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PHALANGEAL EXOSTOSIS IN RELATION TO THE TENDENIOUS AND LIGAMENTOUS ATTACHMENTS IN DONKEYS

(With One Table & 14 Fig.)

By

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النمو العظمي الزائد للاصابع وعلاقته باماكن اتصال الاوتار والاربطه في الحمير

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اجرى البحث على ١٠ حمير تم تشريح أصابعها لتوضيح اماكن اتصال الاوتار والاربطه بها بالاضافه الى فحص ٣٠٠ سلاميه دانيه و ٢٠٠ سلاميه وسطى و ١٥٠ سلاميه قاصيه وذلك لمعرفة ما بها من نمو عظمى زائد . ولقد بين البحث ان النسبه المئويه للنمو العظمى فى السلاميه الدانيه (٣٠ ٪) أعلى منها فى السلاميتين الباقيتين . ويرجع السبب فى ذلك ان الجهاز السمسمانى يتصل أساساً بالسلاميه الدانيه مما يعرضها لضغط أكثر . أما انخفاض نسبة النمو العظمى للسلاميه القاصيه (٣ ر١٧٪) فيرجع الى ان الحافر يقوم بحماية أماكن اتصال الاوتار والاربطه بهذه السلاميه . ولوحظ من البحث ان النمو العظمى الزائد للاصابع فى الحمير يقع فى أو حول أماكن اتصال الأوتار والاربطه ، فاذا ما حدث جزع أو تمزق لهذه التراكيب فانه يؤدى الى النمو العظمى الزائد .

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SUMMARY

The digits of ten donkeys were dissected carefully for determination the sites of the tendenious and ligamentous attachments. Moreover 300 proximal phalanx, 200 middle phalanx and 150 distal phalanx were examined for the presence of the exostosis. The percentage of the exostosis of the proximal phalanx (30%) is higher than that of the other two phalanges, as the sesamoidean apparatus attaches mainly to the proximal phalanx, which exposes this bone to greater compression load. On the other hand, the percentage of exostosis is low in distal phalanx, because the tendinous and ligamentous attachments of this bone are protected by the hoof. It is found that most of the digital exostosis were observed at or around the area of attachments of tendons or ligaments. Therefore it is suggested that sprains or tears of tendons or ligaments causing exostosis in donkeys.

Keywords: Phalangeal exostosis relation, tendenious, ligamentous, attachments, donkey.

INTRODUCTION

It is well known that donkeys are mainly working animals which depend upon their appendicular system. Therefore the incidence of the phalangeal exostosis is common in this animal. The available literature lacks any information about the occurence of this exostosis in donkeys. Along this study, the authors have intended to threw light on the most prevalent types of phalangeal exostosis in this animal, therefore, it is necessary to study, from the anatomical point of view, the tendenious insertions and ligamentous attachments in the digits in relation to the incidence of the exostosis.

MATERIAL AND METHODS

The anatomical studies were carried out on ten adult donkeys of both sexes. The animals were anaesthetized and bled through the common carotid artery. After that the digits were dissected carefully to determine the line of muscular insertions and ligamentous attachments.

The exostosis of the phalanges was studied in 300 proximal phalanx, 200 middle phalanx and 150 distal phalanx after their preparation. These specimens were collected from the

departments of anatomy and surgery which are used for student exercises.

Each phalanx was examined carefully for the presence of any periostial exostosis. Each exostosis was fully described and its relationship with the area of attachment of the tendons and ligaments was investigated.

RESULTS

I- The line of muscular insertions and ligamentous attachments on the phalanges (Fig. 1, 2, 3):

Phalanx Proximalis:

The common digital extensor tendon inserts in the dorsal surface of the proximal extremity of the proximal phalanx (Fig. 1/1) directly distal to the joint capsule of the fetlock joint and 16.30 mm dorsal to the collateral ligament of this joint. The area of attachment is nearly elleptical in outline measures about 8.00 mm long and 3.00 mm wide. The lateral digital extensor tendon inserts directly lateral to the preceding muscle. Its area of attachment (Fig. 1/2) is 10.00 mm long and 4.00 mm wide.

The collateral ligament of the fetlock joint is incompeletly divided into superficial and deep parts. The superficial part has a vertically directed fibers which attach to the rough area (Fig. 3/10) on the side of the proximal extremity of the proximal phalanx. The attaching area measures 7.00 mm in length and 8.00 mm in width. The deep part is thicker than the superficial one, extends distopalmarly to be attached in the eminence and the adjacent area on the side of the proximal extremity of this phalanx. The line of attachment lies immediately distal to the articular surface of the fetlock joint. In addition, the collateral sesamoidean ligament has a small dorsodistally directed branch attaching (Fig. 3/11) the previous eminence.

The cruciate sesamoidean ligament attaches to a small nearly quadriangular area (Fig. 2/6) on the palmar surface of the proximal extremity of the proximal phalanx. The attaching area measures about 6.00 mm in each of length and width. The short sesamoidean ligament attaches to the palmar aspect of the articular surface of the proximal extremity of proximal phalanx. Its area of attachment (Fig. 2/7) is nearly rounded measuring 4.00 mm in diameter and its fibers are directed dorsally and slightly abaxially.

The oblique sesamoidean ligament attaches to the rough triangular area (Fig. 2/5) on the palmar surface of the body of

the proximal phalanx; the width at the base is 20.00 mm, its length is 36.30 mm and its apex ends 11.20 mm proximal to the distal extremity. The borders of the triangular area are thick.

The lateral and medial bands of the palmar ligament of the pastern joint pass upward and outward to be attached to an elongated narrow area on the middle of the corresponding border of the proximal phalanx (Fig. 3/12). The length of the attaching area is 8.00 mm and its width is 3.00 mm, while the central bands of the foregoing ligament attach to the border of the distal part of the rough triangular area (Fig. 2/8).

The superficial digital flexor tendon inserts in a depression (Fig. 2/3) lying directly palmar to the collateral ligament of the pastern joint about 5.30 mm proximal to the articular surface of the this joint. The area of attachment is 9.50 mm long and 4.50 mm wide. The collateral ligament of the pastern joint is slightly wide and thick attaching on an eminence and small shallow depression on each side of the distal extremity of proximal phalanx. The area of attachment (Fig. 3/13) lies directly proximal to the joint capsule of the pastern joint and measures 10.00 mm long and 9.00 mm wide. The suspensory navicular ligament is flat narrow band attaches to the small area on each side of the distal extremity of the proximal phalanx (Fig. 3/14) just dorsal to the preceding collateral ligament.

Phalanx media:

The common digital extensor tendon inserts in rough area at the dorsal aspect of the proximal surface of the middle phalanx (Fig. 1/1) close to the articular surface of the pastern joint. The length of the attaching area is 14.00 mm and 4.60 mm in width. The superficial digital flexor tendon inserts on the palmar aspect of an eminence on each side of the proximal surface of this phalanx. The area of attachment is 10.70 mm long and 5.10 mm wide.

The collateral ligament of the pastern joint attaches to a rough area close to the articular surface of this joint just dorsal to the insertion of the superficial digital flexor muscle. The attaching area measures 8.00 mm long and 6.50 mm wide. The palmar ligaments of the aforementioned joint are attached to the proximal surface of the middle phalanx palmarly close to the complementary cartilage.

The collateral ligament of the coffin joint attaches to a depression on each side of the distal surface of the middle phalanx (Fig. 3/15). The area of attachment is directed distopalmarly and measures 10.00 mm long and 8.00 wide.

Phalanx distalis:

The common digital extensor tendon inserts in the extensor process of the distal phalanx. The area of attachment (Fig. 1, 3/1) measures 7.80 mm long and 5.70 mm wide. The collateral ligament of the coffin joint attaches to an elongated depression 15.00 mm palmar to the extensor process. The attaching area is 7.70 mm in length and 4.00 mm in width. The suspensory navicular ligament sends some fibers to be attached to the angle of the above phalanx palmar to the attachment of the latter ligament.

The deep digital flexor tendon inserts in the semilunar line and the adjacent area of the flexor surface of the distal phalanx directly distal to the navicular bursa. The area of attachment (Fig. 2/4) is cresentic in shape measuring 17.00 mm long and 4.90 mm wide. The distal sesamoidean impar ligament is flat relatively thin ligament attaching to the solar surface of the distal phalanx (Fig. 2/9) proximal to the semilunar line. The area of attachment measures 14.00 mm long and 4.10 mm wide, it is related proximally to the joint capsule of the coffin joint and palmarly to the navicular bursa.

II- Phalangeal bony exostosis:

The number and incidence of the phalangeal bony exostosis in donkeys is illustrated in the following table:

Phalanx	Examined specimens	Exostosed specimens	%
Proximal phalanx	300	90	30.0
Middle phalanx	200	43	21.5
Distal phalanx	150	26	17.3

Phalanx proximalis:

The periosteal exostosis on the proximal phalanx of the donkeys was noticed on 90 out of 300 examined specimens (30%). Two forms of ringbone were recorded:

I- False ringbone:

This type of ringbone was found in 66 out of 90 proximal phalanx exostosis. It was found on different locations as follows:

A) On the lateral and medial margins of the triangular rough area at the palmar surface:

It was encountered in 13 phalanx out of 66 false ringbone. The exostosis has the form of an elongated projection which begins on the distal part of the margins of the rough triangular area, then it extends upward along the margins

(Fig. 4). The bony enlargement varies in length from 1.0 cm to 3.5 cm and from 0.2 cm to 1.3 cm in thickness. In one case the exostosis extends mediopalmar to the attaching part of the oblique sesamoidean ligament. Therefore the ligament is partially covered by the periostial exostosis.

B) On the lateral margin of the triangular rough area (7 out of 66 false ringbone):

This exostosis was noticed on the proximal part of the lateral margin of the triangular rough area. Its length was ranged from 1.0 cm to 3.0 cm and occupies the entire lateral margin. Also one of this exostosis was directed mediopalmarly to cover partially the oblique sesamoidean ligament.

C) On the lateral and medial borders of the proximal phalanx (22 out of 66):

In this position the bony exostosis was found in two forms. The first one (17 out of 22), was a chain-like bony growth scattered nearly at the middle third of both borders of the proximal phalanx (Fig. 5). While the second form (5 out of 22) was large in size and situated on the distal two thirds of both borders of the proximal phalanx (Fig. 6).

D) On the lateral or medial border of the proximal phalanx:

It was encountered in 8 specimens (5 on the medial border and 3 on the lateral one) out of 66. It appears as a rough elevated area nearly at the middle third of the phalanx. Its length ranged from 1.0 cm to 3.0 cm and its width from 0.5 cm to 1.0 cm.

E) On the eminence which present on each side of the distal extremity of the proximal phalanx:

It was encountered in 16 out of 66 cases. The bony enlargement was 12 out of 16 on both side while 4 on the lateral side. The exostosis was small (about 0.5 cm) in 12 phalanx (Fig. 7). But in 4 cases, the exostosis was large in size and extended outward and upward (about 2.0 cm x 1.0 cm).

II- High true periarticular ringbone:

It was encountered in 10 proximal phalanx out of 90. In this type the bony exostosis involved the medial, dorsal and lateral margins of the distal articular surface of the proximal phalanx in most cases (7 out of 10), while in the other 3 cases it involved all the margins of the above mentioned articular surface.

In most of involved cases (9 out of 10), the exostosis takes the form of cauliflour appearance (Fig. 8). While in one

case, the ends of the proximal and middle phalanges aquired a knobby appearance at the lateral aspect and fused together (ankylosis).

In all encountered cases, the lateral exostosis was larger than the medial one. At the same time, in 2 out of 10 periarticular ringbone, the periostial new bony growth was extended from the lateral aspect downward to cover the level of the pastern joint (Fig. 6).

In addition to the above mentioned forms of the ringbone at the proximal phalanx, there are another periostial new bony growth at its proximal extremity (osslets). This type was encountered in 14 out of 90. The bony exostosis involved the lateral margin of the proximal articular surface in 7 cases, medial margin in 2 cases, while involved the lateral, medial and dorsal margins in the other 5 cases (Fig. 9).

Phalanx media:

The periostial exostosis (ring bone) on the middle phalanx of the donkeys was noticed on 43 out of 200 examined specimens (21.5%). The two forms of the ringbone were recorded (false and true periarticular ringbone).

I- False ringbone:

This type of ringbone was encountered in 34 out of 43 middle phalanx exostosis. It was observed in two locations. The first one is located around a depression for the collateral ligament of coffin joint on the distal part of the dorsal surface of the middle phalanx (18 out of 34 false ringbone). This exostosis begins in the above position then extends (in 4 cases) upward to occupy the proximal part of the above mentioned area. In these cases the periostial bony exostosis is subdivided into a bilateral (12 out of 18) (Fig. 10A) and unilateral bony exostosis (6 out of 18) (Fig. 10B). The second location was noticed at the transverse prominence of the palmar surface of the middle phalanx (16 out of 34 false ringbone). In this case the bony exostosis begins on both sides of the thick area at the proximal part of the palmar aspect of the middle phalanx. After that the exostosis extends mediodistally to occupy the ventral border of the thick area, therefore the new bony growth has cresentic shape (8 out of 16 cases) (Fig. 11).

II- True periarticuler high ringbone:

It is encountered in 13 out of 43. In most cases bony exostosis was noticed on the rough area at the middle of the dorsal margin of the proximal surface of the middle phalanx (Fig. 12), where the common digital extensor tendon is inserted.

In two cases the exostosis has appearance of two nodules which are present on both sides of the rough area. In another two cases the exostosis have the same position similar to the preceding case but becomes larger and extends dorsally to occupy part of the rough area. However in 7 cases the exostosis occupies all this area. While in the last two cases, the exostosis was large and occupying all the margins of the proximal surface of the middle phalanx except its palmar aspect.

Phalanx distalis:

The exostosis of the distal phalanx is found in three positions and encoutered in 26 out of 150 (17.3%).

I- True periarticular exostosis:

It was noticed in 10 cases. In 4 cases the new bony growth is found just distal to the caudal border of the articular surface of the distal palanx. But in 4 other cases the exostosis is located slighly distal to the above position between the palmar formaina. In both conditions this bony exostosis is situated at the flexor area of the distal phalanx. In an additional two cases the bony exostosis is present on the semilunar line.

II- Bony exostosis at side of the dorsal surface :

In 6 cases the exostosis is unilateral (Fig. 13) and in 3 cases bilateral. The exostosis is located directly distal to the area of attachment of the collateral ligament and proixmal to the dorsal groove. Here the exostosis is directd upward and slightly outward. The length of this bony growth is 0.3-2.4 cm and its width is 0.2-0.6 cm. But only in one case the exostosis extends downward overlaping the dorsal groove to meet the dorsal surface ventral to the dorsal groove, therefore it forms a canal like appearance.

III- Bony exostosis at the extensor process:

It was encountered in 7 cases. Four of them are located on the extensor process of the distal phalanx. In this condition the new bony growth is directed upward and forward and its length ranged between 0.3-1.5 cm (Fig. 14). In this location the common digital extensor is inserted. In other 3 cases a new bony growth in the form of a nodules is present in each sides of the extensor process consequently exostosis present also on each side of insertion of the before mentioned tendon.

DISCUSSION

According to the position of the bony exostosis on the eminence which present on each side of the distal extremity of the proximal phalanx, which are related to the area of attachment of the collateral ligament of the pastern joint, it is suggested that, the cause of this exostosis may be due to sprain or tears of the collateral ligaments at its attachment when a base-narrow or base-wide conformation exists in conjunction with toeing-in or toeing-out *(SILBERSIEPE and BERGE, 1958; ROONEY, 1969 and ADAMS, 1987).*

It is considered that the sprain of the oblique sesamoidean ligament at its attachment on the lateral and medial margins of the triangular rough area of the palmar surface of the proximal phalanx may be the cause for the prevalence of exostois in this position.

Also, we considered that the sprain of the lateral attachment of the oblique sesamoidean ligament may be the cause for the occurrence of exostosis in the lateral margin of the triangular rough area. This sprain or tears of the above mentioned ligament particularly its lateral attachment, may be results from irregularities of limb and digital conformation such as base-narrow, knocked knee, toe-in or trimming errors such as trimming the wall uneven on medial side or improper shoeing *(HAAKENSTED, 1954; DIETZ and WIESNER, 1984 and WYN-JONES, 1988).*

We considered that the wire cuts and direct trauma over the proximal phalanx and constant, firm fixation of the animal may be the actual cause for periostitis and consequently formation of false ringbone on the lateral and medial borders of the proximal phalanx. These results are in consequence with that given by *ADAMS (1987).* According to the current work the lateral and medial bands of the palmar ligament of the pastern joint attach to the middle of the corresponding border of the proximal phalanx, the area at which this exostosis was observed. Therefore the sprain of the foregoing bands also, may be lead to the above bony exostosis.

Instability of the proximal interphalangeal joint has been blamed, as has poor conformation "base-wide" animals are said to be predisposed to changes on the medial side, with the converse occuring in "base narrow" horses especially if they have a toe-in or toe-out deviation as well one author believes such conformational abnormalities, and therefore a predisposition to ringbone, to be inheritable *(WYN-JONES, 1988).*

The findings of the present work are in agreement with *ADAMS (1987)* who stated that the localization of the osslets may be due to stress on the fibrous portion of the joint capsule. In addition the attachment of the lateral digital extensor, at the dorsolateral surface of the proximal extremity of the proximal phalanx is commonly involved. The exostosis of the proximal phalanx is known as osslets by *MANSMANN and MCALLISTER (1982) and ADAMS (1987).*

The true periarticular high ringbone occupies the area of the insertion of the common digital extensor tendon on the middle phalanx, therefore the exostosis is suggested to be due to sprain of the common digital extensor tendon at its attachment *(WYN-JONES, 1988).*

According to the recent findings, it is considered that the exostosis which lies distal to the caudal border of the articular surface of the distal phalanx or in an area slightly distal to this location may due to the sprain in the distal sesamoidean impar ligament. However, the exostosis on the semilunar line may be due to the stress factor on the deep digital flexor tendon which inserts in the solar aspect of the distal phalanx as stated in horse by *SISSON (1975); SEIFERLE and FREWEIN (1986)* as well as *DYCE* et al., *1(1987).*

The sprain of the collateral ligament of the coffin joint which attach directlly above the side of the dorsal surface of the distal phalanx; area of exostosis; may be the cause of this bony growth.

If the insertion of the common digital extensor tendon is strained or small avulsion fracture may occur a periostitis can result, causing new bone growth and low ringbone *(DUNKIN and DINGWALL, 1971; HAYNES and ADAMS, 1974; RENDANO and GRANT, 1978; RENDANO, 1979 and WYN-JONES, 1988).*

The present results indicate that the percentage of the exostosis varies in the different phalanges depending upon the position of the phalanx and also upon the number of the tendons and ligaments which attach to it. This percentage reaches its maximum (30%) in the proximal phalanx and decreases towards the distal phalanx where it reaches its minimum (17.30%). The high percentage of exostosis in proximal phalanx may be due to the greater compression load on this phalanx in the working donkeys. Moreover the number of the tendons and ligaments which attach the proximal phalanx is more than that attach the other two phalanges. The sprain of the latter structure may cause the exostosis. The low percentage of the exostosis in distal phalanx may be due to its position inside the hoof and its

support by the digital cushion and the cartilage of the distal phalanx. These structures protect the distal phalanx, the tendons as well as ligaments which attach to it.

Finally it is clear that most of the exostosis which were observed in the examined digits are located at or around the area of attachment of the tendons or ligaments. On the other hand, we considered that the wire cuts, direct trauma constant and firm fixation of the animal are the actual causes for the bone exostasis which obsenied from the seat of tendenious and ligamentous attachments on the proximal phalanx. Therefore it is suggested that the sprain or tears of the tendons and ligaments play an important role in the formation of phalangeal exostosis in donkeys.

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Legends:

Fig. (1,2,3): Diagrams for tendenious insertions and ligamentous attachments of the phalanges in donkeys. Dorsal view (fig. 1), Palmar view (fig. 2) and Lateral view (fig. 3).

A-Phalanx proximalis. B - Phalanx media.
C-Phalanx distalis. D - Navicular bone.
1-Area of insertion of common digital extensor tendon.
2-Area of insertion of lateral digital extensor tendon.
3-Area of insertion of superficial digital flexor tendon.
4-Area of insertion of deep digital flexor tendon.
5-Area of attachment of oblique sesamoidean ligament.
6-Area of attachment of cruciate sesamoidean ligament.
7-Area of attachment of short sesamoidean ligament.
8-Area of attachment of central bands of palmar ligament.
9-Area of attachment of distal sesamoidean impar ligament.
10-Area of attachment of lateral collateral ligament of fetlock joint.
11-Area of attachment of collateral sesamoidean ligament.
12-Area of attachment of lateral band of palmar ligament.
13-Area of attachment of lateral collateral ligament of pastern joint.
14-Area of attachment of lateral suspensory navicular ligament.
15-Area of attachment of lateral collateral ligament of coffin joint.

Fig. (4): Palmar surface of the proximal phalanges with bony exostosis at the margins of the rough triangular area.

Fig. (5): Palmar surface of the proximal phalanx with bony exostosis at the middle third of the medial and lateral borders.

Fig. (6): Palmar surface of the proximal phalanx with a large bony exostosis on the distal 2/3 of both lateral and medial borders. N.B. The bony exostosis extended from the lateral aspect downward to cover the level of the pastern joint.

Fig. (7): Dorsal surface of proximal phalanges with bony exostosis on the eminence which present on each side of the distal extremity.

Fig. (8): Dorsal surface of proximal phalanx with a bony exostosis at the medial, dorsal and lateral margins of the distal articular surface in a form of cauliflour.

Fig. (9): Dorsal surface of proximal phalanges with bony exostosis at the proximal extremity.

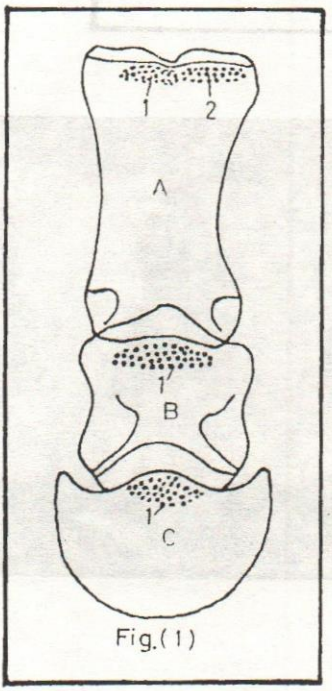
Fig. (10): Dorsal surface of the middle phalanx with bony exostosis located around the depression for the collateral ligament. A) bilateral exostosis (arrows).
B) unilateral exostosis (arrows).

Fig. (11): Palmar surface of the middle phalanx with a bony exostosis at the transverse prominence (arrows).

Fig. (12): Doral surface of two middle phalanges with bony exostosis at the rough area of the dorsal margin of the proximal surface.

Fig. (13): Distal phalanx with unilateral bony exostosis distal to the area of attachment of the collateral ligament and proximal to the dorsal groove (arrow).

Fig. (14): Lateral view of the distal phalanx with bony exostosis at its extensor process.



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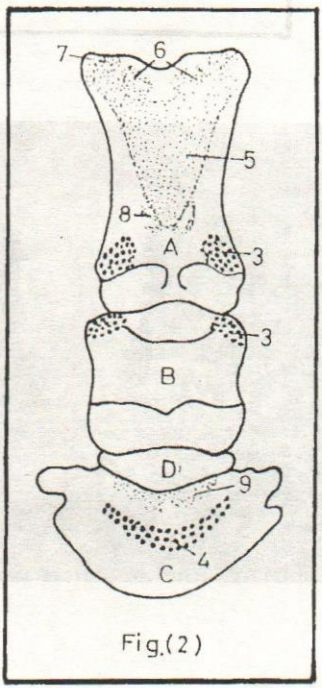

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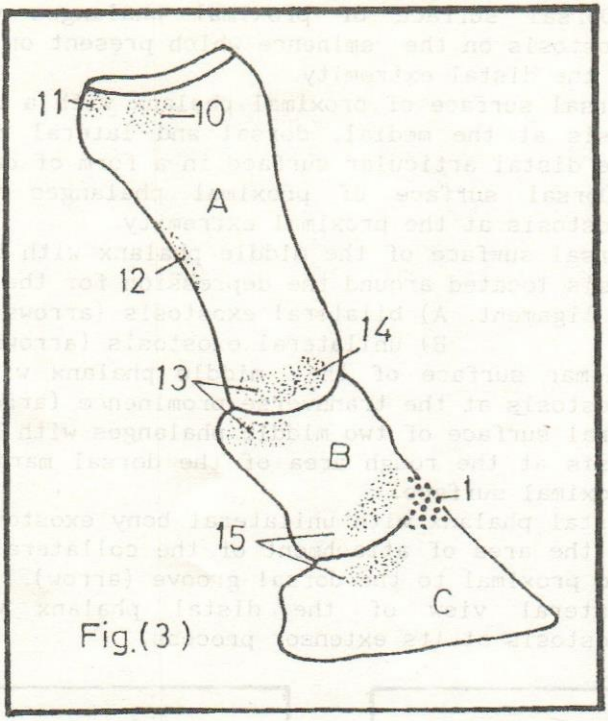

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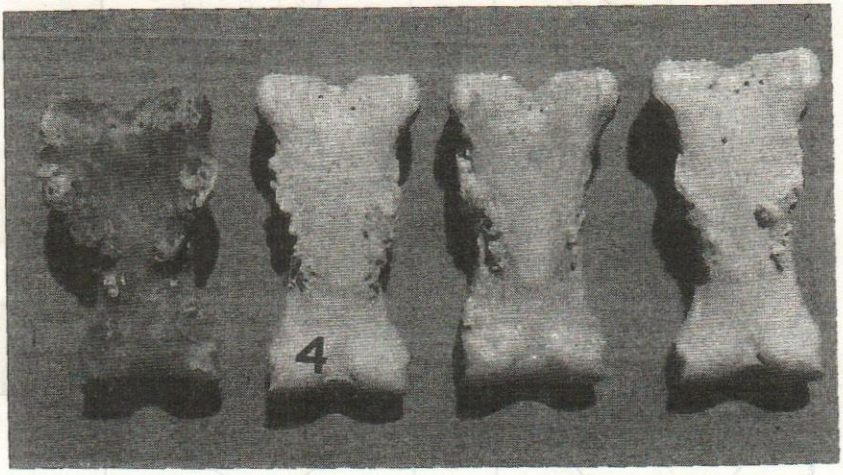

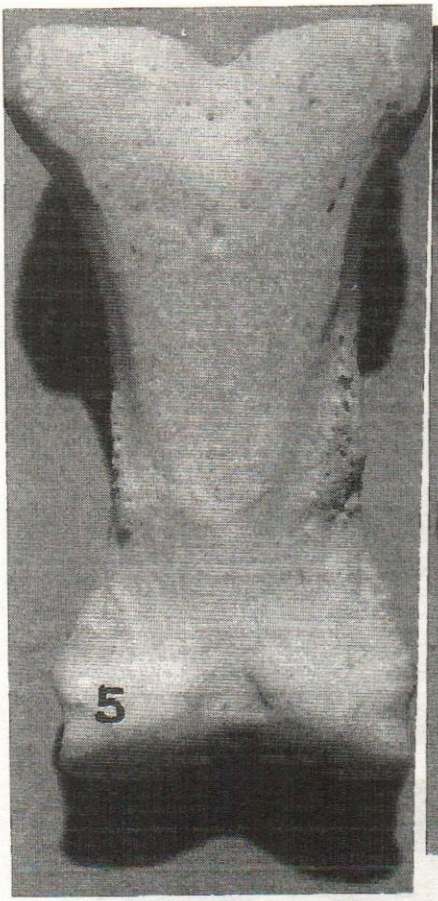
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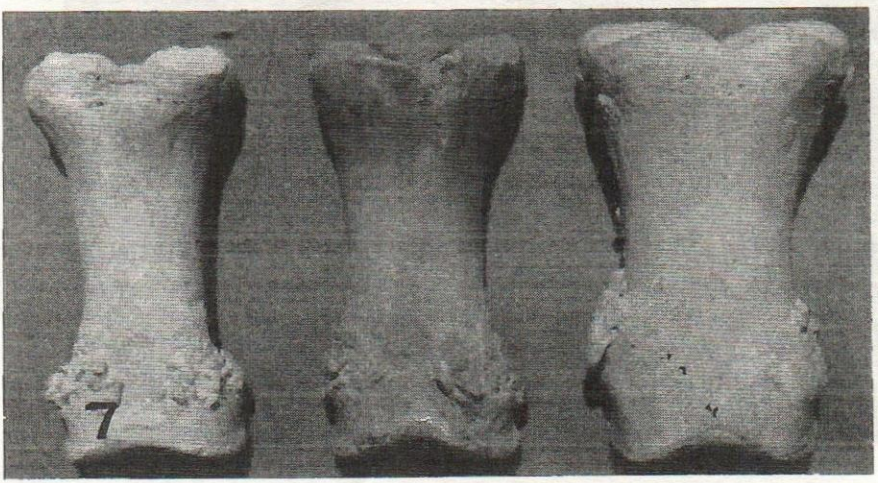
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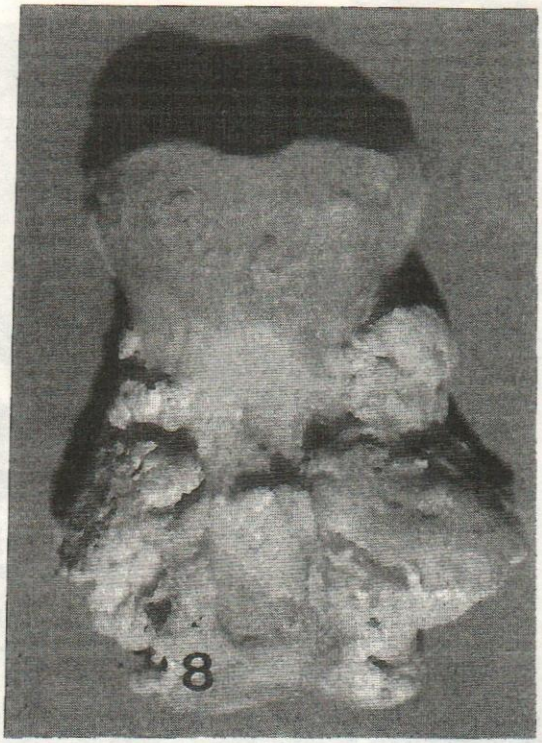
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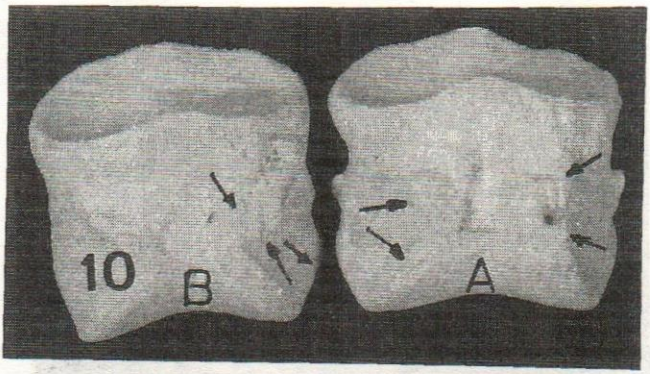
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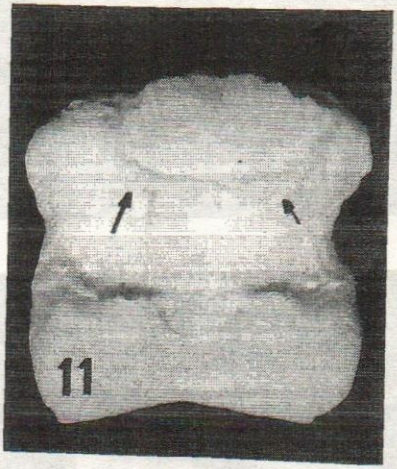
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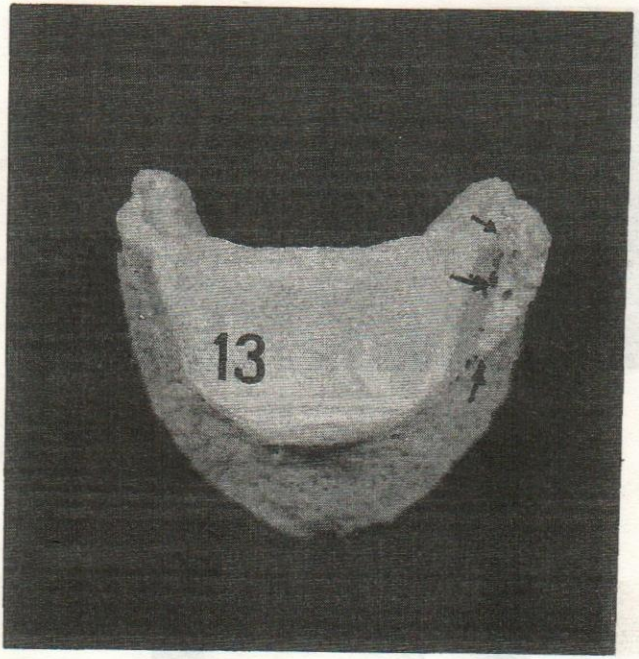
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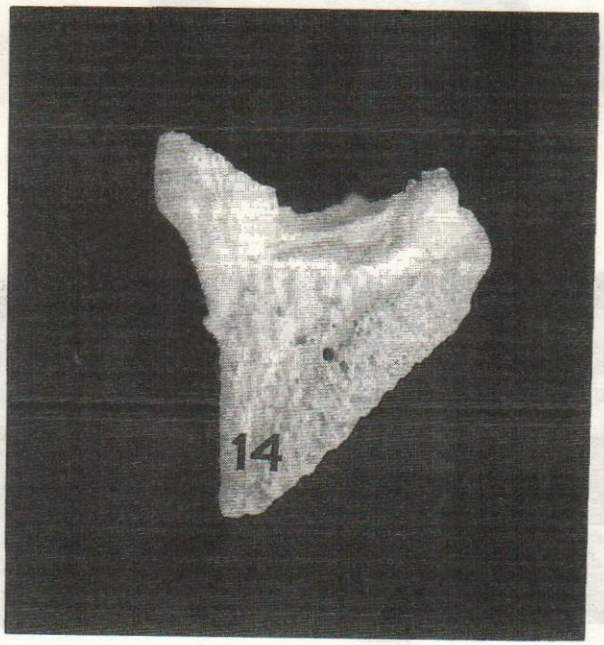
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