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COMPARATIVE ANATOMICAL AND BIOCHEMICAL STUDIES ON THE MAIN BONES OF THE LIMBS IN RABBIT AND CAT AS A MEDICOLEGAL PARAMETERS

(With 2 Tables and 8 Figures)

By

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دراسات تشريحية وبيوكيميائية مقارنة على عظام أطراف الأرانب
والقطط الرئيسية واستخدامها كأدلة طبيـــــــــــــــة شرعيـــــــة

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نظرا لارتفاع أسعار اللحوم في الأونة الأخيرة كثرت الشكوى من تقديم لحوم القطـط بدلا من لحوم الأرانب في المطاعم مما حدا بنا الي اجراء هذا البحث لوضع الأسس العلمية الصحيحة للتفريق بين العظام كبقايا للجثث لما لذلك من أهمية طبية شرعية لكشف هـــذا النوع من الغش التجاري . أجري هذا البحث على عشرين من الأرانب والقطط البالغة مـــن الجنسين وبعد اعدام هذه الحيوانات تم تنظيف العظام بالطرق المألوفة تشريحيا ثـــم أجريت الدراسة التشريحية لمقارنة كل عظمة من العظام موضع الدراسة بمثيلتها فـــي الحيوان الآخر ، وقد أوضحت الدراسة وجود اختلافات جوهرية بين عظام كل من الأرانب والقطط تشريحيا وبيوكيميائيا يمكن الاعتماد عليها من الوجهة الطبية الشرعية للتفرقـــة بين جثث هذين الحيوانين تتلخص في الآتي : النتوء فوق الأخرومي لعظم اللوح فـــي الأرانب يكون أطول عنه في القطط (٤ر١ سم ، ٤ر٠ سم) ، نسبة الحفرة فوق الشوكيـــة الي الحفرة تحت الشوكية في الأرانب ١:٢ بينما تكون في القطط ١ : ١ ، المدور الكبير لعظم الفخذ في الأرانب يرتفع عن مستوى الرأس بينما يكون في مستوى الرأس تقريبا في القطط ، الطـــرف القاصي لعظم القصبة يحتوي على ٣ ميازيب سهمية في الأرانب ويحتـــوي على ميزابين منحرفين في القطط ولقد أوضحت التحاليل البيوكيميائية لنسبة المادة الجافـــة والكالسيوم للعظام الطويلة زيادتها زيادة معنوية في الأرانب عنها في القطط وعلى العكـس فان نسبة الرماد والفوسفور في هذه العظام تكون أعلى في القطط منها في الأرانب كمـــا لوحظ أن مجموع نسبتي الكالسيوم والفوسفور لكل عظمة على حدة يكون أعلى في الأرانـــب عنها في القطط .

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SUMMARY

The present work indicates that the Processus suprahamatus of the scapula is longer in rabbit (1.4 cm) than in cat (0.4 cm). The ratio between the Fossa supraspinata and infraspinata is 1:2 in rabbit, while in cat it is 1:1. The humerus has a rounded Foramen supratrochleare in rabbit, and a slit like Foramen supracondylare in cat. The Trochanter major projects above the level of the head of the femur in rabbit, but the two are situated at the same level in cat. The Cochlea tibiae has three sagittal grooves in rabbit and two oblique grooves in cat. The dry matter and calcium percent of the studied long bones are higher in rabbit than in cat, on the contrary, the ash and phosphorus percent are lower in rabbit than in cat. The summation of the percentage of calcium and phosphorus of each examined bone is higher in rabbit than the corresponding bone in cat.

INTRODUCTION

The dimensions of bone can provide a guide to the stature of the animal and are also useful for the definition of breeds and sub-species (CHAPLIN, 1971). On the other hand, there are complaints from members of the public that they have been served cat meat instead of rabbit in oriental resturants (WILSON, 1985). In spite of this problem, the informations about the differentiation of the carcass between rabbit and cat are meagre from the medicolegal aspect. The aim of the present work is to describe the anatomical and biochemical differences of the main bones of the limbs between rabbit and cat in order to provide a good informations for differentiation between the two animals.

MATERIAL and METHODS

The study was carried out on twenty native, adult animals from both sexes each of rabbit and cat. These animals aged between one to two years andweighing between two to three kg. The bones were dissected free from all soft tissues and the anatomical features were described. After that the cortical bone index (CBI) was measured from radiographs using the technique of BARNETT and NORDIN (1960). From the radiographs of the studied bones (Fig. 1), the total breadth (A-B), breadth of the medulla (DX) and the breadth of mineralized bone (C-D, X-Y) were measured. Then the cortical bone index was calculated from the following equation:

$$\text{Cortical bone index (CBI)} = 100 \frac{CD + XY}{AB}$$

Bone samples of the aforementioned rabbits and cats were taken and dried at 105°C for 24 hours and ashed in a muffle furnace at 600°C for 8 hours. 0.5 gm from the resulting ash was weighed for calcium and phosphorus estimation. The ash was dissolved in 1 M HCL and the volume was adjusted with distilled water to 5' ml. Calcium and phosphorus were estimated using test kits from Biomerieux (Bains and France) after the methods of GINDLER and KING (1972) and MORINL and PROX (1973) respectively. The nomenclature used in this work was that adopted by N.A.V. (1983) as it is possible.

RESULTS

Anatomical observation :

Scapula:

The Spina scapulae (Fig. 2/1) divides the lateral surface into the Fossa supraspinata (Fig. 2/2) and Fossa infraspinata (Fig. 2/3) with a ratio 1:2 in rabbit and 1:1 in cat. The acromion is long in rabbit but short in cat. The Processus suprahamatus (Fig. 2/4) in rabbit is represented by a long bar shaped projection for about 1.3 cm in length, but in cat this process is formed of a short ridge shaped projection with 0.4 cm long.

The Margo dorsalis (Fig. 2/5) is thin and nearly straight in rabbit, but rough and convex in cat. The Margo cranialis and caudalis (Fig. 2/6,7) are thin in rabbit, and thick in cat. Moreover, the cranial border is straight in the former animal and convex in the latter one.

The Collum scapulae (Fig. 2/8) is long and narrow in rabbit, short and wide in cat. Its width is about 0.5 cm in rabbit and 1.3 cm in cat.

The Cavitas glenoidalis (Fig. 2/9) is separated from the Tuberculum supraglenoidale (Fig. 2/10) by a clear constriction in rabbit, and continues cranially upon the tubercle in cat. The Processus coracoideus is relatively long and has a blunt end in rabbit, but it is short and has a pointed end in cat.

Humerus:

The Tuberculum majus in rabbit is situated caudal to the Tuberculum minus, while in cat the two tuberosities begin cranially at the same level. The Crista humeri in rabbit which has a distinct border terminating abruptly on the Corpus humeri and occupying its proximal third. The cat has a less distinct crest which fades distally on the body and occupying its proximal half.

The Capitulum humeri (Fig. 3/1) is nearly equal to theTrochlea humeri (Fig. 3/2) in rabbit, however in cat the former condyle is smaller than the latter one. The Fossa olecrani in rabbit is regarded by two equal ridges which terminate proximally at the same level.However in cat, the lateral ridge is larger than the medial one, and terminates proximal to it. The Fossa olecrani in rabbit communicates the Fossa coronoidea through a round shaped Foramen supratrochleare (Fig. 3/3). This foramen is absent in cat. Only in cat, a slit like Foramen suprachondylare (Fig. 3/4) is located directly proximal to the Epicondylus medialis, the long axis of this foramen is directed proximodistally and measures about 1.1 cm.

Radius:

The radius and ulna are separate in rabbit and cat, but in the former animal the two bones are closely related especially at their distal parts. The humeral articular circumference consists of two articular facets separated by a sagittal groove; the medial facet is convex while the lateral one is nearly flat. However, the humerus in the cat has a concave articular circumference which bears a small convex marginal area.

The Corpus radii (Fig. 4/1) in rabbit is curved throughout its length. In case of cat, the body (Fig. 4/1) is straight. Slightly distal to the proximal extremity, the caudal surface of the shaft bears a distinct articular facet, this feature is present only in cat. The Facies articularis carpea in rabbit consists of three concave facets separated by two ridges; the middle facet is the deepest one. In cat this surface has a large concave articular area.

Ulna:

The Processus coronoideus medialis and lateralis are nearly equal in size in rabbit, however the former one is much larger than the latter in cat. The Tuber olecrani (Fig. 4/2) has a groove which is quarded by two ridges; the medial ridge is directed dorsolaterally and is larger than the lateral one in rabbit. But in cat the medial ridge is directed dorsomedially, moreover the two ridges are nearly equal in size.

The Corpus ulnae (Fig. 4/3) is curved throughout its length in rabbit but nearly straigt in cat.

The Processus styloideus (Fig. 4/4) is relatively small and extends shortly distal to the Circumferentia articularis in rabbit, while in cat the process is much larger in size and projects more distally than the articular circumference.

Femur:

The Trochanter major (Fig. 5/1) projects above the level of the Caput ossis femoris in rabbit, but the two are situated at the same level in cat. This trochanter is curved medially only in rabbit. The Trochanter minor (Fig. 5/2) in rabbit is in the form of a sharp ridge which is located on the medial aspect of the shaft opposite to the distal end of the Fossa trochanterica. This trochanter is represented by a pyramidal shaped blunt eminence which is found on the caudomedial aspect of the shaft and it does not extend to the level of the trochanteric fossa. A cranially curved Trochanter tertius (Fig. 5/3) is present below the Trochanter major in rabbit but is absent in cat.

The Corpus ossis femoris (Fig. 5/4) is slightly curved and flattened cranio-caudally in rabbit while it is cylindrical in cat.

The two condyles (Fig. 5/5,6) of the distal extremity are equal in size in rabbit, however in cat the lateral condyle is larger than the medial one. The Fossa intercondylaris (Fig. 5/7) is narrow in rabbit and wide in cat. The ridges of the Trochlea ossis femoris are similar and sagittal in direction in rabbit, on the other hand, in cat the medial ridge is larger than the lateral one, moreover the two ridges converge below.

Tibia and Fibula:

The Incisura poplitea (Fig. 6/1) is narrow and deep in rabbit while wide and shallow in cat. The Area intercondylaris caudalis (Fig. 6/2) is triangular in rabbit, small and continues with popliteal notch in cat.

The Cochlea tibiae (Fig. 6/3) consists of three sagittally directed grooves in rabbit; the middle groove is the deepest one. In cat, there is only two grooves which are directed obliquely laterally and cranially, moreover, the medial groove is deeper than the lateral one. A prominent Malleolus medialis (Fig. 6/4) projects more distally than the other parts of the distal epiphysis in cat.

The fibula (Fig. 6/5) is fused with the middle of the Corpus tibiae in rabbit, but in cat the two bones are separated along their length. The Malleolus lateralis (Fig. 6/6) of the fibula is a small pointed eminence on the lateral side of the distal epiphysis of the tibia in rabbit, but in cat this malleolus is larger in size and attaches the body of the fibula.

Biochemical and radiological analysis:

Table (1) and Fig. (7) indicates that the calcium percent of the studied long bones is 38.00-41.00% (39.60±1.14%) in rabbit and 27.00-31.75% (30.15±1.96%) in cat. While the phosphorus percent is 17.60-18.90 (17.83±1.20%) in rabbit and 18.28-20.60% (19.84±1.12%) in cat. This results explain that the calcium percent of the examined long bones of rabbit is higher than of cat, on the contrary, the phosphorus percent is higher in cat than in rabbit.

The summation of the percentage of the calcium and phosphorus of each studied bone in rabbit (57.43%) is higher than the corresponding bone of cat (49.99%).

The ratio of the mean values between the calcium and phosphorus percent is 2.2:1.0 in rabbit and 1.5:1.0 in cat. This ratio indicates that the amount of the calcium in the examined bones of rabbit is more than two folds that of phosphorus. But in cat, the amount of calcium is one and half fold that of phosphorus.

The percentage of the dry matter (Table 1) of each studied bone in rabbit (84.14%) is higher than that of cat (76.04%). While the percentage of ash in rabbit (50.94%) is lower than that of cat (55.22%).

Table (2) shows that the investigated bones of cat are longer and thicker than the corresponding bones of rabbit. In both animals the tibia is the longest bone among the other examined bones, however, the shortest bone is the radius. In addition, table (1) indicates that the femur is the heaviest bone in both examined animals while the radius is the lightest bone. The cortical bone index (Table 2 and Fig. 8) of each studied long bone in rabbit (35.75%) is higher than the corresponding bone of cat (26.95%).

DISCUSSION

In corresponding to the present work, the scapula of the rabbit has a long bar shaped suprahamate process about 1.3 cm long, while the cat has a short ridge shaped process about 0.4 cm long. On the other hand, WILSON(1985) stated that the rabbit has a long suprahamate process which is absent in cat. According to McCLURE et al. (1973), GEORGE (1978) and NICKEL et al. (1986) the cat has a suprahamate prrocess.

THAKUR and PURANIK (1984) describe a small medially directed coracoid process in the scapula of the rabbit. In accordance to the present findings, the rabbit has a relatively long and curved coracoid process which has a blunt free end, however the process of cat is short and has a pointed free end. In this respect, NICKEL et al. (1986) reported that the cat has a pronounced cylindrical coracoid process.

The work under investigation shows that the radius and ulna are separate in rabbit and cat, but in the former animal the two bones are closely related. The same result was obtained by THORNTON (1957). On the contrary, WILSON (1985) reported that radius and ulna are separate in the cat but united in rabbit.

The total breadth of the radius and ulna in the examined cases of cat is equal (0.50 cm). Similar result was recorded in the same animal by NICKEL et al. (1986) who reported that the radius and ulna are equally thick. While in case of rabbit the breadth of radius (0.40 cm) is smaller than that of ulna (0.48 cm).

As reported by THAKUR and PURANIK (1984) in rabbit the greater trochanter projects above the level of head, but in cat the two are situated at thesame level. On the other hand, NICKEL et al. (1986) mentioned that the greater trochanter is lower than the head in cat.

McCLURE et al. (1973) pointed out that the lesser trochanter in cat protrudes caudally from the femur at the distal edge of the trochanteric fossa. Corresponding to the present work, this trochanter in the cat is represented by a pyramidal shaped blunt eminence which is located at caudomedial level of the trochanteric fossa. In rabbit the lesser trochanter is in the form of sharp ridge which is situated on the medial aspect of the shaft opposite to the distal end of the trochanteric fossa.

According to the obtained findings in rabbit and cat, the tibia is the longest bone among the other examined bones including femur. While SISSON (1975) reported that the tibia is about the same length as the femur in carnivora.

GETTY (1975) mentioned that the hardness of the bone is due to the deposition of the mineral salts within the soft tissue. He added that decalcification, while not affect in the form and size of the bone, renders it soft and pliable. In this connection the present results indicte that the summation of the percentage of the calcium and phosphorus of each studied bone is higher in rabbit than the corresponding bone of cat. Consequently the examined bones of rabbit are harder than that of the cat.

NORDIN (1976) reported that many dietary and digestive factors have been stated to influence the availability of calcium and its absorption including the bulk of the diet, the amount of the dietary fat, the presence of protein, amino acid and sugars in the diet. Accordingly, the difference of the calcium percent between the bone of rabbit and cat in the present study may be due to the type of food in addition to the species differences.

CHURCH and POND (1978) stated that the calcium occurs in the bone as in about 2:1 ratio with the phosphorus. On the contrary, the results that have been obtained show that the ratio between the calcium and phosphorus in the investigated bones is 2.2:1 in rabbit and 1.5:1 in cat.

During the differentiation between the carcasses of rabbit and cat, THORONTON (1957) mentioned that the forearms are light in the former animal but heavy in the latter one. In this respect, the present study indicates that the calcium percent of the forearm in rabbit is higher than that of cat, but the phosphorus percent in the rabbit is lower than that of cat.

Finally, it becomes easily to differentiate between the carcass of rabbit and cat depending upon the anatomical differences of the studied bones. This method is the simplest method of differentiation because it can applied at any place and does not need to any instruments. Moreover, the measurement of cortical bone index from the radiographs considered another method of differentiation between rabbit and cat. In addition to the foregoing methods, the biochemical analysis is important to differentiate between rabbit and cat especially when a small piece of bone is obtained.

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LEGENDS

Fig. 1: Radiographic diagram of cat's femur.

Fig. 2: Photograph of scapula: A- Rabbit scapula B- Cat scapula.

1- Spina scapulae.
2- Fossa supraspinatus.
3- Fossa infraspinatus.
4- Processus suprahamatus.
5- Margo dorsalis.
6- Margo cranialis.
7- Margo caudalis.
8- Collum scapulae.
9- Cavitas glenoidalis.
10- Tuberculum supraglenoidale.

Fig. 3: Photograph of Epiphysis distalis of the humerus: A- Rabbit B- Cat.

1- Capitulum humeri.
2- Trochlea humeri.
3- Foramen supratrochleare.
4- Foramen supracondylare.

Fig. 4: Photograph of radius and Ulna: A'- Radius, A- Ulna (Rabbit). B'- Radius, B- Ulna (CAT).

1- Corpus radii.
2- Tuber olecrani.
3- Corpus ulnae.
4- Processus styloideus.

Fig. 5: Photograph of femur: A- Rabbit. B- Cat.

1- Trochanter major.
2- Trochanter minor.
3- Trochanter tertius.
4- Corpus ossis femoris.
5- Condylus medialis.
6- Condylus lateralis.
7- Fossa intercondylaris.

Fig. 6: Photograph of tibia and fibula: A- Rabbit B- Cat.

1- Incisura poplitea.
2- Area intercondylaris caudalis.
3- Cochlea tibiae.
4- Malleolus medialis.
5- Fibula.
6- Malleolus lateralis.

Fig. 7: Showing the percentage of the calcium and phosphorus of the studied long bones in rabbit and cat.

Fig. 8: Showing the percentage of the cortical bone index in rabbit and cat.

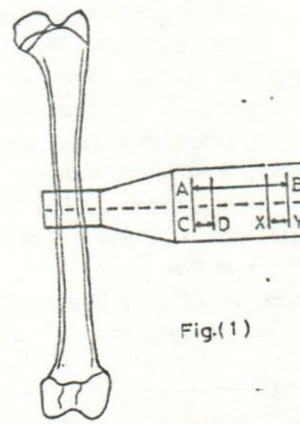


Fig.(1)

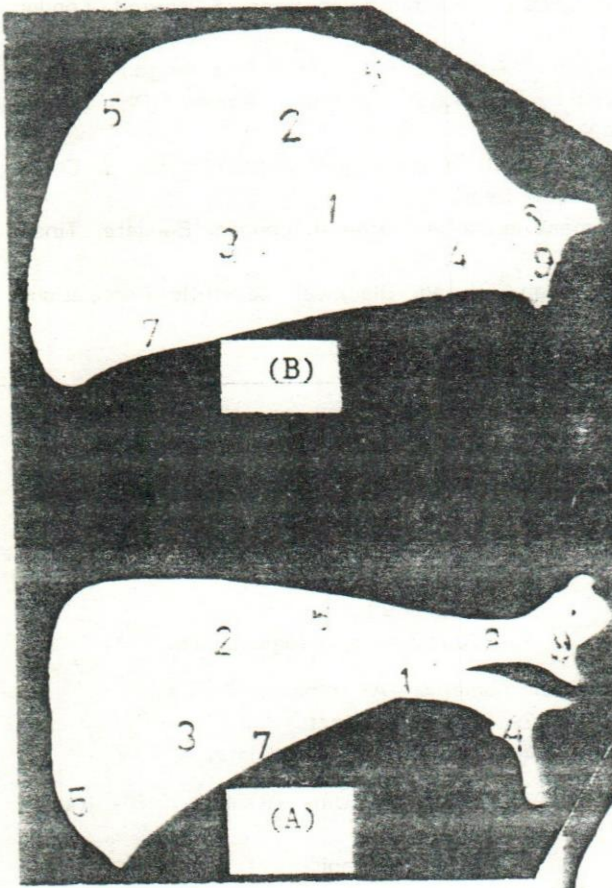


Fig. (2)

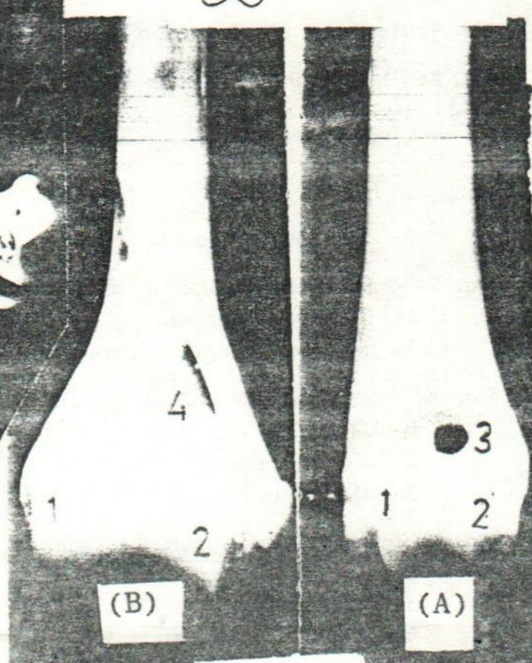
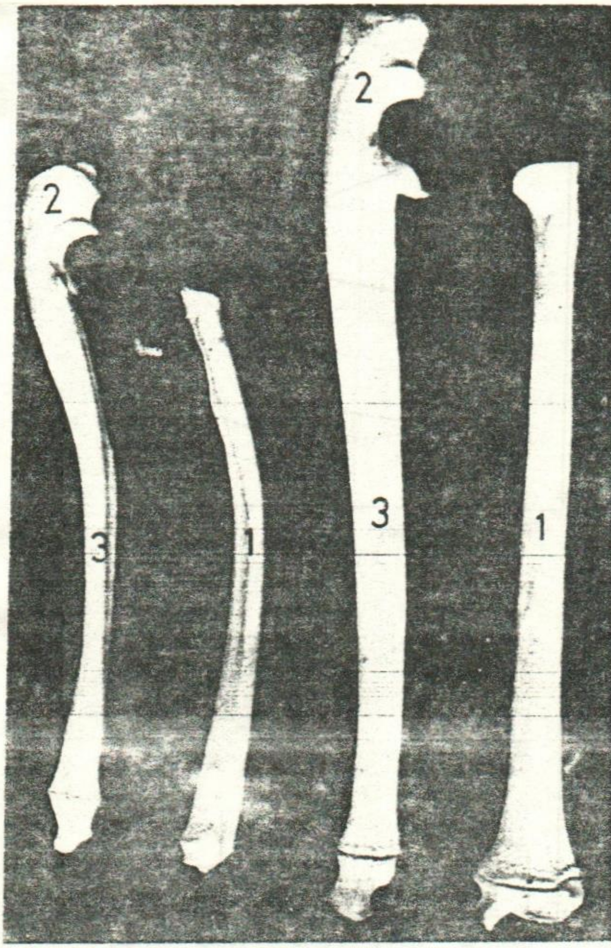


Fig. (3)



A′ A B′ B

Fig. (4)

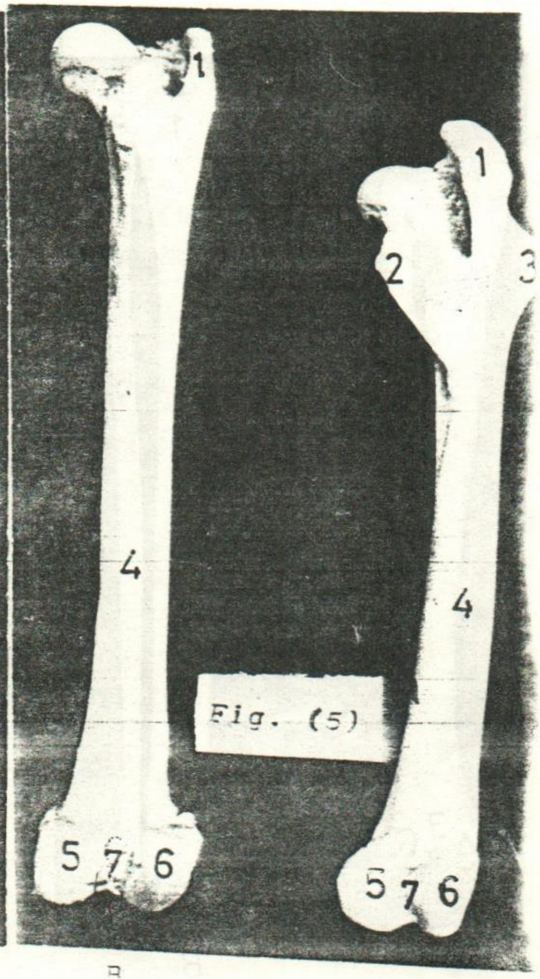
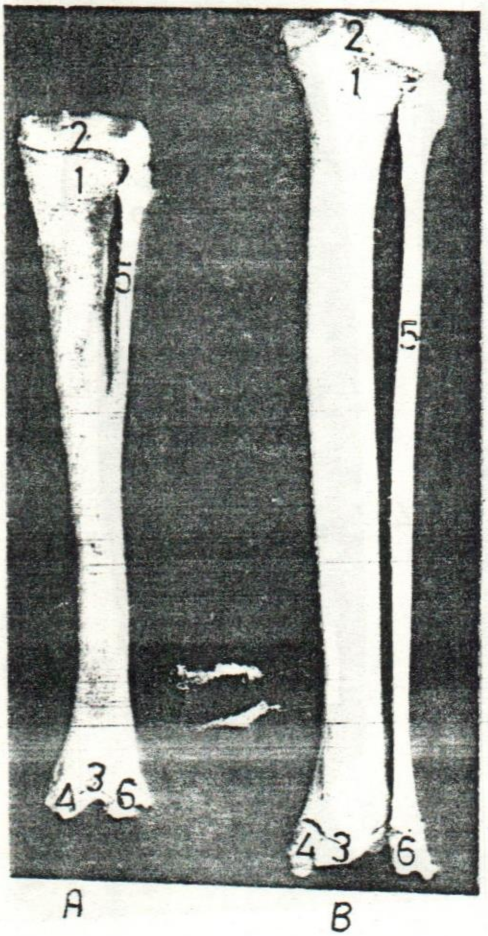


Fig. (5)

B A



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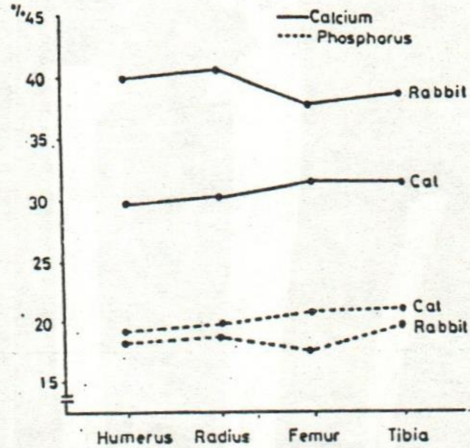

Fig.(7)

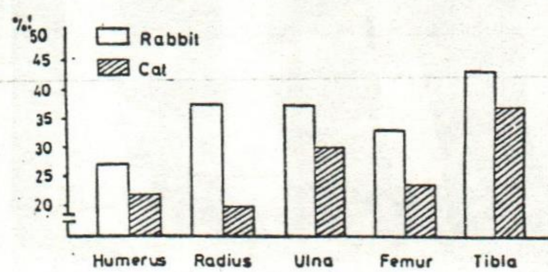

Fig.(8)

Table 1: Mean values of absolute weight, dry matter, ash, calcium and phosphorus in examined bones of rabbit and cat.

Bone	Animal species	Absolute wt. (g)	Dry matter (%)	Ash (%)	Calcium (%)	Phosphorus (%)	Ca/P
			-	**	**	-	
Scapula	Rabbit	2.225 ± 0.50	82.60 ± 1.39	50.60 ± 0.64	40.00 ± 1.70	18.90 ± 0.93	2.12 ± 0.0
	Cat	2.535 ± 0.58	79.20 ± 1.03	54.60 ± 0.47	27.00 ± 1.50	18.28 ± 1.23	1.49 ± 0.0
			**	**	**	-	
Humerus	Rabbit	3.262 ± 0.35	84.80 ± 1.09	51.80 ± 0.52	40.00 ± 1.09	18.29 ± 0.71	2.19 ± 0.0
	Cat	4.329 ± 0.28	74.70 ± 1.80	54.80 ± 0.33	29.75 ± 1.51	19.21 ± 1.81	1.54 ± 0.0
			**	**	**	-	
Radius	Rabbit	1.056 ± 0.15	88.80 ± 1.92	51.50 ± 0.51	41.00 ± 1.61	18.54 ± 0.31	2.21 ± 0.0
	Cat	2.292 ± 0.27	76.40 ± 1.41	55.60 ± 0.50	30.50 ± 1.26	19.96 ± 1.04	1.53 ± 0.0
			**	**	*	-	
Femur	Rabbit	6.966 ± 0.59	83.00 ± 1.43	49.70 ± 0.81	38.00 ± 1.07	17.60 ± 0.23	2.15 ± 0.0
	Cat	8.027 ± 0.75	72.70 ± 1.61	54.70 ± 0.51	31.75 ± 0.90	20.80 ± 0.90	1.52 ± 0.0
			*	**	**	-	
Tibia	Rabbit	6.079 ± 0.58	81.50 ± 1.02	51.10 ± 0.13	39.00 ± 1.13	18.85 ± 0.22	2.07 ± 0.0
	Cat	7.822 ± 0.71	77.20 ± 0.93	56.40 ± 0.53	31.75 ± 1.07	20.98 ± 0.47	1.51 ± 0.0
			-	*	*	-	
Mean ± S.E.	Rabbit	—	84.14 ± 2.86	50.94 ± 0.82	39.60 ± 1.14	17.83 ± 1.20	2.15 ± 0.
	Cat	—	76.04 ± 2.47	55.22 ± 0.77	30.15 ± 1.96	19.84 ± 1.12	1.52 ± 0.0

- Non significant * Significant at P≤ 0.05 ** Significant at P≤ 0.01

Table 2: Mean values of radiographic measurements (in cm) of the studied bones of rabbit and cat.

Bone	Animal species	L	A - B	DX	(C - D) ÷ (X - Y)	CBI (%)
Humerus	Rabbit	6.35 ± 0.32	0.52 ± 0.03	0.38 ± 0.01	0.14 ± 0.005	26.92 ± 1.53
	Cat	8.90 ± 0.43	0.62 ± 0.05	0.48 ± 0.02	0.14 ± 0.007	22.58 ± 1.80
Radius	Rabbit	5.80 ± 0.27	0.40 ± 0.04	0.25 ± 0.01	0.15 ± 0.004	37.50 ± 2.10
	Cat	7.50 ± 0.57	0.50 ± 0.03	0.40 ± 0.03	0.10 ± 0.003	20.00 ± 1.95
Ulna	Rabbit	7.25 ± 0.80	0.48 ± 0.05	0.30 ± 0.02	0.18 ± 0.015	37.50 ± 2.30
	Cat	9.20 ± 0.63	0.50 ± 0.04	0.35 ± 0.01	0.15 ± 0.020	30.00 ± 1.87
Femur	Rabbit	8.40 ± 0.57	0.53 ± 0.05	0.35 ± 0.01	0.18 ± 0.005	33.96 ± 0.58
	Cat	9.30 ± 0.78	0.71 ± 0.03	0.53 ± 0.05	0.18 ± 0.006	24.66 ± 1.09
Tibia	Rabbit	9.10 ± 0.83	0.70 ± 0.06	0.40 ± 0.03	0.30 ± 0.008	42.86 ± 2.35
	Cat	9.60 ± 0.98	0.72 ± 0.05	0.45 ± 0.02	0.27 ± 0.005	37.50 ± 2.51