

DETERMINATION OF EPIPHYSEAL LINES CLOSURE TIME OF STIFLE JOINT IN DONKEYS

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SUMMARY

The present work was conducted on a total of 66 donkeys varied in age from one day to four years old. They were used for radiographic description of the normal ossification centers in the stifle joint and their ossification times. The investigation revealed that the stifle ossification centers are, distal metaphysis & epiphysis of the femur, the proximal epiphysis, metaphysis of the tibia and apophysis of the tibia and that of the patella.

The joint spaces appeared more wider in young than that of adult donkeys. The distal femoral epiphysis and the patellar articular surface were observed smooth with disappearance of granular subchondral bone opacity at 6 months of age. The lateral and medial trochlear ridges of the femur are similar in size at one day old then the medial one increased in height at one month old and fixed at six months of age. The proximal tibial ep-

iphysis was observed smooth with disappearance of the granular subchondral bone opacity at 9 months. The distal femoral metaphysis was fused gradually starting at middle third at 9 months followed by the planter third at 12 months and finally the dorsal third at 24 months of age. The proximal tibial metaphysis was ossified gradually starting at the middle third at 12 months followed by the dorsal third at 18 months and finally the planter third at 24 months of age. The apophyseal center of the dorsal tibial tuberosity was closed gradually and began firstly at middle third at 15 months followed by proximal third at 18 months and finally the distal third at 36 months of age. Fusion of both the distal femoral metaphysis and apophysis of the tibial tuberosity were indicated by presence of radio-opaque lines which disappeared completely at 30 months and 42 months of age respectively.

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INTRODUCTION

The assessment of the ossification time of epiphyseal lines is a good indicator for skeletal maturity. The early use of animals for training or for drafting before full skeletal maturity is considered to be a proper cause of elevation of the incidence of unsoundness and

skeletal lameness in equines (Banks et al., 1969 and Mason & Bourke, 1973). Also, the accurate determination of the fusion times has a great importance in clinical medicine and forensic practice (Williams & Warwick, 1980). In addition, prevention of confusion of fractures with a radiolucent growth plate (MacCallum et al., 1978 and Seleim et al., 1999). As growth of the bone ceases, the cartilaginous epiphyseal plate is thus replaced by bone. Therefore, the functional-epiphyseal closure time is necessary on timing surgery to correct angular limb deformities (Stashak, 1995).

The stifle joint is the largest and most elaborate of all articulations of the body, it consists of three joints, femoropatellar, femorotibial and fibulotibial joints. The knowledge of normal radiographic anatomy and radiographic signs of stifle joint defects and anomalies are necessary for diagnosing joint disorders (McIlwraith and Trotter, 1996).

The aim of the present work is the determination of the different ossification centers in the stifle joint in donkeys and their closure time.

MATERIAL AND METHODS

The present study was carried out on 66 donkeys of both sexes and different ages. They were clinically apparent healthy donkeys and their age varied from one day to four years old. The animals were collected from different villages present around the Faculty of Veterinary Medicine, Zagazig University. They were put under radiographical investigation for description of normal epiphyseal lines and their closure times in the stifle joint. Four radiographs were taken from each animal for both stifle joints. Latero-medial and caudo-cranial views were applied for each joint. These radiological examinations were carried out for:

- 1) Recording and illustrating the normal radiographic picture as well as the developmental rate of the epiphyses of stifle joint from birth to full maturity at nearly four years old.
- 2) Description of the epiphyseal and apophyseal lines (shape and average width at different ages).
- 3) Determination of closure times of these epiphyses in this species of animals.

The data were described, tabulated and discussed with the previous results.

The exposure factors used according to the difference in the radio opacity of the stifle joint in different ages were 66-74 kV, 1-10 mA/s with high speed film screens and 75 cm F.F.D.

RESULTS AND DISCUSSION

The different ossification centers of the distal femur, proximal tibia and patella and their closure according to time at the stifle joint are illustrated in table 1.

The present study revealed that the stifle joint in donkeys possesses six ossification centers; distal metaphysis and epiphysis of the femur, the proximal epiphysis and metaphysis of the tibia, the tibial apophysis and that of the patella (Figs. 1&2). The same centers were also recorded by Butler et al., (1999) in horses. The obtained radiographic pictures indicated that the epiphyseal and apophyseal plates of the stifle remained evident, lucent and of wavy band through the first year of life as also demonstrated by Jeffcott (1979) and El-Shair et al., (1992). The other ossification centres appeared firstly by presence of granular subchondral bone opacity, indicating an incomplete ossification of these centres. The same result was recorded by Butler et al., (1999) in the horse.

As regards the closure times of ossification centres the present results revealed that the distal femoral epiphysis and the patella were closed at first centers and apophysis was the last one as also manifested by Stashak (1995).

Concerning the character of the closure of both

epiphyseal and apophyseal lines, it started first at the middle third then progressed to include the planter third and lastly included the dorsal third. This was in case of the distal femoral physis. While in the proximal tibial physis, the closure started first at the middle third lastly to the planter third. Moreover, the closure line of cranial tibial apophysis started at the middle third, then to the proximal third and lastly to the distal third. The closure of the distal femoral epiphysis and the patella is indicated by disappearance of the granular subchondral bone opacity and appearance of smooth regular contour of the articular surfaces. This was manifested earlier at an average age of six months old (Fig. 4) a result that is confirmed also by Butler et al., (1999).

The irregular contour and granular subchondral bone opacity of the trochlear ridges of the distal femoral epiphysis is attributed to the irregular subchondral bone ossification. A condition which must be differentiated from some similar radiographic findings as in case of infectious arthritis or joint ill in foals. At birth both the lateral and medial trochlear ridges of the femur were similar in size while at one month of age (Fig. 3). The medial trochlear ridge began to be slightly higher than the lateral one and fixed at 6 months of age (Fig. 4).

The closure of the proximal tibial epiphysis

achieved at 9 months of age that was indicated by the tibial condyles that become more horizontal with well developed intercondylar eminences (Fig. 5). Morgan (1972) and Butler et al., (1999) recorded similar result.

In donkeys, the closure of the epiphyseal lines of both distal femur and proximal tibia was achieved at 24 months of age (Fig. 6). This manner of closure was similar to that observed by Douglas and Williamson (1970) in horses. However, Stashak (1995) recorded in horses that the distal femoral physis was closed at 22-42 months of age while that of the proximal tibial physis took place at 36-42 months of age.

At one day age the femoral condyles are smooth and regular (Fig. 1). Irregularity of these condyles should be interpreted as pathological finding at any age. This was also supported by Butler et al., (1999) in horses. The medial femoral condyle was found more round than lateral condyle at 3 months of age. Similar result was also described by Thrall (1998). The cranial tibial tuberosity was closed at 36 months of age (Fig. 7), a finding which was also mentioned by Getty (1975) and

Butler et al., (1999) in horses. However, this result disagreed with that of Douglas and Williamson (1970) who recorded that closure at 12 months of age in horses.

Concerning the radio-opaque line, its appearance is an indication for complete closure of the epiphyseal plates at the afore- mentioned times and it disappeared with aging of the animal. It disappeared at 30 months of age at the distal femoral physis and at 42 months of age at the apophysis of the cranial tibial tuberosity (Fig. 8). These findings are supported by Ragab (1976) and El-Mezyen (1987) who recorded that the disappearance of that line in horses occurred after 6-18 months from the closure time.

The joint spaces at birth appeared wider than in adult age, a result that was attributed to the presence of more proportional of cartilage present and incomplete ossification of the epiphyseal center as also supported by Butler et al., (1999). However, at maturity the lateral femorotibial joint space became narrower than the medial space. Morgan (1972), Schebitz & Wilkens (1986) and Butler et al., (1999) reached to similar results.

Table (1). Illustrated the different ossification centres of the distal femur, proximal tibia & patella and their closure according to time at the stifle joint.

	The ossification centres of the distal femur						Ossification centres of the proximal tibia						Patella
	Distal femoral physis			Distal femoral epiphysis	Proximal tibial epiphysis	Proximal tibial physis			Apopyseal centre of the cranial tuberosity				
	Plaster third	Middle third	Dorsal third			Plaster third	Middle third	Dorsal third	Proximal third	Middle third	Distal third		
1 day old	(3 mm)	(3 mm)	(3 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	(3 mm)	(3 mm)	(4 mm)	(2 mm)	(4 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)		
1 month old	(1.9 mm)	(1.7 mm)	(2 mm)	Complete ossification (regular and round contour at proximal parts of trochlear ridges with disappearance of granular subchondral bone opacity) and smooth concave articular surface	Complete ossification (disappearance of granular subchondral bone opacity and the tibial condyles at horizontal level)	(2 mm)	(2 mm)	(3.1 mm)	(1.7 mm)	(3.8 mm)	Disappearance of its subchondral bone opacity (smooth concave articular surface + regular contour)		
3 months old	(1.7 mm)	(1.5 mm)	(2 mm)			(2 mm)	(1.6 mm)	(2 mm)	(1.2 mm)	(3.7 mm)			
6 months old	(1.1 mm)	(0.9 mm)	(2 mm)			(0.9 mm)	(1.2 mm)	(1.6 mm)	(1 mm)	(3.7 mm)			
9 months old	(0.2 mm)	C.F.	(1.1 mm)			(0.9 mm)	(0.5 mm)	(0.6 mm)	(0.3 mm)	(3.7 mm)			
12 months old	C.F.	C.F.	(0.8 mm)			(0.7 mm)	(0.3 mm)	(0.3 mm)	0.2 mm)	(3.3 mm)			
15 months old	C.F.	C.F.	(0.6 mm)			(0.7 mm)	F.F.	F.F.	C.F.	(3.0 mm)			
18 months old	C.F.	C.F.	(0.5 mm)			(0.4 mm)	C.F.	C.F.	C.F.	(2.3 mm)			
21 months old	C.F.	C.F.	(0.2 mm)			F.F.	C.F.	C.F.	C.F.	(1.8 mm)			
24 months old	C.F.	C.F.	opaque line			C.F. + Radio opaque line	C.F.	C.F.	C.F.	(0.9 mm)			
30 months old	C.F.	C.F.	No radio opaque line			No radio opaque line	C.F.	C.F.	C.F.	(0.3 mm)			
36 months old	C.F.	C.F.					C.F.	C.F.	C.F.	C.F. + Radio opaque line			
42 months old	C.F.	C.F.					C.F.	C.F.	C.F.	No radio opaque line			

F.F.: Faint fusion.

C.F.: complete fusion.

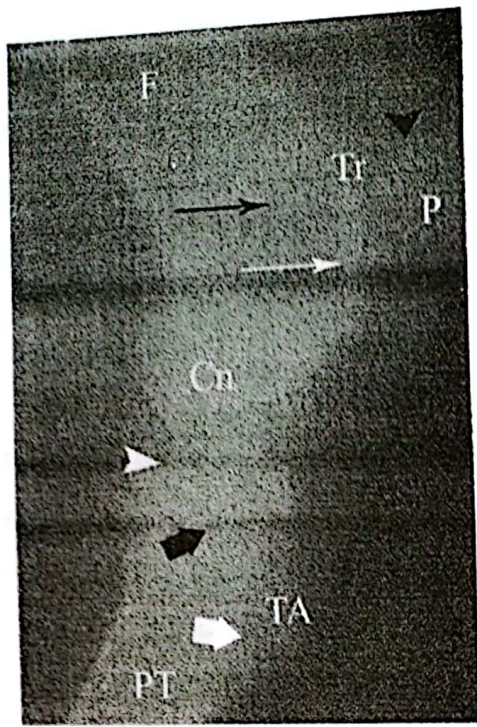


Fig.1. Latero medial radiograph of the stifle joint of a one day old donkey foal. Notice six ossification centres; distal femoral physis with irregular outlines (black thin arrow), distal femoral epiphysis (white thin arrow), patella with irregular contour (black arrow head), proximal tibial epiphysis with sloped tibial condyles (white arrow head), proximal tibial physis (black thick arrow) and cranial tibial apophysis (white thick arrow). F: femur, Tr: trochlear ridge, P: patella. Cn: femoral condyle, TA: cranial tibial tuberosity, PT: proximal tibia.

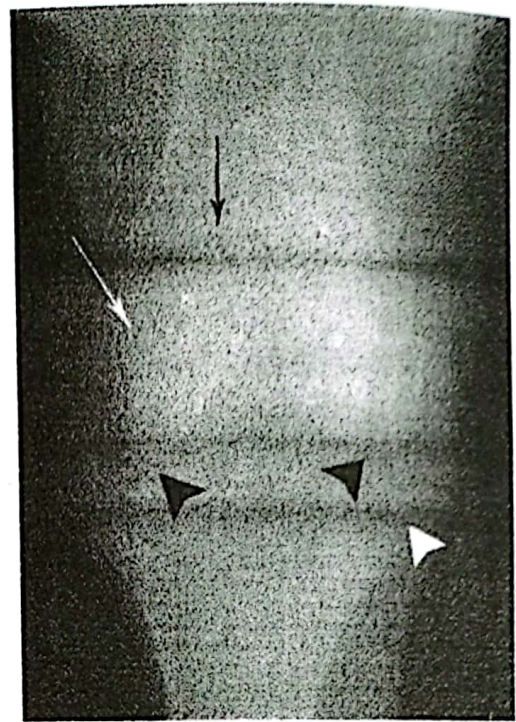


Fig.2. Plantro dorsal radiograph of the stifle of a one day old donkey foal. Notice distal femoral physis (black thin arrow), distal femoral epiphysis (white thin arrow), proximal tibial epiphysis with sloped tibial condyles (black arrow heads), proximal tibial physis (white arrow head).



Fig.3. Latero medial radiograph of the stifle joint of a one-month old donkey. Notice the increased medial trochlear ridge in height at its proximal part (black arrow) and ovoid shaped patella

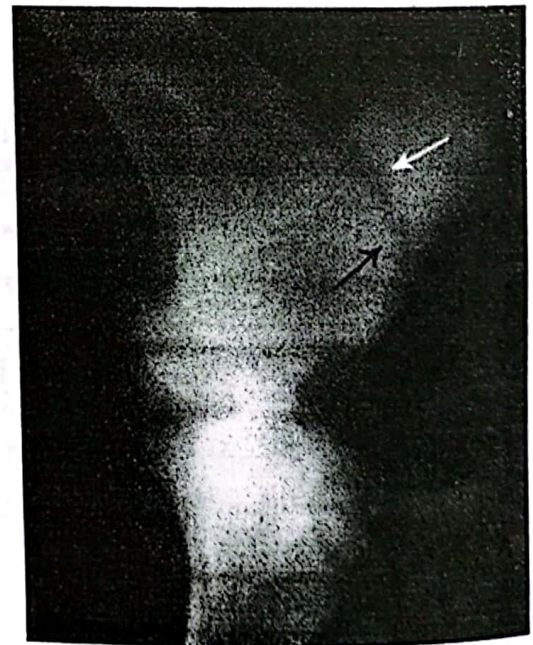


Fig.4. Latero medial radiograph of the stifle joint of a six months old donkey. Notice disappearance of subchondral bone opacity of the trochlear ridges with regular round contour (black arrow) and quadrilateral shaped patella with smooth concave articular surface (white arrow).

Table (1). Illustrated the different ossification centres of the distal femur, proximal tibia & patella and their closure according to time at the stifle joint.

	The ossification centres of the distal femur						Ossification centres of the proximal tibia						Patella	
	Distal femoral epiphysis			Distal femoral epiphysis	Proximal tibial epiphysis	Proximal tibial physis			Apophysal centre of the cranial tuberosity					
	Plaster third	Middle third	Dorsal third			Plaster third	Middle third	Dorsal third	Proximal third	Middle third	Distal third			
1 day old	(3 mm)	(3 mm)	(3 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	(3 mm)	(3 mm)	(3 mm)	(4 mm)	(2 mm)	(4 mm)	(4 mm)	(4 mm)	Disappearance of its subchondral bone opacity (smooth concave articular surface + regular contour)
1 month old	(1.9 mm)	(1.7 mm)	(2 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	(1.8 mm)	(2 mm)	(2 mm)	(3.1 mm)	(1.7 mm)	(3.1 mm)	(3.1 mm)	(3.8 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
3 months old	(1.7 mm)	(1.5 mm)	(2 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	(1.2 mm)	(1.6 mm)	(2 mm)	(2 mm)	(1.2 mm)	(2 mm)	(2 mm)	(3.7 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
6 months old	(1.1 mm)	(0.9 mm)	(2 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	(0.9 mm)	(1.2 mm)	(1.6 mm)	(1.6 mm)	(1 mm)	(1.6 mm)	(1.6 mm)	(3.7 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
9 months old	(0.2 mm)	C.F.	(1.1 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	(0.2 mm)	(0.3 mm)	(0.3 mm)	(0.6 mm)	(0.3 mm)	(0.6 mm)	(0.6 mm)	(3.7 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
12 months old	C.F.	C.F.	(0.8 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	(0.3 mm)	(0.3 mm)	(0.3 mm)	0.2 mm)	(0.3 mm)	(0.3 mm)	(3.3 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
15 months old	C.F.	C.F.	(0.6 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	F.F.	F.F.	F.F.	C.F.	F.F.	F.F.	(3.0 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
18 months old	C.F.	C.F.	(0.5 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	(2.3 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
21 months old	C.F.	C.F.	(0.2 mm)	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	(1.8 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
24 months old	C.F.	C.F.	opaque line	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	(0.9 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
30 months old	C.F.	C.F.	No radio opaque line	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	(0.3 mm)	Incompletely ossified (irregular contour and granular subchondral bone opacity)
36 months old	C.F.	C.F.	No radio opaque line	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F. + Radio opaque line	Incompletely ossified (irregular contour and granular subchondral bone opacity)
42 months old	C.F.	C.F.	No radio opaque line	Incompletely ossified (irregular contour at proximal parts of trochlear ridges with granular subchondral bone opacity)	Incompletely ossified (sloped tibial condyles with granular subchondral bone opacity)	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	C.F.	No radio opaque line	Incompletely ossified (irregular contour and granular subchondral bone opacity)

F.F.: Faint fusion. C.F.: complete fusion.

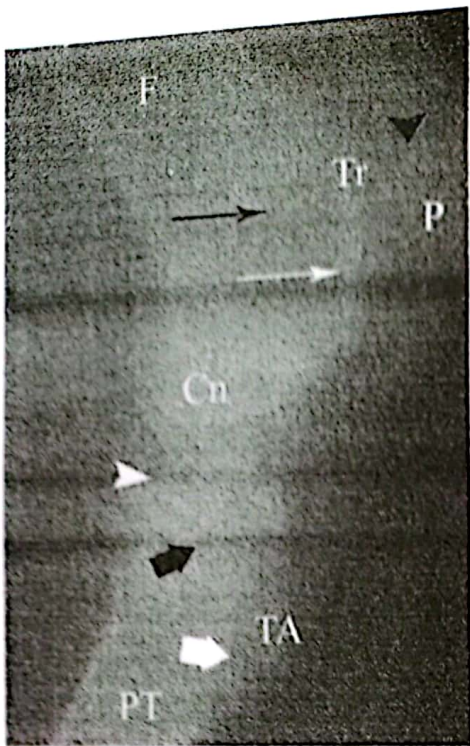


Fig.1. Latero medial radiograph of the stifle joint of a one day old donkey foal. Notice six ossification centres: distal femoral physis with irregular outlines (black thin arrow), distal femoral epiphysis (white thin arrow), patella with irregular contour (black arrow head), proximal tibial epiphysis with sloped tibial condyles (white arrow head), proximal tibial physis (black thick arrow) and cranial tibial apophysis (white thick arrow). F: femur, Tr: trochlear ridge, P: patella, Cn: femoral condyle, TA: cranial tibial tuberosity, PT: proximal tibia.

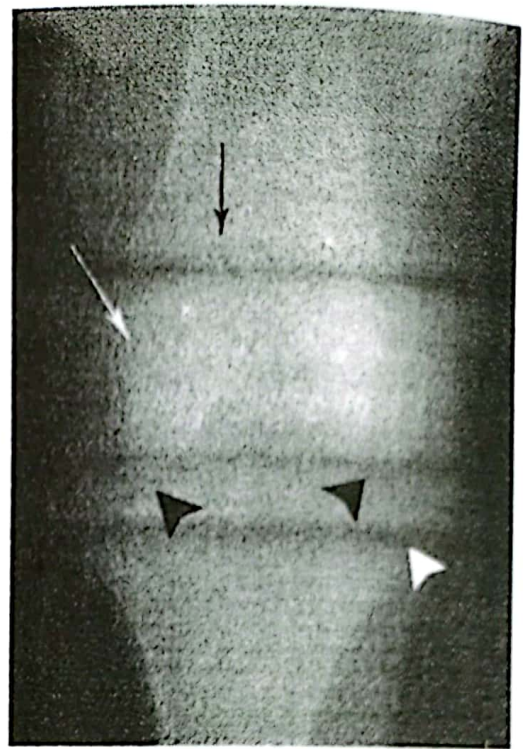


Fig.2. Plantro dorsal radiograph of the stifle of a one day old donkey foal. Notice distal femoral physis (black thin arrow), distal femoral epiphysis (white thin arrow), proximal tibial epiphysis with sloped tibial condyles (black arrow heads), proximal tibial physis (white arrow head).



Fig.3. Latero medial radiograph of the stifle joint of a one-month old donkey. Notice the increased medial trochlear ridge in height at its proximal part (black arrow) and ovoid shaped patella

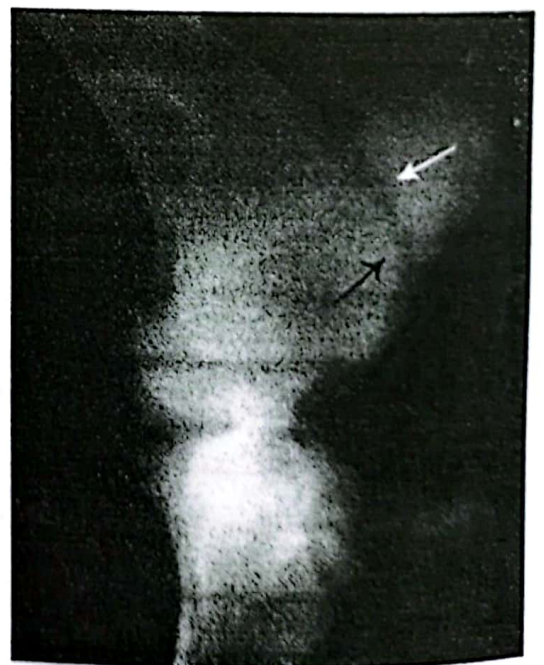


Fig.4. Latero medial radiograph of the stifle joint of a six months old donkey. Notice disappearance of subchondral bone opacity of the trochlear ridges with regular round contour (black arrow) and quadrilateral shaped patella with smooth concave articular surface (white arrow).

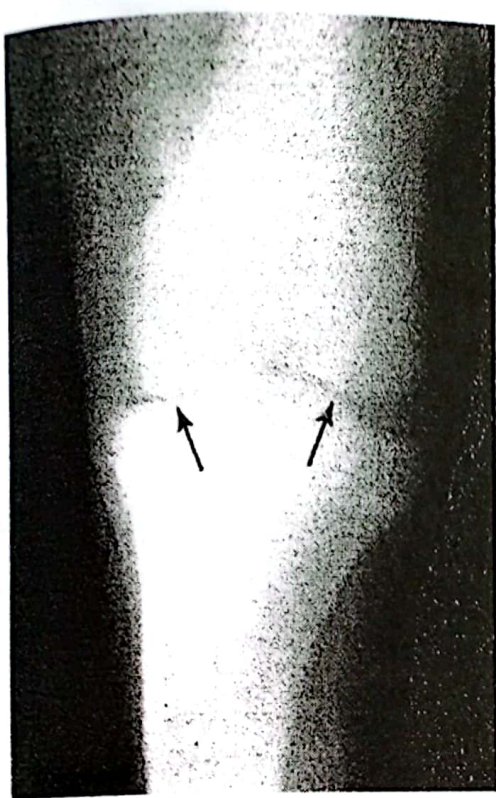


Fig.5. Planterodorsal radiograph of the stifle joint of a nine-months old donkey. Notice the tibial condyles become horizontal (arrows).

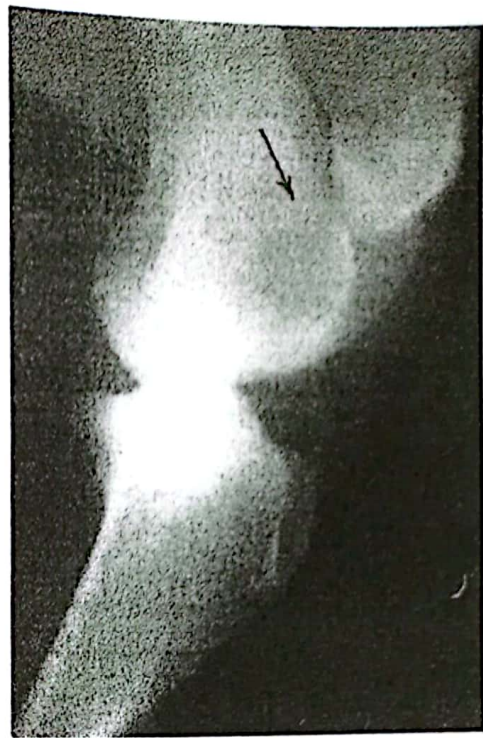


Fig.6. Lateromedial radiograph of the stifle joint of a twenty four-months old donkey. Notice the closure of the distal femoral physis with a faint radio-opaque line at its dorsal third (black arrow) and the complete closure of the proximal tibial physis with presence of a faint radio-opaque line at its plantar third (white arrow).



Fig.7. Lateromedial radiograph of the stifle joint of a thirty six-months old donkey. Notice complete fusion of the apophyseal line with presence of the radio-opaque line (arrow).



Fig. 8. Lateromedial radiograph of the stifle joint of a forty two-months old donkey. Notice the disappearance of the radio-opaque line at fused apophyseal line.

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تحديد أوقات التئام خطوط الصفائح الغضروفية فى مفصل الركبة الخلفية فى الحمير

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أجريت هذه الدراسة على عدد ٦٦ حمارا تراوحت أعمارها ما بين يوم واحد إلى أربعة أعوام استخدمت للتوصيف بالأشعة السينية لمراكز التمعظم الطبيعى ووقت حدوثه فى مفصل الركبة الخلفية.

وقد أظهرت هذه الدراسة أن مراكز التمعظم فى مفصل الركبة الخلفية هى الخط الكردوسى والمركز الكردوسى السفلى لعظمة الفخد والخط الكردوسى والمركز الكردوسى العلويين لعظمة الساق والنتوء الأمامى لعظمة الساق وعظمة الردفه. كما لوحظ أن التجايف المفصالية كانت واسعة فى العمر الصغير عنه فى عمر ما بعد البلوغ.

ولقد تم توصيف وتحديد أوقات التئام خطوط جميع الصفائح الغضروفية فى مفصل الركبة الخلفية. ولقد وجد أن هذا الفحص بالأشعة السينية لمفصل الركبة الخلفية ذات أهمية عالية فى تحديد العمر السليم للنضوج الهيكل العظمى وبالتالي عند هذا العمر يكون الحيوان صالح للأستخدام فى العمل. كما وأن هذا الفحص يهمننا فى التفرقة بين التغيرات الطبيعية والمرضية كما فى الكسور والتهاب المفصل الصديدى.