 8.840±1.0024cm. The mean length of the ulna was 7.330±.8001 and 10.350±.8127 cm in rabbit and cat respectively. The interosseous space (Spatium interosseum antebrachii) was small, proximally located in rabbit but extended along the length of the bone in the cat (Fig. 4A). In the rabbit, the radius had crossed the ulna cranially along its length, proximally tended to be medial while distally it was lateral in position (Fig. 4A). The body of the radius was flattened, its caudal surface bore two elongated parallel lines left a rough area inbetween as faces aspera in the rabbit that was absent in cat (Fig. 4B). The humeral articular surface carried two condyles separated by a groove in rabbit while in the cat, it was kidney shape facet (Fig. 4C). In the rabbit, the carpal articular surface was two facets and a groove inbetween though it was one oval deeply concave facet (Fig. 4D) with a clear styloid process (Processus styloideus) in the cat (Fig. 4E). In rabbit and cat, there were four ridges separated by grooves in the distal extremity cranially (Fig. 4E). The body of the ulna was flattened along its length in both animals however in cat distally the body was three sided with three surfaces and three borders (Fig. 4F and G). The proximal extremity carried crescentic semilunar notch which distally ended by two facets for articulation with radiuswhile proximally overhung by the anconeus

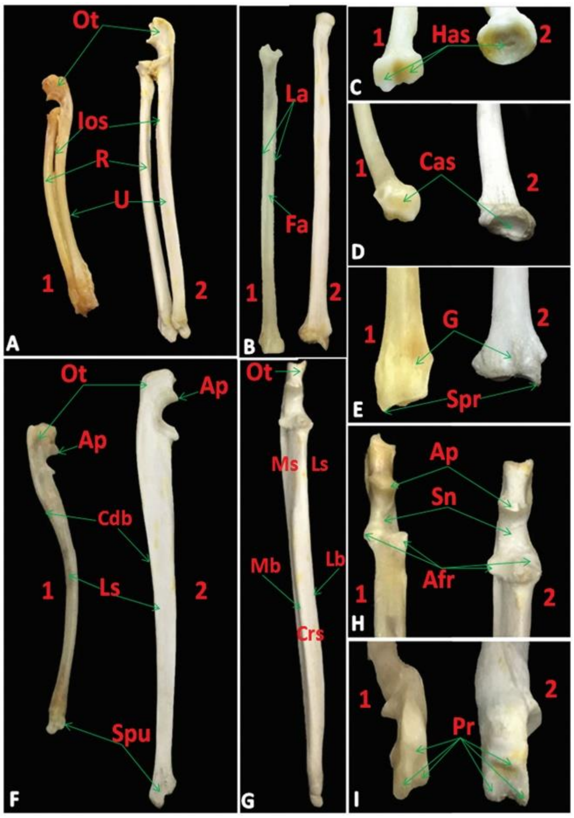

Fig. 4: photomacrographs of radius and ulna of (1):rabbit and (2): cat (A) (lateral view), radius of (1): rabbit and (2): cat (B) (caudal view), proximal extremity of radius of (1): rabbit and (2): cat (C) (caudodorsal view), distal extremity of radius of (1): rabbit and (2): cat (D) (caudoventral), distal extremity of radius of (1): rabbit and (2): cat (E) (cranial view), ulna of (1): rabbit and (2): cat (F) (lateral view), ulna of cat (G) (cranial view), proximal extremity of ulna of (1): rabbit and (2): cat (H) (cranial view) and proximal extremity of ulna of (1): rabbit and (2): cat (I) (dorsal view). Ls: Lateral, Ms: Medial and Crs: Cranial surfaces, Lb: Lateral, Mb: Medial and Cdb: Caudal borders, R: Radius, U: Ulna, Ot: Olecranon tuber, Ios: Interosseous space, La: Lina aspera, Fa: Faces aspera, Has: Humeral articular surface, G: Groove, Cas: Carpal articular surface, Spr: Styloid process of radius, Spu: Styloid process of ulna, Ap: Anconeus process, Sn: Semilunar notch, Afr: Two facets for articulation with radius and Pr: Three prominences on Ot.

process (Processus anconeus) (Fig. 4H). The olecranon tuber (Tuber olecrani) carried three rough prominences (Fig. 4I). The styloid process represented the distal extremity of the ulna which was divided (Fig. 4F).

Carpal bones

In the rabbit, the carpal bones (Ossa carpi) were nine short bones (Fig. 5A) while in the cat they were seven in number (Fig. 5B) (Table 1). They were arranged in proximal and distal rows in the two animals. In the rabbit, the proximal row included radial (Os carpi radiale), intermediate (Os carpi intermedium), ulnar (Os carpi ulnare) and accessory (Os carpi accessorium) carpal bones from medial to lateral. They were Shuttle, crescentic, triangular and pisiform in shape respectively. In the cat, the proximal row included three bones which; radio-intermediate (Os carpi intermedioradiale), ulnar and accessory. The former was the largest one with irregular six-sided shape and a tubercle caudo-medially. The ulnar carpal bone was regular six-sided while the accessory carpal bone was elongated with concave medial border and convex lateral one. Its caudal part was broader than the cranial one.

The distal row included five bones in rabbit (Fig. 5A), they were first, second, central (Os carpi centrale), third and fused fourth with the fifth one. They were appeared as triangle, quadrilateral, wedged, elongated crescentic and bicycle chair respectively. In the cat, the distal row had four bones (Fig. 5B); first, second, third and fourth. The first three bones were crescentic in shape with ascending variation in its size while the fourth one was irregular in shape.

Metacarpals and digits

In rabbit and cat, there were five metacarpals (Ossa metacarpalia) and five digits (Ossa digitorummanus) (Fig. 5C and D) (Table 1). The metacarpal arranged from medial to lateral as first, second, third, fourth and fifth. The first metacarpal was the shortest and carried two small phalanges of the reduced first digit while the other metacarpal carried three phalanges. The third metacarpal was the longest. The metacarpal appeared long bone had proximal and distal extremities and shaft. The distal phalanx (Phalanx distalis[Os unguiculare]) in rabbit was laterally compressed with a pointed divided free end(Fig. 5E), whereas in cat it was triangular in shape without division in the pointed distal end (unguicular process)(Fig. 5F). In both species, the third phalanx was enclosed in the claw (Fig. 5G). The manus region in rabbit measured about 4.990±.8724cm in length and 6.700±.2494cm in the cat.

Sesamoid bones

There were three sesamoids in rabbit and two in the cat for each digit except the first digit its sesamoids were absent in rabbit and cat (Table 1). The proximal sesamoids (Ossa sesamoidea proximalia) were paired and vertically situated on the palmar surface of the fetlock joint. It was pyramidal in shape with notched base in rabbit (Fig. 5G and H) while in cat it was elongated (Fig. 5D). The distal sesamoid (Osse samoideum distal) was single and transversely situated on coffin joint. It was shuttle shaped in rabbit (Fig. 5H), whereas in cat it was absent.

DISCUSSION

The presence of clavicle in both species studied in this research was important for stabilized distal extremity of scapula for accurate movement which was reported also in guinea pig (Wagner and Manning, 1976), rabbit (Uçar*et al*., 1985), mole rat (Özkan, 2002), wombat (Saber, 2013) as well as in the Orange-rumped agouti by (Venkatesan, *et al*., 2015). The shape of clavicle varied from species to another as observed in our work. It appeared flat and slightly bent in the cat (König and liebich, 2004) and shortly curved rod-like in Orange-rumped agouti (Venkatesan *et al*., 2015).

Regarding the acromion process in rabbit Craigie (1948) recorded that, it bore a directed backward metacromion. Our study reflected that the acromion ended by hamatuswhich carried suprahamatus caudally that

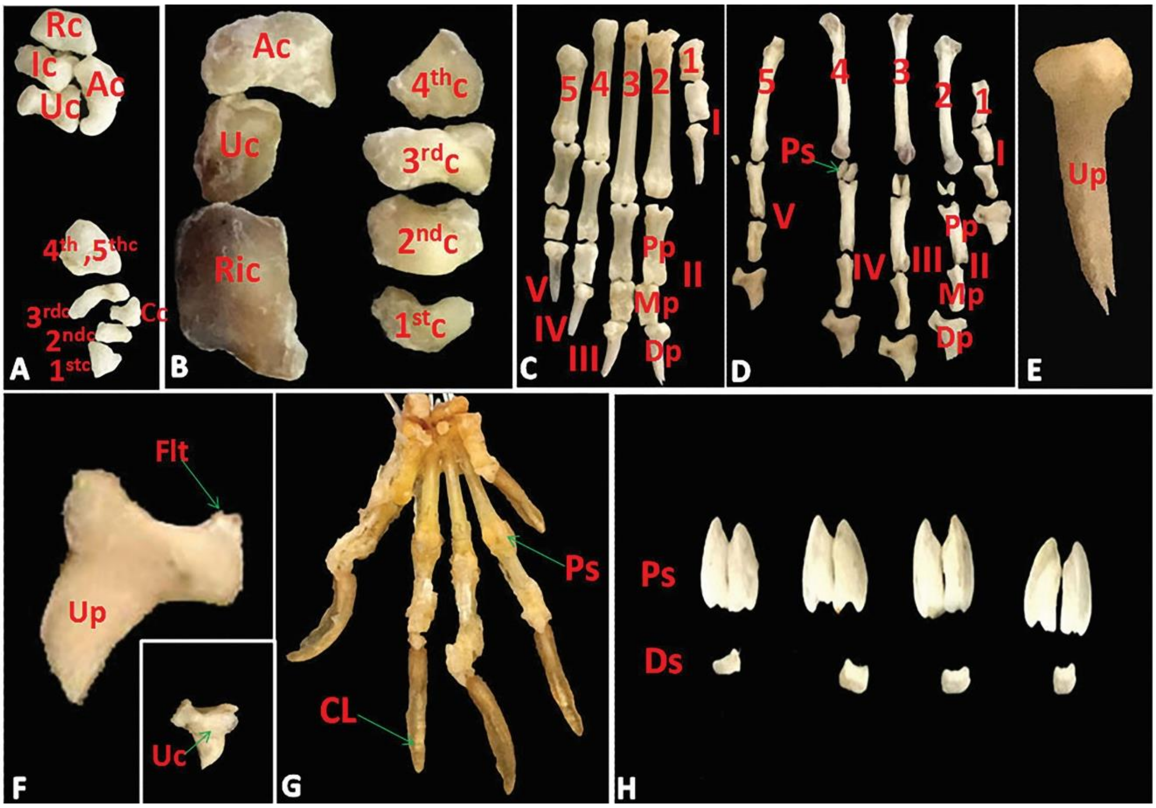

Fig. 5: photomacrographs of carpal bones of rabbit (A) and cat (B) (dorsal view), metacarpal bones and digits of rabbit (C) and cat (D) (palmar view), pointed divided unguicular process of the distal phalanx of rabbit (E) (caudolateral view), axial surface of distal phalanx of cat (F)with the insert showing the unguicular crest on the abaxial surface, manus region of rabbit (G) (palmar view), proximal and distal sesamoid bones of rabbit (H) (palmer view).Rc: Radial, Ic: Intermediate, Uc: Ulnar, Ac: Accessory, 1st c: First, 2nd c: Second, Cc: Central, 3rd c: Third, 4th,5th c: Fused fourth and fifth, Ric: Radiointermediate and 4th c: Fourth carpal bones, 1,2,3,4 and 5: First, second, third, fourth and fifth metacarpal bones, I,II,III,IV and V: First, second, third, fourth and fifth digits, Pp: Proximal, Mp: Middle and Dp: Distal phalanges, Up: Unguicular process, Uc: Unguicular crest, Flt: Flexor tubercle, Cl: Claw and Ps and Ds: Proximal and distal sesamoid bones.

Table 1: Elucidatethe differences between numbers of the bones in manus region of rabbits and cats.

Species / bones	Rabbit	cat
Carpal (from Medial to lateral)	9	7
1st row→	4 (Radial, Intermediate, Ulnar and Accessory).	3(Radiointermediate, Ulnar and Accessory)
2nd row→	5 (I, II, central,III, fused IV & V).	4 (I, II, III & IV).
Metacarpals	5	5
(from Medial to lateral)	(I, II, III, IV & V). I is the shortest. III is the longest.	(I, II, III, IV & V). I is the shortest.
digits	5 I→ carries two phalanges	5 I→ carries three phalanges
Sesamoid bones	8	8
Proximal	2 for each digit except the first, it is absent. 4	2 for each digit except the first, it is absent. Absent
Distal	1 for each digit except the first, it is absent	

agreed with (Al-Hussaini and Demian, 1964; Popesko, *et al.*, 1990; Okerman, 1994; Dyce, *et al.*, 2010) in carnivores and (Nzalak, *et al.*, 2010) in lion. Suprahamate process adapted the nature of fast running in cats, an opinion mentioned by (Venkatesan, *et al.*, 2015) in Orange-rumped agouti.

The highly sensitive hamatus process in small cursorial mammals, provide a muscular attachment, maintain the fixation of shoulder joint throughout the movement and to resist ground reaction forces during fast running (Seckel and Janis, 2008). Moreover the acromion and hamatus process documented without suprahamateprocess by Sisson (1975) in carnivorous, Hebel and Stromberg (1976), Özkan, *et al.*, (1997) and Nzalak, *et al.*, (2010) in Rodentia, Olawoye, *et al.*, (2011) in African giant rat, Saber (2013) in wombat and Venkatesan, *et al.*, (2015) in the Orange-rumped agouti.

Concerning the infraspinous fossa of the scapula was triangular in rabbit and more rounded in the cat (Okerman, 1994) as our results. It was larger than supraspinous in rabbit (Craigie, 1948) and in the mole-rat (Özkan, 2002). On contrary with Yilmaz, *et al.*, (1998) in porcine, the supraspinous fossa was larger than the infraspinous one. On the other hand, both fossae were nearly equal in size in the African giant rat (Olude, *et al*., 2010 and Olawoye, *et al*., 2011) and in wombat (Saber, 2013).

Whereas long humerus with the absence or ill distinction of deltoid tuberosity, smooth surfaces without muscular attachment location as teres tubercle, humeral crest and absence of musculospiral groove recommended as adaptations for fast running in rabbit and cat. In contrast with a prominent deltoid tuberosity described in the Muridae family (Saunders and Manton, 1969; Çalitlar, 1978 and Özkan, 2002), as well as in African giant rat (Olawoye, *et al*., 2011) and in wombat (Saber, 2013). The spherical and rounded humeral head of rabbit and cat respectively amplified in the probability of movement in the rostro-caudal direction and decline those of the lateral movement, which is an agreement with Stein (2000) in subterranean.

Our study stated that, the presence of supratrochlear foramen in rabbit which disagreed with (Al-Hussaini and Demian, 1964) which pointed to it as supracondyloid foramen. On the other hand, the existence of the supracondyloid foramen of the cat was agreed with (Dyce, *et al*., 2010) in cat and (Saber, 2013) in the wombat.

The separated radius and ulna of the cat in our study suggested to qualify cats for more running and jumping than rabbits which supported by (Venkatesan, *et al*., 2015) in Orange-rumped agouti. The presence of the styloid process of the radius and ulna in our research, look like what was recorded in dog and cat (Miller, 1964 and Dyce *et al*., 2010) and in porcupines (Yilmaz *et al*., 1998).

The order of the carpal bones in rabbit and cat was similar to the main structure of rodents. Its number was nine in rabbit which was typical of the Rodentia order (Saunders and Manton, 1969; Demy'rsoy, 1997 and 1998) and agreed with the work of Greene (1968) on the albino rat and Olawoye, *et al*., (2011) in the African giant rat. Al-Hussaini and Demian (1964) in rabbit which mentioned that, the center carpal bone present in the center between the two rows and a pisiform bone situated caudo-medial to the carpus which in contrary with our work. The carpal bones were seven in the cat in our work which agreed with that reported in the cat by (Sisson, 1975). In porcupine (Yilmaz, *et al*., 1998) revealed that the carpal bones were four proximally and distally.

The presence of radial and ulnar sesamoid bones in the proximal row was described by Venkatesan, *et al*., (2015) in the Orange-rumped agouti, Saunders and Manton (1969) the mole rats, Olude*et al*., (2010) in African giant rat and Stein (2000) in subterranean rodents. The previous sesamoid carpal bones not described in the species used in this study. The distal row included five bones in rabbit which similar to Morgan and Verzi (2011) in some burrowing rodents, where a fifth carpal bone, namely the central carpal. Contrary to our results in cat where four carpal bones in the same row as confirmed by Venkatesan, *et al*., (2015) in Orange-rumped agouti,Yilmaz *et al*., (1998) in porcupines and Saunders and Manton (1969) in other rodents.

The presence of five meta-carpals demonstrated by Hughes and Dransfield (1953) in dog, Yilmaz, *et al*. (1998) in porcupines and Özkan (2002) in mole-rat as our results. Al-Hussaini and Demian (1964) declared that the first metacarpal was the shortest while the third and fourth were the longest. In the present study the third was the longest as confirmed in Orange-rumped agouti by Venkatesan, *et al*., (2015) which was in contrast to that reported in burrowing rodents by Morgan and Verzi (2011) wherever the metacarpals were short and robust.

Rodent species had five digits (Saunders and Manton, 1969; Demy'rsoy, 1997 and 1998 and Venkatesan *et al*., 2015). In dog Hughes and Dransfield (1953) revealed that the medial digit had two phalanges only. The unguicular process of the third phalanx was pointed and divided distally in rabbit although in cat it was undivided which explained the easy burrowing and shoveling by the rabbit that agreed with Olude, *et al*., (2010) in African giant rat.

Conclusion

There were many differences between the bones of the thoracic limbs of rabbits and cats, which gave us an idea for the next research that comparing their muscular system in both species.

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REFERENCES

Abidu-Figueiredo M, B Xavier-Silva, T Cardinot, M Babinski and M Chagas, 2008. Celiac artery in New Zealand rabbit: anatomical study of its origin and arrangement for experimental research and surgical practice. Pesquisa. Vet Brasil, 28:237-240.

Al-Hussaini AH and ES Demian, 1964. Practical animal biology,Vol.II, Systematiczoology, 2nd ed. DarAl-Maaref, Cairo, Egypt.

Aspinall V, M Cappello and C Phillips, 2015. Introduction to Veterinary Anatomy and Physiology Textbook. 3rd ed. Elsevier,pp 166-170.

Çalitlar T, 1978. LaboratuvarHayvanlary´ Anatomisi. Fy´ratÜniv. Vet. Fak. Yay. 14, Ankara Ün. Basy´mevi, Ankara, pp 106-123.

Craigie EH, 1948. BENSLEY'S Practical Anatomy of the Rabbit (An Elementary Laboratory Text Book in Mammalian Anatomy). 8th ed. The University of Toronto Press Printed in Canada, pp: 198-205.

Demy´ Rsoy A, 1998. Yay´ amy´nTemelKurallary´. Meteksan AT, Ankara. pp 33-76.

Demy´Rsoy A, 1997. TürkiyeOmurgaly´ lary´. Memeliler, Meteksan AT, Ankara. pp 83-105.

Dyce KM, WO Sack and CJG Wensing, 2010. Textbook of veterinary anatomy. 4th ed.Philadelphia: WB Saunders Company.

Greene CE, 1968. The anatomy of the rat: Transactions of the American Philosophical Society. New Series. Hafner Publishing Company, New York, London, 27: 1-50.

Hall LW, KW Clarke and CM Trim, 2001. Veterinary Anaesthesia. 10th ed. WB Saunders. Harcourt Publishers Limited, pp 441 – 466.

Hebel R and M Stromberg, 1976. Anatomy of the laboratory rat. Williams and Wilkins Company, Baltimore, MD, pp 106-132.

Hudson LC and WP Hamilton, 1993. Atlas of the feline anatomy for veterinarians. W.B. Saunders Company. Phalidelphia, London, Toronto, Montreal, Sydney, Tokyo, pp 24-39.

Hughes HV and JW Dransfield, 1953. McFadyean's Osteology & Arthrology of the domesticated animals. Bailliere, Tindall and Cox, London.

König HE and HG Liebich, 2004. Veterinary Anatomy of Domestic Mammals Textbook and Colour Atlas. Schattauer GmbH, HölderlinstraBe 3, D-70174 Stuttgart, Germany, pp 129-144.

McCracken T O, RA Kainer and D Carlson, 2008. Color Atlas of Small Animal Anatomy: The Essentials. First ed. Blackwell Publishing.

Miller ME, 1964. The Anatomy of the Dog. W.B. Saunders Co.Philadelphia, pp 64-78.

Morgan CC and DH Verzi, 2011.Carpal-metacarpal specializations for burrowing in South American Octodontoid rodents. J Anat, 219:167–175

NominaAnatomicaVeterinaria, 2012:5th ed, prepared by the International Committe on Veterinary Gross Anatomical Nomenclature (I.C.V.G.A.N.) and authorized by the General assembly of the World Association of Veterinary Anatomists (W.A.V.A.), konxville,T.N (USA). Published by the Editorial Committee, Hannover, Columbia, Ghent and Sapporo. p 18-23.

Nzalak JO, MM Eki, MH Sulaiman, AD Umosen, SO Salami, SM Maidawa and CS Ibe, 2010. Gross anatomical studies of the bones of the thoracic limbs of the lion (Pantheraleo). J Vet Anat, 3(2):65-71.

Okerman L, 1994. Anatomical peculiarities. In Diseases of domestic rabbits. 2nd ed. Blackwell Scientific Publications.Oxford, London, Edinburgh Boston, Melbourne, Paris, Berlin,Vienna, pp 10-14.

Olawoye SS, KO Tobechukwu, O Byanet, SI Chikera and SO Adeniyi, 2011. Morphological studies of the appendicular skeleton of the African giant pouched rat (*Cricetomysgambianus*) Part (i) pectoral limb. J Vet Med. Anim Health, 3(7):82-87.

Olude MA, JO Olopade,AK Akinloye and OA Mustapha, 2010. Macro-anatomical investigations of the skeletons of the African giant rat (Cricetomysgambianus Waterhouse 1840) II: Fore limb**.** Eur J Anat, 14 (1): 19-23.

Onwuama KT, SO Salami, O Ali and JO Nzalak, 2012. Effect of different methods of bone preparation on the skeleton of the african giant pouched rat (Cricetomysgambianus). Int J Morphol, 30(2):425-427.

Özkan ZE, 2002. Macro-anatomical investigations on the forelimb skeleton of mole-rat (SpalaxleucodonNordmann) Veterinarskiarhiv 72 (2): 91-99.

Özkan ZE, G Dinç and A Aydin, 1997. Tavsan (Oryctolaguscuniculus)kobay(Caviaporcellus)veratlar da(Rattusnorvegicus),scapula,clavicula,skeletonbrachiiveskeletonantebrachii'ninkarsılastırmalı.

Popesko P, V Rajtova and J Horak, 1990. A colour atlas of anatomy of small laboratory animals. Vol.1. Aylesbury.

Saber AS, 2013. Some Morphological Observations on the Thoracic Limb Bones of the Hairy-nosed Wombat (Lasiorhinuslatifornis, Owen). J Vet Anat, 6 (2): 93-109.

Saunders JT and SM Manton, 1969. A manual of practical vertebrate morphology. Clarendon Press, Oxford, 4: 208-286.

Seckel L and C Janis, 2008. Convergences in scapula morphology among small cursorial mammals: An osteological correlate for locomotory specialization. J Mammal Evol, 15:261–279.

Sisson S, 1975. Carnivore Osteology. In R.Getty. Sisson and Grossman's. The anatomy of the domestic animals. 5th ed. Vol. II. W.B. Saunders Company, Philadelphia, London, Toronto, pp1427-1503.

Stein BR, 2000. Morphology of subterranean rodents. In: Lacey AE, Patton JL, Cameron GN. The Life Under ground. The biology of subterranean rodents. Chicago: University of Chicago Press.

Uçar Y, M Öcal and M Haziroglu, 1985. Makro-anatomischeUntersuchungenuber die Clavic-uladeseinheimischenHundes, der einheimischenKatze und Neuzelandshasens. J FacVet Med Univ Ankara, 32:42-52.

Venkatesan S, N Dumas, A Adogwa, S Rao and SB Nayak, 2015. Morphological Studies of the Forelimb Skeleton of the Orange Rumped Agouti (Dasyproctaleporina Linnaeus, 1758). Annual Research & Review in Biology, 8(4): 1-9.

Wagner JE and PJ Manning, 1976. The Biology of the Guinea Pig. Academic Press, New York, San Francisco, London, pp 10-44.

Yilmaz S, ZE Özkan and RD Özdemy´, 1998. Macroanatomical investigations on the skeletons of porcupine (*Hystrixcristata*).I.Ossamembrithoracici. Tr J Vet Anim Sci, 22:389-392.