

Dept. of Surgery,

Fac. Vet. Med., Assiut University

Head of Dept. Prof. Dr. M.T. Nassef

## RADIOGRAPHIC DETERMINATION OF THE OSSIFICATION CENTERS APPEARANCE AND ITS CLOSURE IN LONG BONES OF RABBITS

(With 2 Tables & 3 Fig.)

By

M.A. ALI and A.S. SALEH

(Received at 23/6/1993)

**تحديد وقت ظهور مراكز التمعظم وأوسدادها راديولوجياً  
في العظام الطويلة للأرجل الأمامية والخلفية في الأرانب**

محمد عادل ، أحمد صالح

أجريت هذه الدراسة على ٨ أرانب حديثة الولادة من السلالات البلدية. ولقد توبعت مراكز التمعظم وألتحامها في العظام الطويلة أشعاعياً من عمر يوم وحتى عمر سنة في فترات مختلفه. ومن هذه الدراسة وجد أن عدد مراكز التمعظم وكذلك ظهورها تختلف من عظمه وأخرى. كما لوحظ أن التهام العظم يظهر مبكراً في الجزء العلوى من العظمه عنه في الجزء السفلى.

### SUMMARY

The present study was performed on 8 newly born native breed rabbits. The appearance of ossification centers and physal closure were determined by radiographic follow-up from birth till one year in several intervals. The length of the long bones was measured in the same intervals with assesment of The radiographs. It was found that the number of the ossification centers as well as its appearance were varied from one bone to another. Also the physal closure were noticed earlier in the proximal epiphyses than the distal one. The bone length showed a smooth even curve with no sudden accelerated growth.

### INTRODUCTION

Radiographic studies of skeletal maturation consists essentially of determining the rate and the time of appearance of the secondary ossification centers and the age at which closure of the epiphyses occurs (ROBBINS, 1961). Various studies were reviewed on the appearance of the ossification centers and the time of epiphyseal closure of thoracic and pelvic limbs of the dog by HARE (1959, 1961) and CHAPMAN (1965). The ossification centers were recorded by FRETZ et al (1984) in horses, by HOLMBERG et al. (1984) in cattle and by BOLBOL et al. (1986) in sheep.

In comparison between the radiologic assessment of selected sites of ossification and assessment of the same sites by means of examining sections macroscopically, MACCALLUM et al. (1978) concluded that the accuracy was of the radiographic interpretations.

The rabbit is now well an economical meat producing farm animal, there is need to understand its growth in related to age. The available literatures are lack about this point, so the purpose of the present study is to throw a light on the radiological time of appearance of the ossification centers as well as the physal plate closures in long bone. Also the measurments of the bone length in different ages with assessment of radiographs.

### MATERIAL AND METHODS

Eight new born native breed rabbits were used in the present study. Radiographs of the animals were taken at

intervals beginning from 24 hours after birth till 14 days (daily), weekly until six weeks, then once every two weeks till six months and later at one year of age.

Mediolateral and craniocaudal radiographs of the thoracic and pelvic limbs were taken using a mobile x-ray apparatus. The exposure factors were varied according to the age of the animals (40-45 Kv., 8-10 MAS and 90 cm. focal film distance).

### RESULTS

The radiological examination of the ossification centers in both thoracic and pelvic limbs in rabbits revealed that there was variation in numbers. The radius and fibula during their developments were ossify from three centers. These centers include the center of the shaft (diaphyses) and at either proximal and distal extremities of the bone (epiphyses). Ulna and tibia had four centers of ossifications include diaphyses, proximal epiphyses, distal epiphyses, olecranon (ulna) and tibial tuberosity (tibia). There were five ossification centers in humerus and femur. Humerus was developed from diaphyses, proximal physal plate, medial condyle, lateral condyle and epicondyles. Femur was developed from femoral head, trochanter major, trochanter minor and distal physal plate. The radiologic criterion for determination of these ossification centers was based on the appearance of an radiopaque area near the joints on the radiographs (Fig. 1 & 2). The closure of the physal plate was considered to have occurred when the radiolucent line between the ossification centers and the main bone was disappeared (Fig. 3). The radiological time of appearance and closure of the ossification centers was recorded in table (1). The relationship between the bone length and the age of the animal was recorded in table (2).

### DISCUSSION

The time of appearance of the ossification centers that present after birth has been studied radiographically. This method has the advantage that the ossification process can be followed throughout the growth stages of an individual animal. *SEOUDI (1948)* stated that the accurate estimation of the age by dentition beyond the seventh month in dogs was not possible. The x-ray examination of the physal union as an aid to estimate the age was preferable. The difference in the time of appearance of the ossification centers in animals from different breed is usually less for the centers that appear early in life than that appear later in life (*HARE, 1961*). In

the present study, it was found that, the time of appearance of the ossification centers was varied between three and ten days while in femur, all ossification centers were appeared in the fifth day. In tibia, the ossification center of the condyles was appeared in the third day while tibial tuberosity was appeared after thirteen days after birth.

The dissection method of the rabbit that was performed by WHITEHOUSE AND GROVE (1962) gave uncorrect determination of the number of ossification centers. They concluded that the long bones (humerus, femur, radius, tibia, etc.) during development ossify from three centers so the adult bone consists diaphyseal, proximal and distal physeal plate. In the present study it was found that the number of ossification centers were varied from one bone to another (3,4 or 5 centers). These centers had been detected accurately by radiograph.

The physeal union was considered to have occurred when the epiphyseal plate had disappeared and bone trabeculae could be seen passing from the diaphyses along the entire length of the epiphyseal line (HARE, 1959). On the base of this criterion, in the present work, it was observed that the beginning of the physeal union was earlier in the proximal epiphyses (within weeks) than the distal one (within months) table 1. Also from the measurement of the bone length in different ages, it was observed that the bone length follows a smooth with no sudden accelerated growth table 2.

#### LEGENDS

Fig. 1 (a&b): Mediolateral and craniocaudal radiographs showing the appearance of some ossification centers of the thoracic limb at 11 days:

- 1- Proximal epiphyses of the humerus.
- 2- Epicondyl physes of the humerus.
- 3- Condyl of the humerus.
- 4- Medial condyl of the humerus.
- 5- Proximal epiphyses of the radius.
- 6- Distal epiphyses of the radius.

Fig. 2 (a&b): Mediolateral and craniocaudal radiographs showing the appearance of some ossification centers of the pelvic limb at 11 days:

- 1- Head of the femur.
- 2- Greater trochanter.
- 3- Lesser trochanter.
- 4- Distal epiphyses of the femur.
- 5- Proximal epiphyses of the tibia.
- 6- Distal epiphyses of the tibia.

Fig. 3 (a&b): Radiographs of both thoracic and pelvic limbs showing physeal bone closure of some ossification centers (8 week old rabbit):

(a) Thoracic limb:

- 1- Proximal epiphyses of the humerus.
- 2- Epicondyl physes of the humerus.
- 3- Condyl of the humerus.
- 4- Proximal epiphyses of the radius.
- 5- Distal epiphyses of the radius.
- 6- Olecranon process.
- 7- Proximal epiphyses of the ulna.
- 8- Distal epiphyses of the ulna.

(b) Pelvic limb:

- 1- Head of the femur.
- 2- Greater trochanter.
- 3- Lesser trochanter.
- 4- Distal epiphyses of the femur.
- 5- Proximal epiphyses of the tibia.
- 6- Distal epiphyses of the tibia.
- 7- Proximal epiphyses of the fibula.
- 8- Tibial tuberosity was not closed.

#### REFERENCES

- Bolbol, A.E.; Saber, A.S. and Schienk-Saber, B. (1986): A radiographic study on the development sheep tarsus from birth to eighteenth month of age. Congress of the European Association of Veterinary Anatomists, Budapest, 24-29.
- Chapman, W.L. (1965): Appearance of ossification centers and epiphyseal closures as determined by radiographic techniques. J. Am. Vet. Med. Ass. 147: 138-141.
- Fretz, P.B.; Cymbaluk, N.F.; Pharr, J.W. (1984): Quantitative Analysis of long-bone growth in the horse. Am. J. Vet. Res. 45: 1602-1609.
- Hare, W.C.D. (1959): Radiographic anatomy of the canine pectoral limb. Part 1. Fully developed limb. J.A.V.M.A., 135: 264-271.
- Hare, W.C.D. (1961): The ages at which the centers of ossification appear roentgenographically in the limb bones of the dogs. Am. J. Vet. Res., 9: 825-835.
- Holmberg, T.; Berglund, B.; Ral, G. and Ahman, B. (1984): A radiographic study on the skeletal development in Swedish dairy cattle breeds on different rearing intensities. Zbl. Vet. Med. A. 31:193-204.

RADIOGRAPHIC, OSSIFICATION CENTERS, LONG BONES & RABBITS

- MacCallum, F.J.; Brown, M.P. and Goyal, H.O. (1978): An assessment of ossification and radiological interpretation in limbs of growing horses. *Br. Vet. J.* 134: 366-374.
- Robbins, I.L. (1961): *Diagnostic Radiology*. 1st ed. Vol. II William and Wilkins.Co. Baltimore.
- Seoudi, R. (1948): X-ray examination of epiphyseal union as an aid to the estimation of the age in the dogs. *Br. Vet. J.* 104: 150-155.
- Whitehouse, H.R. and Grove, J.A. (1962): *The dissection of the rabbit, with appendix on the rat*. 1st ed. University Turtoral press Ltd. London.

Table -1: The radiographical time of appearance and closure of the physal plate

Bone	Center of ossification	Time of appearance (days)	Time of closure
Humerus	Diaphyses	-	-
	Proximal epiphyses	5	5
	Medial condyle	5	5 week
	Lateral condyle	5	5
	Epicondyle	5	5
Radius	Diaphyses	-	-
	Proximal epiphyses	7	8 week
	Distal epiphyses	4	5 month
Ulna	Diaphyses	-	-
	Proximal epiphyses	8	8 week
	Distal Epiphyses	8	5 month
Olecranon process	Olecranon process	10	6 month
	Diaphyses	-	-
	Femoral head	7	5
Femur	Trochanter major	13	6 week
	Trochanter mainor	13	6
	Distal epiphyses	3	6
Tibia	Diaphyses	-	-
	proximal epiphyses	3	8 week
	Tibial tuberosity	30	5 month
Distal epiphyses	11	8 week	
Fibula	Diaphyses	-	-
	Proximal epiphyses	21	7 week
	Distal epiphyses	7	8 week

Table -2: The relationship between the age of the rabbit and the length of the long bone in both thoracic and pelvic limbs.

Time	Length of the bone (cm)				
	Humerus	Radius	Ulna	Femur	Tibia
1	1.0	1.0	1.2	1.2	1.4
2	1.2	1.0	1.2	1.2	1.4
3	1.2	1.1	1.4	1.3	1.4
4	1.2	1.2	1.5	1.5	1.7
5	1.4	1.3	1.5	1.5	1.7
6	1.4	1.4	1.5	1.9	2.2
7	1.4	1.4	1.6	2.0	2.2
8 (days)	1.7	1.6	1.7	2.1	2.2
9	2.0	1.6	1.7	2.1	2.2
10	2.2	1.6	1.8	2.2	2.2
11	2.3	1.8	2.0	2.5	2.7
12	2.4	1.8	2.2	2.6	2.8
13	2.4	1.8	2.2	2.6	2.8
14	2.5	1.8	2.4	2.7	3.0
<hr/>					
3	2.8	2.7	3.0	3.3	3.7
4	3.4	2.8	3.2	4.0	4.5
5	3.5	3.0	3.6	4.2	4.9
6	4.0	3.8	4.5	4.7	5.3
8	4.4	4.0	4.7	5.0	5.7
10 (weeks)	4.6	4.3	4.9	6.0	6.8
12	4.9	4.5	5.0	6.5	7.0
16	5.5	5.3	5.0	6.8	8.4
20	5.9	5.5	5.0	7.1	8.6
24	6.0	5.5	5.5	7.8	9.0
<hr/>					
One year	6.0	5.5	5.5	7.8	9.0

RADIOGRAPHIC, OSSIFICATION CENTERS, LONG BONES & RABBITS

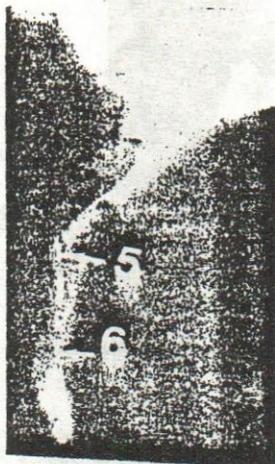


Fig. 1 a



Fig. 1 b

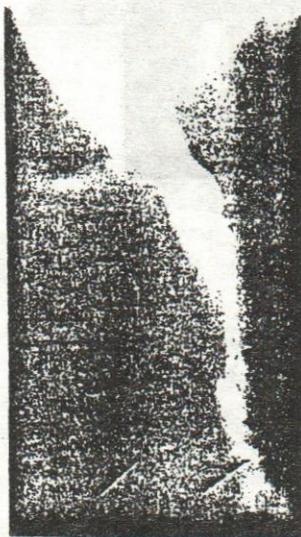


Fig. 2 a

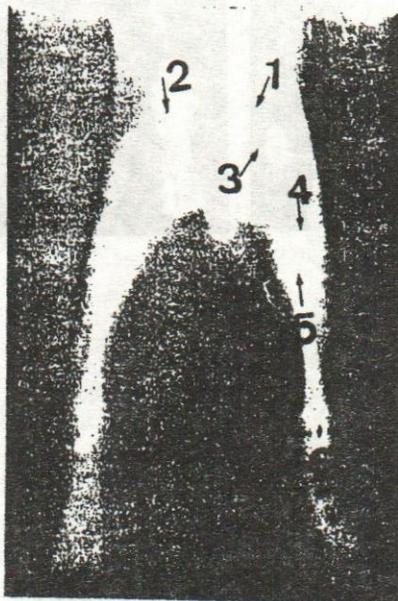


Fig. 2 b

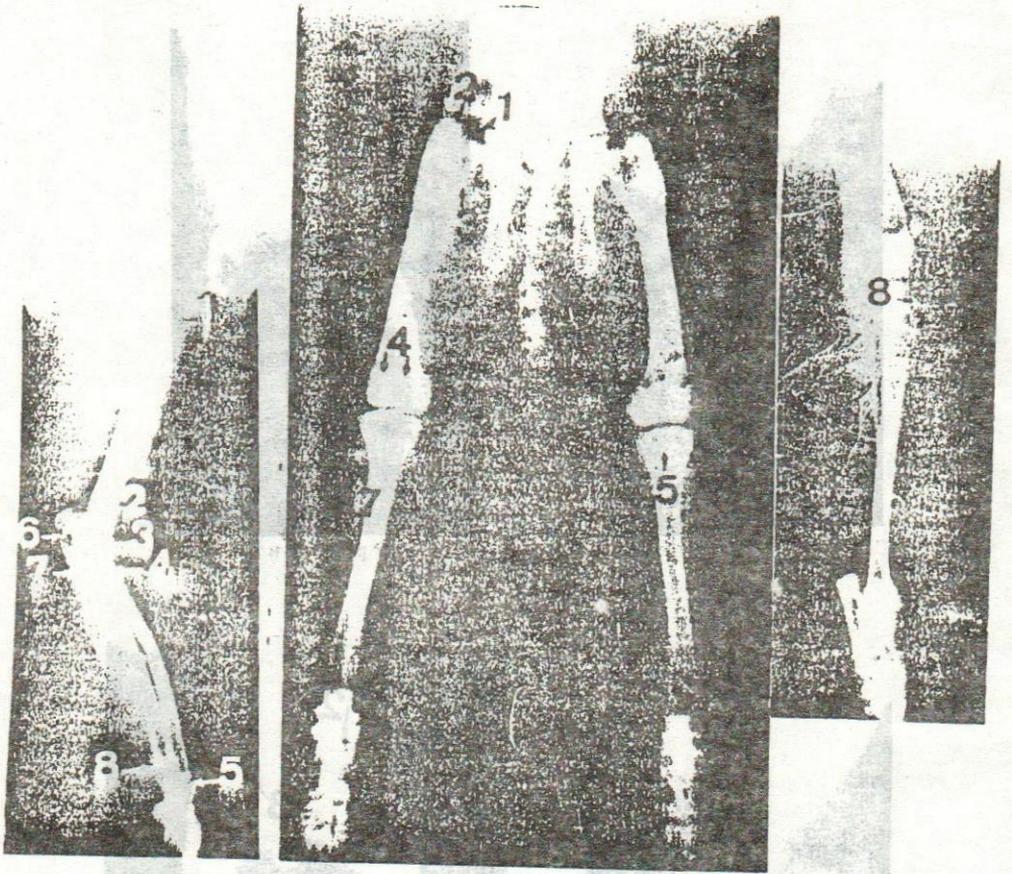


Fig. 3 a

Fig. 3 b