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DETERMINATION OF EPIPHYSEAL LINE CLOSURE TIME

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SUMMARY

Sixty six donkeys were used for radiological description of the normal ossification centers and determination of their closure time of bone related to the hock joint. The animals were apparently healthy of both sexes ranged from one day to four years old. The recorded ossification centers were the distal metaphysis, epiphysis and medial & lateral malleoli of the tibia and that of the tarsal bones; the talus, calcaneus, central, fused first & second, third and fourth, in addition to the proximal epiphysis of second and fourth metatarsal bones. The calcaneus (fibular tarsal bone) developed from two ossification centers; one for the calcaneus proper and the other for the tuber calcis.

The proximal physis of the third metatarsal bone was completely fused at birth while that in between the first and second tarsal bones was separated at birth and completely fused at one month of age. At three months of age; the lateral malleolus and the proximal epiphyseal line of the lateral splint bone were completely fused in addition to the talus, central and the third tarsal bones which were observed smooth with disappearance of subcondral bone opacity. At six months age; the medial malleolus and the proximal epiphyseal line of the medial splint bone were fused in addition to the fourth tarsal bone, epiphysis of calcaneus proper, distal tibial epiphysis which were observed smooth with disappearance of the granular subcondral bone opacity. The distal tibial metaphysis was ossified gradually from its middle third up to nine months of age until be completely ossified at 18 months age. The apophyseal line of the tuber calcis was also fused gradually up to 15 months of age until be

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apophyseal line of the tuber calcis was also fused gradually up to 15 months of age until be completely fused at 30 months age with appearance of a radio-opaque line. The radio-opaque line of apophysis fusion disappeared at 48 months of age.

INTRODUCTION

The hock joint forms a powerful centre for movement and consists of four major articulations. The structures of the hock constitute a region of special clinical importance from the anatomical point of view.

The calcaneus bone which is the largest tarsal bone forms a lever for the extensor muscles of the hock. The assessment of the ossification time of epiphyseal lines is a good indicator for skeletal maturity. The early use of animals for training or drafting before skeletal maturity is considered to be a proper cause of the elevation of the incidence of unsoundness and skeletal lameness in equine (Banks et al. 1969, Stashak 1995 and Stashak 2002). The accurate determination of the closure times has a great importance in clinical medicine and forensic practice in addition to establishment of age and prevention of confusion of fractures with a translucent growth plate (Jani et al. 1983 and Seleim et al. 1999). Also the functional physeal closure time has an important factor on the timing of surgery suggested to correct angular limb deformities (Stashak 1995). The study aimed to describe the normal epiphyseal lines of bones related to the hock joint of the donkey and determine their ossification time.

MATERIALS AND METHODS

The present study was carried on 66 animals of both sexes (38 males & 28 females), ranged from one day to four years old. The animals were clinically apparent healthy and were collected from villages present around the faculty of veterinary medicine, Zagazig University. They were put under radiographic examination of hock joint for recording and description of epiphyseal ossification centers of bone related in all ages from birth to full maturity at four years. In addition to that the determination of complete fusion and ossification times of these centers were recorded.

A Mobile Fischer X-ray machine, H.G. Fischer, inc. Franklin park, Illinois, USA, with maximum out put of 125 k.V. and 100-300mA was used. The developer and fixer was from El-Nasr Pharmaceutical chemicals Co. Abou Zabal A.R.E. The radiographic films were of ACMA,

MXB-blue, medical x-ray film, produced by Kodak (24x30cm.). The film cassette enveloped super fast intensifying screens.

Different exposure factors were used according to the thickness and age of the animals.

Kilovoltage ranged from (50-56) k.V. and Milliampere/ Second ranged from (1-6) mAs. Two views were used. The antero-posterior view needed two k.V. more than the latero-medial view. The focal film distance was 75cm. in all radiografs. The processing was done with the manual technique.

RESULTS

The study revealed that there were thirteen ossification centers in the bones related to the hock joint. The developmental changes of ossifications from birth until determination of the closure time of these centers were also recorded (table 1).

-One-day-old (figure 1&2): The distal tibial physis clearly appeared as a large irregular translucent band and the distal tibial epiphysis was incompletely ossified showing granular subcondral bone opacity. The lateral malleolus was separated from the distal epiphysis by translucent line and the medial malleolus showed incomplete ossification by its irregular rough surface and granular subcondral bone opacity. The apophysis of the tuber-calcis is displayed as a wide translucent band and the calcaneus tuber appeared as ovoid in shape. The epiphysis of the calcaneus proper appeared incompletely ossified with its irregularity and subcondral bone opacity. The medial and lateral ridges of trochlea tali in addition to the

Table (1)The different ossification centres of the hock joint and their closure according to time

	The distal tibial ossification centres						Ossification centres of the tarsal bones								Metatarsal bones		
	Distal tibial physis			Distal tibial epiphysis	Lateral malleolus	Medial malleolus	calcaneus				Talus	Central & third	Fourth	1st and 2nd	Second	Third	fourth
							Apophysis			Calcaneus proper							
	Planter third	Middle third	Dorsal third				Planter third	Middle third	Dorsal third								
1 day old	(2 mm)	(2 mm)	(2 mm)	Incompletely ossified with granular subchondral bone opacity	(0.8mm)	Incomplete ossification, irregular and rough contour	(2 mm)	(1.9 mm)	(2.5 mm)	Incomplete ossification, irregular articular surface with granular sub chondral bone opacity	Lateral and medial ridges irregular and flat contour with granular sub chondral bone opacity	Round corners Nearly straight	Contour nearly visible with sub chondral bone opacity Clearly visible	Separated	Separated	Fused	Separated
1 month old	(2 mm)	(1.4 mm)	(2 mm)		(0.3mm)		(1.9mm)	(1.8 mm)	(2.5 mm)					C.F.	Separated	Fused	Separated
3 months old	(1.5 mm)	(0.8 mm)	(1.8 mm)		C.F.		(1.1mm)	(1.2 mm)	(2.4 mm)					C.F.	Fused	Fused	Separated
6 months old	(1.2 mm)	(0.7 mm)	(1.6mm)		C.F.		(1 mm)	(0.9 mm)	(2.3 mm)					C.F.	Fused	Fused	Fused
9 months old	(0.5 mm)	F.	(0.7mm)	Complete ossification, regular and smooth trochlear ridges with disappearance of granular subchondral bone opacity	C.F.	Complete ossification and clear appearance	(0.4mm)	(0.3 mm)	(1.3 mm)	Complete ossification, regular articular surface with disappearance of granular sub chondral bone opacity	Regular and round trochlear ridges with disappearance of granular sub chondral bone opacity	Outlines are more clearly appeared and straight	Planter border is clearly determined with granular subchondral bone opacity	C.F.	Fused	Fused	Fused
12 months old	C.F.	C.F.	(0.5mm)		C.F.		(0.2 mm)	F.F.	(1 mm)					C.F.	Fused	Fused	Fused
15 months old	C.F.	C.F.	I.F.		C.F.		I.F.	C.F.	(0.9 mm)					C.F.	Fused	Fused	Fused
18 months old	C.F.	C.F.	C.F.		C.F.		F.F.	C.F.	(0.7 mm)					C.F.	Fused	Fused	Fused
21 months old	C.F.	C.F.	C.F.		C.F.		C.F.	C.F.	(0.5 mm)					C.F.	Fused	Fused	Fused
24 months old	C.F.	C.F.	C.F.		C.F.		C.F.	C.F.	I.F.					C.F.	Fused	Fused	Fused
30 months old	C.F.	C.F.	C.F.		C.F.		C.F. with radio opaque line							C.F.	Fused	Fused	Fused
36 months old	C.F.	C.F.	C.F.		C.F.		C.F.	C.F. with radio opaque line						C.F.	Fused	Fused	Fused
42 months old	C.F.	C.F.	C.F.		C.F.		C.F.	C.F.	C.F. with radio opaque line					C.F.	Fused	Fused	Fused
48 months old	C.F.	C.F.	C.F.		C.F.		C.F.	C.F.	C.F. without radio opaque line					C.F.	Fused	Fused	Fused

F.: Fusion. I.F.: Incomplete fusion. C.F.: complete fusion. F.F.: Faint fusion.

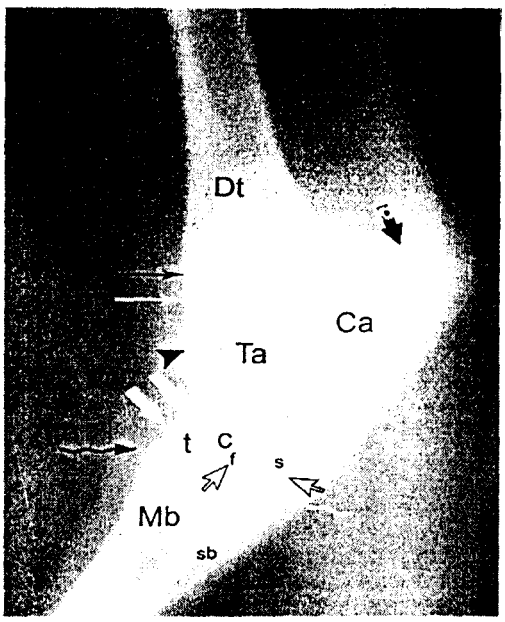

Fig. 1: Lateral radiograph of the hock joint one-day-old donkey; Dt:distal tibia, Ta:talus, Ca:calcaneus, C:central, t:third ,s:second, f:first tarsal bone, sb:splint bones, Mb:third metatarsal bone. The distal tibial physis (thin black arrow), distal tibial epiphysis (thin white arrow), talus (black head arrow), calcaneus proper(white head arrow), apophysis of tuber cacis (thick black arrow), central and third tarsal bones with irregular round borders (white arrows), separated first and second tasal bones (black open arrow), fourth (tarsal bone (white open arrow), fused proximal physis of third metatarsus (black zigzag arrow), proximal epiphysis of medial splint bone (white zigzag arrow)

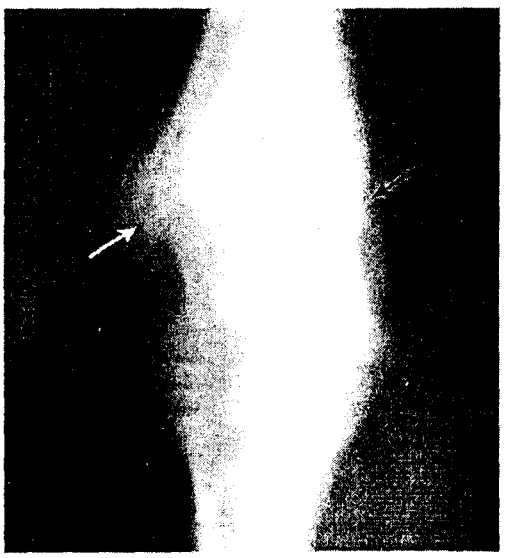

Fig. 2: Dorso planter radiograph of the hock joint one-day-old donkey; notice separated center of lateral malleolus (black arrow) and incomplete ossification center of medial malleolus (white arrow)

Fig .3: Lateral radiograph of the hock joint one-month-old donkey; notice fusion of the first and second tarsal bones (white arrow), incomplete ossification and subcondral bone opacity manifested by irregular surfaces of tarsal bones and wide joint spaces.

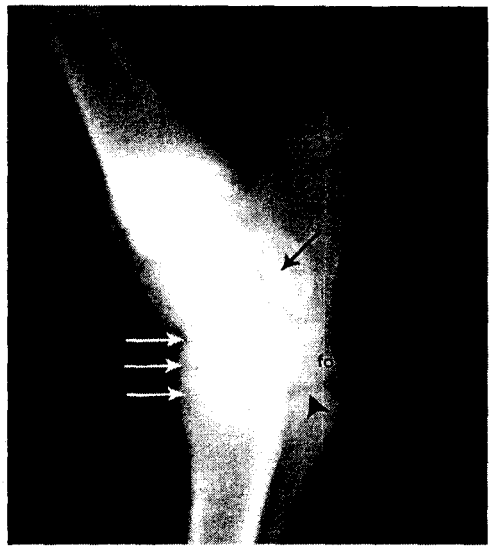

Fig. 4: Lateral radiograph of the hock joint three-month-old donkey; the tuber calcis appeared as head-cap in shape, the joint spaces showed marked narrowing and straightness, the outlines of the central & third tarsal bones in addition to the troclear ridges were clear and smooth, the apophysis of the lateral malleolus was completely ossified and the proximal epiphyseal line of the medial splint bone was completely fused.

Fig. 5: Lateral radiogarph of the hock joint six-month-old donkey; notice the tuber calcis appeared as beak like projection, pointed dorsally and with broad blunt base plantarly with marked narrowing of the middle third (white arrow), the proximal epiphysis of the lateral splint bone was fused and distal tibial epiphysis was smooth and regular

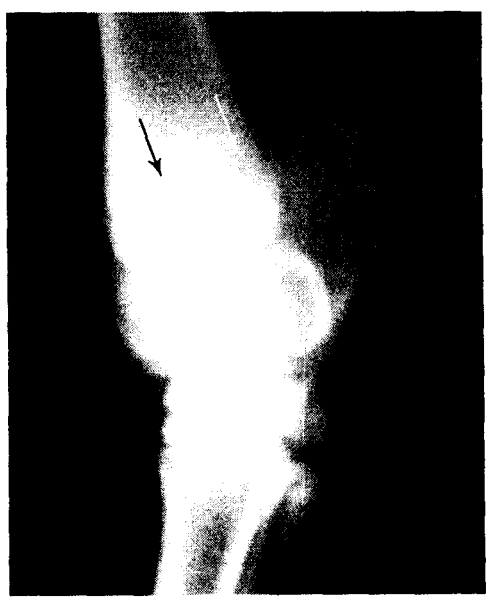

Fig. 6: Lateral radiograph of the hock joint twelve-months-old donkey; the tuber calcis capping the whole proximal surface of calcaneous proper with faint fusion in the middle and marked narrowing in the distal part, complete fusion of the middle third (black arrow) and planter third (white arrow) of the distal tibial physis

Fig. 7: Lateral radiograph of the hock joint fifteen-months-old donkey; notice complete fusion of the middle third of the apophyseal line of tuber calcis

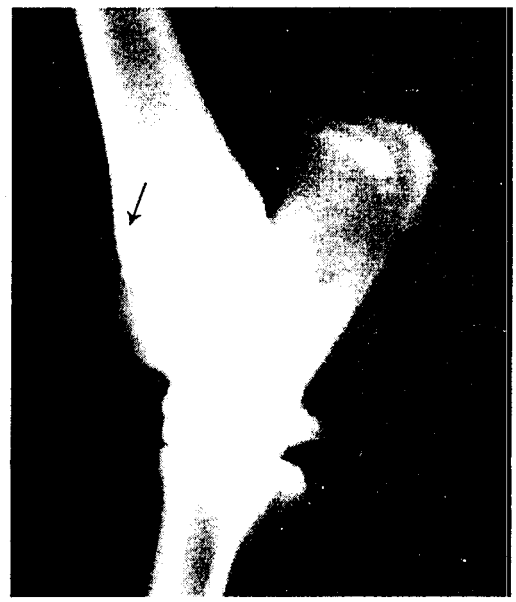

Fig. 8: Lateral radiograph of the hock joint twenty months-old donkey; The planter third of the apophyseal center of the tuber calcis showed complete fusion

Fig. 9: Lateral radiograph of the hock joint forty-two-months-old donkey; Very faint radio-opaque line was noticed at the middle of the apophysis of the tuber calcis

central and third tarsal bones had irregular flat contour and granular bone opacity (incomplete ossification). The fourth tarsal bone was displayed as irregular quadrilateral shaped bone. The first and second tarsal bones were completely separated and ovoid in shape with granular bone opacity. The proximal physis of the third metatarsal bone was not displayed. The proximal epiphyseal lines of the lateral and medial splint bones were clearly separated.

-One-month-old (figure 3): Marked narrowing at the ossification center of the lateral malleolus was observed. Incomplete ossification and subcondral granular bone opacity of all tarsal bones were clearly demonstrated. This was indicated by irregular bone surface and wide joint spaces. Complete fusion of the first and second tarsal bone was evident.

-Three-months-old (figure 4): The apophysis of the lateral malleolus was completely ossified with complete fusion with the lateral margin of the distal tibial epiphysis. The tuber calcis appeared as head-cap in shape. The articular surface of the calcaneus proper showed

irregular surface. The trochlear ridges of the

talus were regular and round. The outlines of the central and third tarsal bones were clear and smooth. The joint spaces showed marked

narrowing and straightness. The proximal epiphyseal line of the lateral splint bone was fused and in the medial splint bone is narrowed and separated.

-Six-months-old (figure 5): The distal tibial epiphysis appeared smooth and regular. The medial malleolus was completely fused. The tuber calcis appeared as beak like projection, pointed dorsally and with broad blunt base plantarly. The epiphysis of the calcaneus proper showed regular and smooth articular surface. The border of the fourth tarsal bone was clearly demarcated. The proximal epiphyseal line of the medial splint bone was completely fused.

-Nine-months-old: The middle third of the distal tibial physis was fused and the dorsal and planter thirds showed marked narrowing. The tuber calcis appeared capping the whole proximal surface of the calcaneous proper.

-Twelve-months-old (figure 6): The distal tibial physis showed fusion of the planter third with marked narrowing of its dorsal third. The apophyseal ossification center of the tuber calcis showed faint fusion of its middle third and marked narrowing of both planter and dorsal thirds.

-Fifteen-months-old (figure 7): The middle third of the apophyseal ossification center of the tuber calcis was completely fused.

-Eighteen-months-old: The dorsal third of the distal tibial physis was completely fused. The apophyseal center showed faint fusion of its

planter third with marked narrowing of its dorsal third.

-Twenty-months-old (figure 8): The planter third of the apophyseal center of the tuber calcis showed complete fusion.

-Thirty-months-old: Complete fusion of the apophysis of the tuber calcis was evident with radio-opaque line at the whole length of the closed apophyseal line.

-Thirty six-months-old: The radio-opaque line of the apophyseal closure of tuber calcis was seen in the middle and dorsal part.

-Forty two months (figure 9): Very faint radio-opaque line was noticed at the middle of the apophysis of the tuber calcis.

-Forty eight-months old: Disappearance of the radio opaque sclerotic line from the apophysis of the tuber calcis.

DISCUSSION

The recorded radiological findings for determination of the ossification centers and their closure time of hock joint in donkeys are not completely described or classified before. Lack of literatures concerning this subject stimulated the authors of this work to determine the different epiphyseal lines and other ossification centers of hock joint and estimation of their ossification time.

The hock joint of donkey revealed thirteen ossification centers; the distal metaphysis, epiphysis and medial & lateral malleoli of the tibia and the ossification centers of the talus, calcaneus proper & tuber clacis, central, fused first & second , third and fourth tarsal bone in addition to the medial and lateral metatarsal bones. These centers were also recorded in horses by Getty (1975), MacCallum et al. (1978), Stashak (1995) and Butler et al. (1999).

The characters of the epiphyseal and apophyseal plates were evident, lucent and wavy band through the first year of age. These characters were also described in the apophysis of tuber calcis in donkeys by El-Shair et al. (1992) and in camel by Ahmed et al. (2003). The irregular contour and granular subcondral bone opacity of the epiphysis indicating in addition to wide joint spaces to incomplete ossification of these centers. This should be differentiated from the similar radiogarphic findings as in cases of infectious arthritis and joint ill in foals. These observations were similar to that recorded in horses by Thrall (1998) and Butler et al. (1999).

The proximal physis of the third metatarsal bone was not displayed at birth. This is attributed to its closure at birth. This observation was in agreement with Getty (1975), Buttler et al. (1999) and Dyce et al. (2002). Separation of the first and second tasal bones at birth and fusion after one month was in agreement in horses with Getty (1975), Dahn & Ueltschi (1989) and Butler et al. (1999). Closure of the lateral malleolus and talus, central & third tarsal bones in addition to the proximal epiphysis of the lateral metatarsal bone occurred at three months. These results agreed with that of Butler et al. (1999), while Douglas and williamson (1970) stated that the lateral malleolus fused from 3-8 months in horses. Closure of the medial malleous, medial metatarsal bone, epiphysis of the calcaneus proper and fourth tarsal bone at six months was in agreement with Butler et al. (1999). The closure of distal physis at 18 months was in agreement with Douglas & Williamson (1970) and Stashak (1995) in horses. Closing of the apophysis of tuber calcis at 30 months agreed nearly with the results of El-Shair et al. (1992) in donkeys while disagreed with results given by Smallwood et al. (1984) and Butler et al. (1999). The later stated that the closure of that center in horses occurred from 16-24 months. Disappearance of the radio-opaque line at the fusion of calcaneus apophysis at 48 months was in agreement with the results recorded by El-Shair et al. (1992).

REFERENCES

Ahmed, F.A.; Semieka, M.A. and Misk, N.A. (2003): Radiographic studies on the development of some secondary ossification centers in camels (Camelus Dromedaries). Journal of Camel practice and Research; 10 (1): 23-31.

Banks, W.J. ; Kemier, A.G.; Guttridge, H. and Kirkham. W. (1969): Radiography of the tuber calcis and its use in thorough bred training Proc. 15th Convention Am. Assoc. Equine Pract. 209-219.

Butler, J.A.; Colles, C.M.; Dyson, S.J.; Kold, S.E. and Poulos, P.W. (1999): Clinical radiology of the horse. 2nd Ed. Blackwell Science Ltd, London. 247-326.

Dahn, M. and Ueltschi, G. (1989): The radiologic image of the normal equine tarsus. Schweiz Arch. Tierheilkd, 131 (4): 165-175.

Douglas, S.W. and Williamson, H.D. (1970): Veterinary radiological interpretation. William Heinemann Medical books Ltd, London 140-141.

Dyce, K.M.; Sack, W.O. and Wensing, C.J. (2002): Text book of veterinary anatomy . 2nd. Ed. W.B. Saunders Co., Philadephia, London, Toronto, Sydney, Tokyo. 611-620.

El-Shair, M.A.; El-Mezyen, A.F.; Kandeel, A.E.; Abd El-Aal, A.M. and Samy, M.T. (1992): Radiological studies on the ossification changes in tuber calcanei of donkeys. Zag. Vet. J., 20 (4): 683-691.

Getty, R. (1975): The anatomy of the domestic animals. 5th Ed. Saunders Co., Philadephia, London, Toronto, 296-316.

Jani, B.M.; Mannar, M.N. AND Vyas, K.N. (1983): A radiographic study on the time of fusion of the ossification loci around the elbow joint of the patanwadi, sheep. GAU. Res. J. 8 (2): 117-120.

MacCallum, B.J.; Brown, M.P. and Goyal, H.O. (1978):Assessment of ossification and radiological interpretation in limbs of growing horses. Br.Vet.J.; 134 (4): 366-374.

Seleim, M.A.; El-sayed, G.A.; Youssef, G.A. and Karouf. G.I. (1999): Some radiological studies on the postnatal development and fusion of the tuber calcanei in buffaloes (Bos bubalis. L.) Beni-Suef Vet. Med. J.; 9 (3-B): 739-749.

Smallwood, J.E.; Auer, J.A.; Martins, R.J.; Morris. E.L.; McCall. V.H.; Raenigk, W.J. and Boyd, C.L. (1984):The development of equine tarsus from birth to six months of age. Equine practice. 6 (4):7-48.

Stashak, T.S. (1995): Horse owner's guide to lameness, Williams and Wilkins. Baltimore, Philadelphia, Hong Kong, London, Munich, Sydney, Tokyo. 26-42.

Stashak, T.S. (2002): Adam's lameness in horses. Fifth Edition Lippincott Wiliams and Wilkins. Awolters Kluwer Company, Philadelphia, Baltimore. New York,

London.Thrall, D.E. (1998): Text book of veterinary diagnostic radiology, 3rd Ed. W.B. Saunders Company, Philadephia, London, Toronto, Monterial, Sydney, Tokyo.

تحديد وقت إلتئام الخطوط الكردوسية لمفصل العرقوب فى الحمير

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أجريت هذه الدراسة على ٦٦ حمارا لتوصيف مراكز التمعظم ووقت تمعظمها بالأشعة السينية فى مفصل العرقوب و قد تراوحت أعمار هذه الحيوانات من عمر يوم حتى أربعة أعوام من الجنسين

اظهرت هذه الدراسة ان مراكز التمعظم هى: الخط الكردوسى والمركز الكردوسى السفليين لعظمة الساق ومركز التمعظم فى النتوء الداخلى والخارجى للنهاية السفلى لعظمة الساق بالأضافة لمراكز التمعظم فى عظام العرقوب وهى عظمةالعقب- العرقوب الكبرى-الوسطى- ما بين الأولى والثانية -الثالثة- الرابعة فضلا عن الخط الكردوسى للعظمة المشطيةالأنسى والوحشى٠ ووجد مركزين لعظمة العقب وهما عظمة العقب الأساسية وحدبة العقب

ولقد وجد ان الخط الكردوسى للعظمة المشطية الثالثة ملتحم تماما عند الميلاد أما مركز التمعظم بين عظمة العرقوب الأولى والثانية فيلتحم عند عمر شهر٠ وقد وجد عند ثلاثة شهور أن النتوء الخارجى لعظمة الساق السفلية والخط الكردوسى العلوى للعظمية المشطية الوحشى ملتحما تماما فضلا عن اختفاء العتامة الأشعاعية المحببة للعظام ما تحت الغضروف فى عظمة العرقوب الكبرى والوسطى والثالثة واستواء سطحهم٠عند ستة شهوركما وجد تمعظم كامل للنتوء الداخلى لنهاية عظمة الساق السفلى و الخط الكردوسى العلوى للعظمة المشطية الأنسى بالاضافة الى استواء سطح كلا من عظمة العرقوب الرابعة ومركز الكردوس لعظمة العقب والمركز الكردوسى الأسفل لعظمة الساق مع اختفاء العتامة الأشعاعية المحببة لعظام ما تحت الغضروف٠أما الخط الكردوسى السفلى لعظمة الساق فقد وجد انه يتمعظم تدريجيا مبتدأ من الثلث الأوسط عند تسعة شهور ثم الثلث الخلفى فالأمامى حيث يقفل تماما عند ثمانية عشر شهرا٠ ويبدأ أيضا الخط الكردوسى لحدبة العقب تدريجا فى الالتحام من الثلث الأوسط عند خمسة عشر شهرا ويقفل تماما عند ثلاثون شهرا٠ ويختفى خط الاشعاع المعتم لقفل حدبة العقب عند عمر ثمانية وأربعون شهرا