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SOME RADIOLOGICAL STUDIES ON THE POSTNATAL DEVELOPMENT AND FUSION OF THE TUBER CACANEI IN COWS

(with 2 Tables & 13 Fig.)

By

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بعض الدراسات بالاشعه على تطور والتحام الحدبه العقبيه في الابقار

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اجرى هذا البحث على ستة عجول حديثة الولادة وتسع بقرات بالغة. وقد تم تصوير ٢٠٠ صورة اشعاعية في الوضع الجانبي الوحشى وذلك علي فترات مختلفة من مراحل العمر تبدا بعد الولادة مباشرة وذلك لمفصل الرسغ الخلفى وقد لوحظ ان الحدبة العقبية تنمو من مركز تمعظم منفصل. وهى تنمو في البدلية جهة الخلف حتى الاسبوع الحادى عشر ثم تبدا فى النمو فى الاتجاة الامامي. هذا ويتم التحامها بالكامل مع جسم عظمة العقب عند عمر ٤٠ شهرا.

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SUMMARY

This work was carried out on 6 newly born calves and 9 adult clinically healthy cows. All radiographs were evaluated for the degree of ossification of the tuber calcanei which firstly developed in a distoplantar direction then in a proximodorsal direction. The complete fusion of the tuber calcanei takes place at the age of 40 months. Using Bioscane optimus program, different measurements of the tuber calcanei and the calcaneus proper were estimated. The obtained data were tabulated and illustrated by two curves, From the anatomical point of view the structure of the tarsus is complex, and according to *GREENOUGH, MACCALLUM and WEAVER (1972),* the bovine tarsus is a region of clinical importance, as the Tarsal joint is second only to the stifle joint in most appendicular arthritis. The tarsus of cow includes five tarsal bones, the largest one being the calcaneus which is enlarged at its proximal end to form the Tuber Calcanei or the point of hock as stated by *GETTY (1975).* The available references which contain information on the development and fusion time of the tuber calcanei in different animals are *MACCALLUM,* et al. *(1978)4 SMALLWOOD* et al. *(1984)* in horse, *TICER (1975)* in dog & cat but these references demand the informations on the development and fusion of the Tuber Calcanei in cow. The primary objective of this study was to give an accurate determination of fusion time and development of the Tuber Calcanei which is necessary to prevent confusion of fractures with the radiolucent physis.

Keywords: Radiology ossification cow.

MATERIAL and METHODS

This work was carried out on 6 newly born calves and 9 adult cows. The calves and the cows were owned and maintained by the department of sungery. faculty of veterinary medicine Assiut University.

All the animals used were clinically healthy and housed in open stable and hand fed on standard diet.

One radiograph (lateromedial view) of each tarsus was made using mobile X-ray machine and screen film.

Both tarsi of each calve were radiographed at weekly intervals (1, 7, 14, 21, 28, 35, 42 day) untill the calves were 6 weeks old. Biweekly intervals (7, 9, 11, 13, 15, 17, 19, and 21 weeks) Then monthy interval (11-19 months).

On the other hand both tarsi of the adult cows were radiographed at the age of (27, 32, 34, 40, 42, 46, 72, 84, 96 months).

All radiographs were evaluated to the degree of ossification and fusion of tuber calcanei.

Using Bioscan optimus program, different measurements are shown in Fig. (1) and include long axis of tuber & calcaneus proper, width of physis and dorsoplantar surface of fusion surfaces) were obtained and tabulated.

The anatomical terminology used here in conforms to that listed in NAV (1983) while the radiographic terminology in conforms to that reported by *SMALLWOOD* et al. *(1985).*

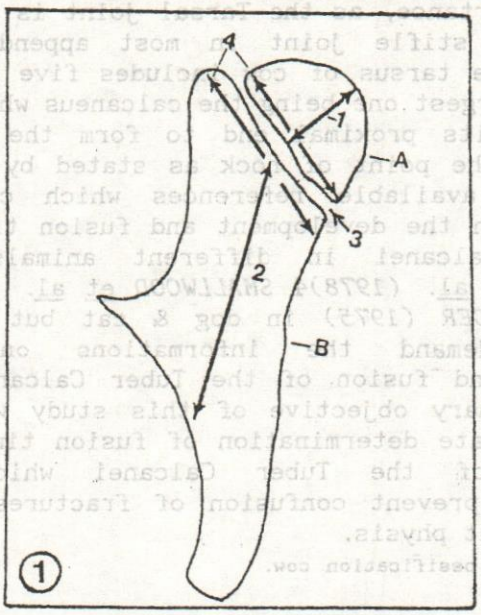

Fig (1) : Different measurements on the calaneus using Bioscan optimus program.

A. Tuber calcanei B. calcaneus proper 1.2 long. axis of A& Brespectively.

3. Epiphysial cartilage (physis).

4. Fusion surface of A & B.

RESULTS

The radiographic data consists of about 200 radiographs. After evaluation of this data, representative radiographs were selected to evaluate the development and fusion of the Tuber calcanei from birth to 96 month age.

At one week old a faint line was observed at the plantar end of tuber calcanei *Fig. 3/1). At 7 week old this line separate an elleptical radiolucent area (Fig.4/1) which persist till 12 weeks old. By 13 week old this area disappered and was replaced by a radiographic irregular area which represent the beginning of fusion (Fig.6/1).

At age of 11 week a pointed area of ossification developed and directed distoplantarly (Fig.7/1). This area continue to ossify in this direction untill the age of 20 weeks (Fig. 8/1&11) where it overlaps the apical part of the plantar border of the calcaneus proper.

At age of 20 weeks the tuber calcanei began to develop proximodorslly (Fig. 11 and 8/2) and continue to develop in this direction till 11 months old where it caps the proximodorsal angle of the Calcaneus proper in the form of a beak (Fig.11 & 9/1). This beak like projection persists untill the complete fusion of the tuber Calcanei takes place.

At birth the epiphyseal cartilage (physis) is clearly evedent and separate the smooth fusion surface of both tuber calcanei and Calcaneus proper (Fig 2/1). During development the width of the physis is nearly equal (Table 1). From the age of 18 month the physis gradually narrows untill the age of 36 months where it partially deminish. it is completely disappeared at age of 40 months where complete fusion occur (Fig.10).

On the other hand an irregularity appeared on the fusion surface at age of 11 weeks (Fig.7/2). This irregularity increases gradually in upward direction untill in complete fusion at 16 months age.

The complete fusion of the tuber calcanei takes place at 40 months old (Fig. 10) where a radiolucent line is clearly evident at the site of fusion.

Table (1) and Fig (12&13) comprise a computerized data, by using Bioscan optimus program, which reveals that the development of tuber calcanei was directly proportion to that of the calcaneus proper in respect to their longitudinal axis. On the other hand the fusion surface of both tuber calcanei and the calcaneus proper are equal in length from age of 15 months untill the complete fusion takes place.

DISCUSSION

At first week old calf a peculiar observation was the development of a distinct separation in the plantar part of the tuber calcanei. This division was most obvious at 7 weeks old. Such a split could easily be interpreted as a fracture, but there was no evedence of pain or swelling. In subsequent radiographs the separation became less obvious and by 13 weeks was barely detectable.

The present work reveals that the tuber calcanei firstly developed in a distoplantar direction till 20 weeks old calf, then in a proximodorsal direction till the complete fusion takes place. However many investigators *(BROWN & MACCALLUM (1975) and SMALL WOOD* et al. *(1984)* in horse) have reported that the tuber calcanei ossifies in a dorsoproximal direction.

The most available literatures concerning the epiphyseal closure of tuber calcanei were concentrated mainly on, carnivores *[Ticer (1975) and Chapman (1965)]*, horse *[BROWN MACCALLUM (1975) and SMALL WOOD* et al. *(1984)]*, sheep *[BOLBOL* et al. *(1986)]* and goat *(ABDEL HAFEEZ, 1988)*. According to that reported by the previous authors, the time of closure and complete fusion of the tuber calcanei in the aforementioned animals and the present work were recorded in Table (2).

Table (2) Time of fusion of Tuber Calcanei in different Domestic animals

Auther,s name	Animal name	Time of fusion
Ticer (1975)	Dog	3-8 month
Ticer (1975)	Cat	7-13 month
Abdel Hafeez (1988)	goat	3-year
Smallwood (1993)	horse	16-24 month
Present work	Cow	40 months

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LEGEND OF RADIOGRAPHS

Fig. (2): A lateromedial radiograph of tarsi of one day old calf shows a clearly evedent physis and smooth fusion surfaces of both tuber calcanei and calcaneus proper.

Fig. (3): A Lateromedial radiograph of tarsi of one weeks old calf shows; the secondary ossification centers for the tuber calcanei is initially related to the plantar aspect of calcaneus proper. 1, Appearance of a faint line on the plantar end of tuber calcanei. 2, The dorsal border of the calcaneus proper is concave.

Fig. (4): A lateromedial radiograph of tarsi of 7 weeks old calf shows. 1, separate elleptical area. 2, The dorsal border of calcaneus proper is still Concave.

Fig. (5): A Lateromedial radiograph of tarsi of 3 weeks old calf shows, the appearance of radiolucent line which define the sustentoculum tali (1).

Fig. (6): A Lateromedial radiograph of tarsi of 13 weeks old calf shows; the disappearance of the line and the elleptical area on the plantar part of the tuber calcanei (1). The concavity of the dorsal border of the Calcaneus proper becomes nearly straight (2).

Fig. (7): A Lateromedial radiograph of Tarsi of 11 weeks old Calf shows, the ellephcal area on the plantar part of the tuber calcanei is partially fused with the tuber, the dorsal border of the Calcaneus proper become less concave. 1, Appearance of a pointed ossification area on the plantar part of the tuber calcanei 2, Appearance of irregularity on the fusion surface of the calcaneus proper.

Fig. (8): A Lateromedial radiograph of Tarsi of 20 weeks old Calf shows. 1, The distoplantar development of tuber calcanei which overlap the apical part of the plantar border of calcaneus proper. 2, The beginning of proximodorsal development of Tuber calcanei. 3, The dorsal border of the calcaneus proper is nearly straight.

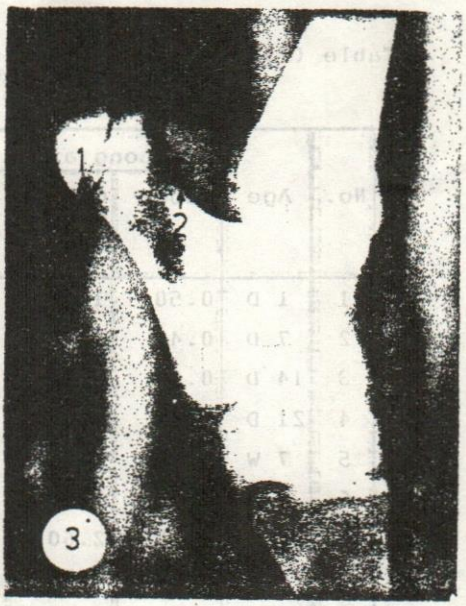
Fig. (9): A Lateromedial radiograph of tarsi of 11 months old cow shows. 1, the proximodorsal development of the tuber Calcanei form a beak like exiension which overlaps the dorsal border of the calcaneus proper 2, The dorsal border of the calcaneus proper is completely straight.

Fig.(10): A Lateromedial radiograph of tarsi of 40 months old cow shows, the complete fusion of the tuber calcanei with the calcaneus proper (indicated by arrow).

Table (1) Some measurements (in cm) related to the development and fusion of the Tuber Calcanei and Calcaneus Proper using Bioscan optimus program.

No.	Age	Long axis			Width of Physis	Dorso-plantar length of fusion surfaces	
		Tuber	Cal. Proper	%		Tuber	Cal. Proper
1	1 D	0.50	1.50	33.3	0.06	1.04	1.25
2	7 D	0.45	2.10	21.5	0.06	1.09	1.20
3	14 D	0.56	2.25	24.9	0.06	1.10	1.25
4	21 D	0.61	2.25	27.1	0.06	1.10	1.25
5	7 W	0.50	2.25	22.2	0.06	1.10	1.25
6	9 W	0.53	2.35	22.5	0.05	1.20	1.25
7	11 W	0.57	2.60	21.9	0.06	1.16	1.12
8	12 W	0.60	2.75	21.8	0.06	1.11	1.06
9	13 W	0.62	2.75	22.5	0.05	1.15	1.00
10	16 W	0.66	2.90	22.8	0.05	1.40	1.20
11	18 W	0.66	3.10	21.3	0.06	1.30	1.20
12	20 W	0.66	3.10	21.3	0.06	1.40	1.30
13	11 M	0.66	3.40	19.4	0.07	1.60	1.50
14	12 M	0.70	3.60	19.4	0.06	1.20	1.10
15	14 M	0.73	3.70	19.7	0.06	1.20	1.10
16	15 M	0.76	3.80	20.0	0.07	1.10	1.10
17	18 M	0.76	3.80	20.0	0.05	1.30	1.30
18	19 M	0.78	3.90	20.0	0.04	1.14	1.14
19	27 M	0.78	4.00	19.5	0.04	1.30	1.30
20	32 M	0.79	4.00	19.75	0.03	1.40	1.40
21	36 M	0.86	4.00	21.5	0.00	1.40	1.40
22	40 M	0.87	4.00	21.75	0.00	1.50	1.50
23	42 M	0.90	4.00	22.5	0.00	1.60	1.60

D: Day W: Week. M: Month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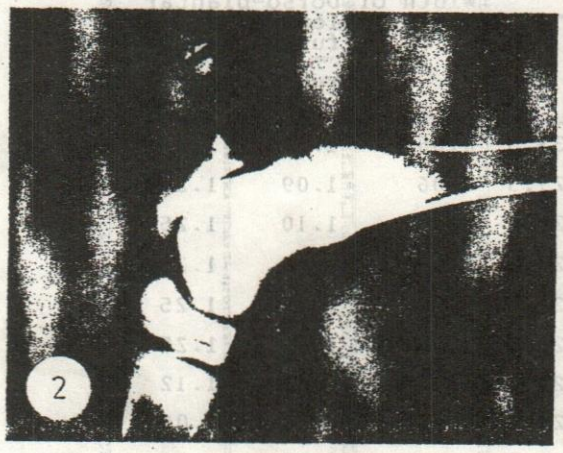
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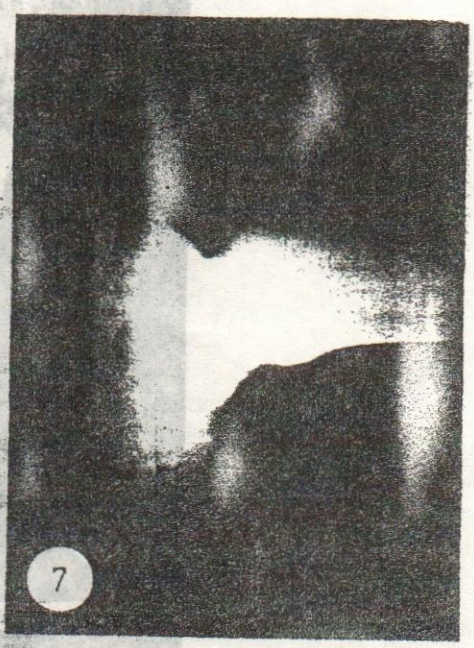
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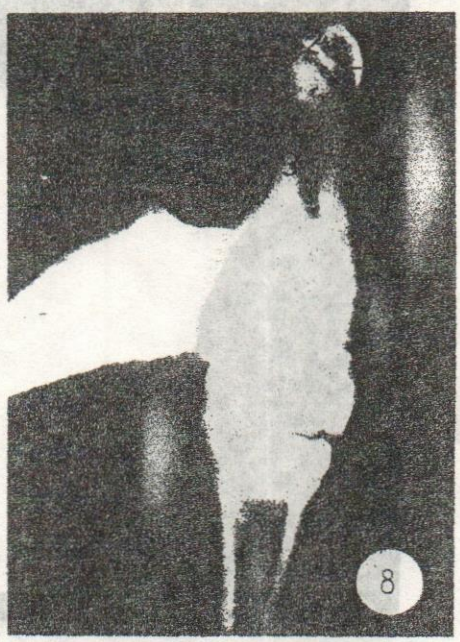
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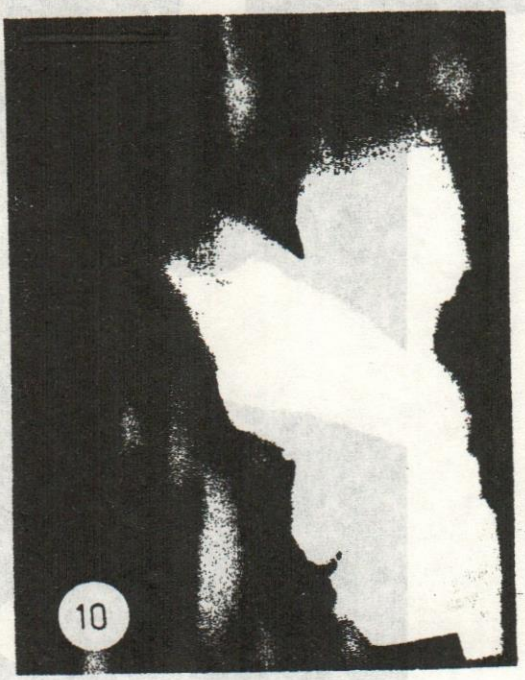
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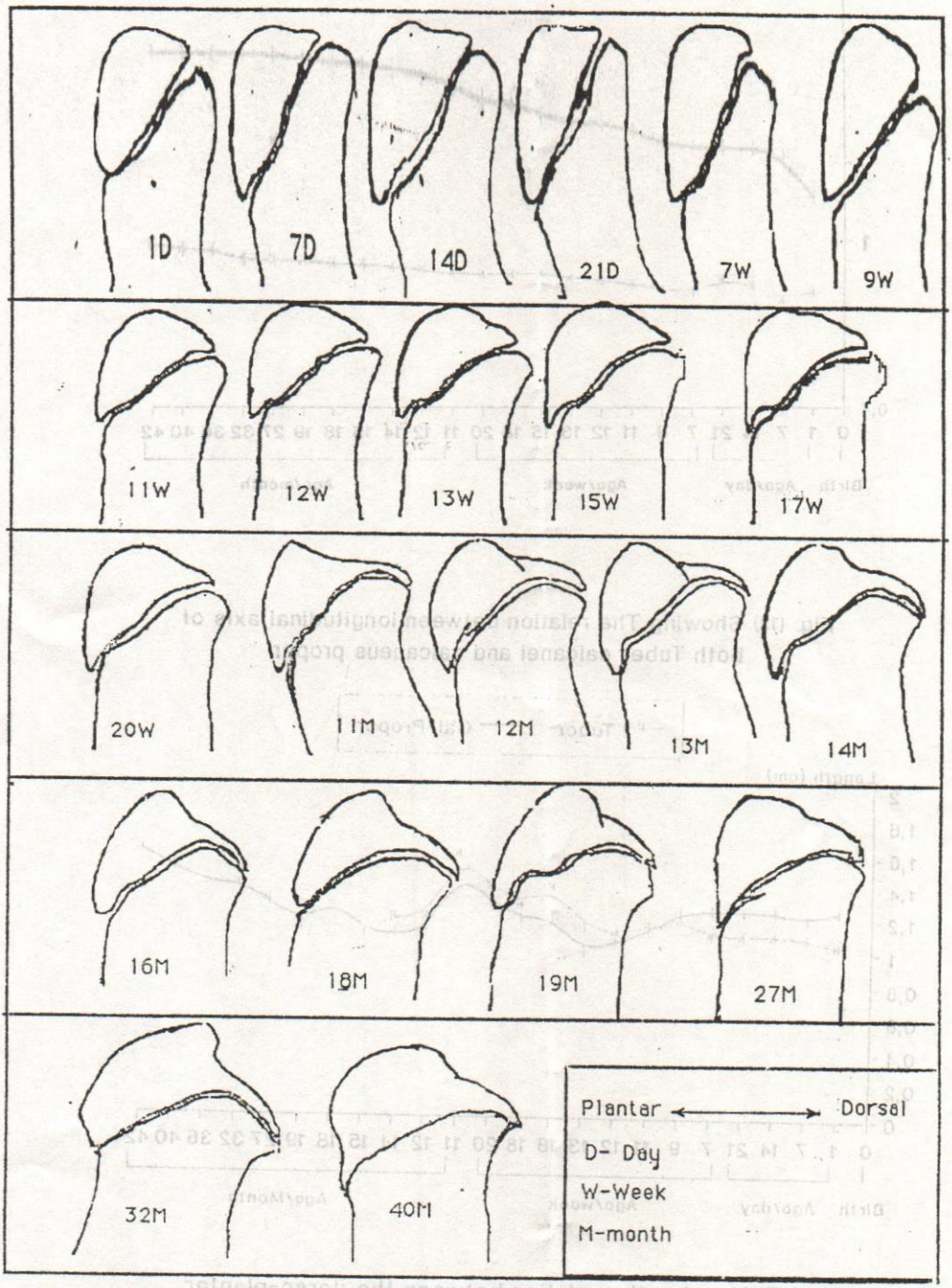

Fig. (11) Tracings of progressive ossification of Tuber calcanei of Cow

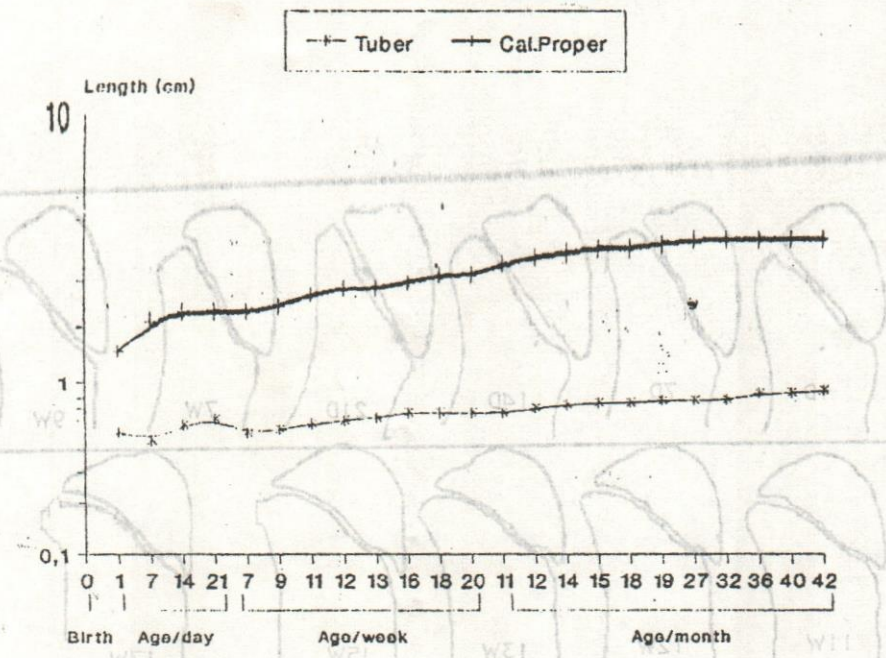

Fig. (12) Showing The relation between longitudinal axis of both Tuber calcanei and calcaneus proper

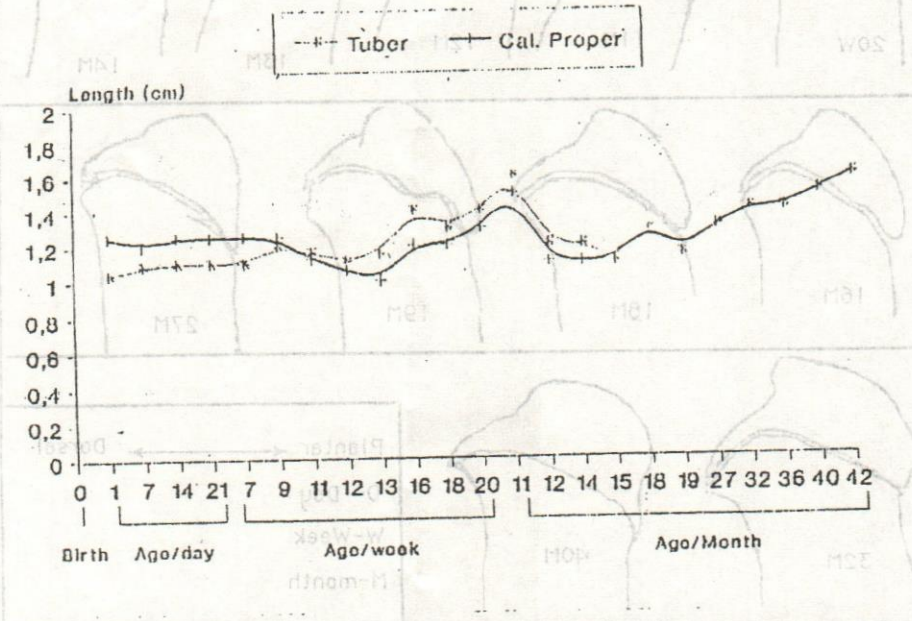

Fig. (13) Showing the relation between the dorso-plantar length of fusion surface of both Tuber and calcaneus proper