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جروح الاوتار القابضة والثامها في الخيول

تيسير سامي ، اسماعيل شعبان ، محمود سامي

تمت هذه الدراسة على تسعة حالات مرضيه أصيبت بحوادث سببت جروح حديثة في الاوتار القابضة في الخيول . ولقد تم اجراء علاج جراحی ناجح لهذه الجروح . كما استعملت مجموعة من ستة حمير لاجراء قطع تجريبي في كل من الوتر القابض والسطحي والغائر لاستبيان عملية الالتئام بعد أسبوعين وأربعة أسابيع من اجراء العملية . ولقد التأم جميع الجروح الحديثة والتجريبيه في اوتار الحيوانات التئاما تاما بالقصد الاول بعد أربعة أسابيع من اجراء العملية .

كما تم اجراء دراسة هستوياثولوجيه لملاحظة الفرق في الالتئام بين الاوتار المقطوعه حد يثا والغير حد يثا .

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Dept. of Surgery,
Faculty of Vet. Med., Zagazig University,
Head of Dept. Prof. Dr. S. EL-Sawaf.

FLEXOR TENDON WOUNDS AND THEIR HEALING IN EQUINES (With 7 Figures)

By
M.T. SAMY, I.A. SHABAAN and M.M. SAMY
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SUMMARY

Nine cases of complete accidentally severed digital flexor tendons in equines were reviewed and discussed. The successful surgical treatment was investigated. A group of 6 donkeys were used for performance of experimental tenotomy of both superficial and deep digital flexor tendons to demonstrate their healing process 2 and 4 weeks post-operation. All recent and the experimentally operated animals survived with good recovery. The healing of the severed flexor tendons and the skin per perimum was studied 4 weeks after the operation. Comparative histopathological observations between recent and contaminated transected tendons were moreover investigated.

INTRODUCTION

Tendon and ligament injuries in equines are not uncommon and they result in great financial loss. Studies have been made of abnormal tendons and their injuries (REED, 1962; ASHEIM, 1964; FRANK, 1970; STROMBERG, 1971; FACKELMANN, 1973; BOLZ *et al.* 1975 and WEBBON, 1977). However, less is known about healing of equine flexor tendons after complete severance in recent and contaminated cases.

The superficial digital flexor tendon (SFT) and the deep digital flexor tendon (DFT) are the continuations of their respective muscles, the heads of which are not easily separable. Their main action is the flexion of the digit and carpus.

The suspensory ligament or muscle interosseus medius is much so modified and contains little muscular tissue being transformed very largely into a strong tendinous band (Tendo interosus) and having for its chief function the supporting of the fetlock joint as part of the "stay apparatus" (SISSON and GROSSMANN, 1953 and ADAMS, 1974).

FORSSELL (1915) described the symptomatology of tendon dehiscence after experimental division of the tendons of the digital flexors individually and in various combinations. The divisions were all in the mid-metacarpus. He found that, the greatest effect seen after cutting one individual tendon, judged relatively by the resultant lack of support to the fetlock joint, was that following section of the SFT. Cutting of the suspensory ligament alone caused only a slight drop in the fetlock, while section of the DFT at this level resulted merely in an inability to "paw" with the toe. The same symptoms were also described by KEOWN (1972) and BOLZ *et al.* (1975) after complete accidental transecting wounds of these structures in horses.

JOHNSON and BARTELS (1972) described the rupture of SFT and DFT as it may involve one or both flexor tendons and recorded that the suspensory ligament may also be torn. If

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only the SFT is involved, the fetlock will drop, while rupture of the DFT has a result that the toe will tip upwardly. In rupture of both, the fetlock will drop and the toe will turn upwardly.

FACKELMANN (1973) recommended a technique of tendon transplantation for treatment of relatively fresh ruptures as well as in some cases of chronically diseased tendons. This was done by autotransplantation of the lateral digital extensor tendon along the entire length of its metacarpal segments to be replaced for the SFT. Histopathologically, the graft was found to be invaded and repopulated by new blood vessels, both of which originated from the surrounding paratendon.

ADAMS (1974) and BOLZ *et al.* (1975) recognized rupture of the DFT following low volar neurectomy for the alleviation of navicular disease in horse, as well as due to accident, severe trauma, over-extension, incoordinated movements or during casting of the animal on the operation table. While WEBBON (1977) recorded that more abnormalities in the flexors of the hind limbs. These were seen relatively infrequently in any type of horse. The ratio of hind to fore limb changes being approximately 7 : 1.

The purpose of this study was to investigate the successful surgical treatment of completely severed flexor tendons in equines as well as to study the healing process in tendon injuries.

MATERIAL and METHODS

Nine cases (2 horses, 2 mules and 5 donkeys) suffering from complete flexor tendon severance were admitted in the last two years to the surgery clinic of the Faculty of Veterinary Medicine, Zagazig University. The lesions were present in 5 hind limbs and 4 fore limbs. Four of these animals were presented to the clinic just after the occurrence of the accident and the other five animals were presented on the second day of the occurrence of the injury. In these animals tendons within their synovial sheaths showed slight necrotic changes. Wounds were present in most animals in the mid-metacarpal and mid-metatarsal area, due to injury with barbed wire, accidents and with farm instruments. Four cases showed complete severance of the SFT with exposure of the digital sheath. The skin wounds were horizontally cut and showed slight haemorrhage. The animals showed a middle degree of continued supporting lameness as well as dropping of the fetlock with decrease of the dorsal angle of the joint. Another 4 cases were with complete severance of both SFT and DFT and showed beside the local wound symptoms, severe haemorrhage, sagging of the fetlock more than in the above cases, instability of the toe and the foot remained flat on the ground. In one case, in which the suspensory ligament was also ruptured together with both SFT and DFT, the toe was turned upward. In two cases the carpal synovial sheath was opened and in one case the digital synovial sheath was injured; these conditions were accompanied with escape of synovial fluid (Fig. 1).

To investigate the healing process of the flexor tendons, a group of 6 donkeys were operated after performance of experimental tenotomy of both SFT and DFT in either one fore or one hind limb. The animals were classified into two groups each of 3 according to the time of condemnation and taking the specimens for histopathological examination.

SURGICAL PROCEDURES

Each animal was tranquilized with intravenous injection of Combelen (Bayer) and casted on the operation table in lateral recumbancy under the control of chloral hydrate anaesthesia

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which was continued with intravenous injection of sodium pentobarbital for deepening and maintaining the surgical plane of anaesthesia. The site of the operation was surgically prepared and a longitudinal skin incision (10 cm. long) was made at the middle of the limb and just behind the flexor tendons. One the experimental animals both the SFT and DFT were transversally transected with a tenotome. In the clinical cases, the ruptured blood vessels were ligated, the wound was thoroughly cleaned with normal saline solution. In the contaminated old cases, the skin wound with the ruptured ligaments were thoroughly cleaned and freshed as well as partially widened with a scalpel. In all animals, the skin was prepared from the underlying tissues. The ruptured ends of the tendons were freely prepared and sutured together by the Bunnell-Mayer tendon stitches using Dexon* number 4. The tendon sheath was then sutured with simple continuous suture using fine catgut number 0. The skin and subcutaneous tissue were then sutured with simple interrupted sutures using silk number 3. The whole limb from the carpal or hock joint including the hoof was bandaged with soft padding and a plaster of paris bandage was applied. A post-operative course of antibiotics was given. On the 7th day after the operation, the skin sutures were removed. The wound healing and the tendon thickness was looked upon and the limb was replastered for another 3 weeks and the animals were put in a convalescence period for about 2 weeks.

The experimentally operated animals were condemned 15 and 30 days post-operatively. Three cases with old contaminated tendons were condemned 5-7 weeks after the operation. The sutured tendons were surgically exposed and removed. Their thickness, the condition of the tendon healing and the suture materials were looked upon. Specimens were taken at the suture line and fixed in 10% neutral buffer formaline solution. Thin sections of five microns thickness were cut longitudinally and stained by haematoxylin and eosin for general microscopic examination.

RESULTS

The results of the sutured flexor tendons healing in all animals except 3 cases (1 horse and 2 donkeys) of the 5 cases with old wounds, proved to be satisfactory. All recent and experimentally operated animals survived with good recovery and healing of the severed flexor tendons and skin wounds by primary union was found 4 weeks post-operatively.

Macroscopically, there was slight to moderate thickening (Fig. 2) with tenderness of the operated flexor tendons in comparison with those of the other side 7 days post-operatively. These returned nearly to their normal thickness within 8 weeks after the operation. The animals firstly showed slight degree of lameness which disappeared within 2-3 weeks post-operation. The tendons were moderately thickened and lameness persisted for a longer period. In the other 3 animals the tendons were severely thickened to reach their double thickness and showed severe tenderness with pain. The healing processes were greatly retarded with the formation of unhealthy granulation tissue (Fig. 3). These animals showed severe degree of supporting lameness.

The Dexon suture material was macroscopically still present in all the experimentally operated animals 15 days post-operatively, while it disappeared after 4 weeks. In the second group, the skin was no longer separated readily from the underlying flexor tendons so that the leg is more or less thickened from the carpus or hock to the fetlock and the individual structures cannot be differentiated by palpation.

* Dexon B. Braun-Dexon GmbH Melsungen.

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Histopathologically, the experimentally operated animals showed 15 days post-operatively in one specimen small focal areas of haemorrhage which separated the tendon fibers from each others. Rounded and stellate fibroblasts with large nuclei invaded the peritendon and the area of haemorrhage with beginning of organization. The capillaries around the cut tendon ends had wide diameter and surrounded by tenoblasts and some macrophages. At the cut margin, the collagen fibers were acidophilic and swollen. Inbetween, there was newly formed wavy bundles of collagen. At the edges of the cut tendon, organization with young granulation tissue and newly formed wavy collagen bundles with tenocytes can be well seen (Fig. 4). In the other specimens, the number of tenocytes was less, while the wavy appearance of somewhat bluish newly-formed collagen was predominant. Degenerated collagen appeared as compressed acidophilic fibers between the newly-formed capillaries and very large number of tenocytes. The zone of connection appeared wavy and rich in tenocytes. Dixon suture material was still present in this stage as a faintly stained basophilic material surrounded by a zone of reaction mainly neutrophils and macrophages.

At the end of one month after the operation, the tendon appeared with the usual orientation of wavy bundles of collagen. Degeneration of collagen appeared but to mild degree. The number of tenocytes was reduced, while the capillaries were of normal diameter. Dexon suture material appeared at this stage as a remnants.

In the old contaminated tendons, the reaction was more severe with marked vascular changes and perivascular infiltration of large number of neutrophils (Fig. 6). Degenerated collagen fibers were swollen acidophilic with structurless appearance, while newly formed collagen was not observed. The capillaries were widely dilated. The tendon sheath was markedly thickened while tenocytes and neutrophils were found underneath invading the tendon (Fig. 7). The connection zone contained clotted blood, dead neutrophils, degenerated collagen fibers and tenocytes. In some areas wavy bundles of newly formed collagen were present. The orientation of the bundles was haphazardly distributed. The organized tissue was nearly replaced by scar tissue with newly-formed wavy collagen surrounding it. Dixon suture material appeared in some cases as remnants.

DISCUSSION

A single tendon, both flexor tendons and sometimes the suspensory ligament as well may be partially or completely severed. When only one tendon is involved, it is usually the superficial one. Wounds located in the mid-metacarpal or mid-metatarsal area do not involve synovial sheaths. Above this point, the carpal synovial sheath may be entered and near the fetlock the digital synovial sheath may be opened. The prognosis of accidental wounds of the flexor tendons depends on a number of factors including the extent and severity of injury, the absence or presence of infection and the degree of damage to blood and nerve supply. A wound that severs the SFT only is less serious than when both flexor tendons are cut or when the suspensory ligament in addition to flexors are severed as indicated in our results. A very poor prognosis was indicated when all three structures were severed; a long period of treatment was required and permanent lameness was anticipated. The results emphasized healing by first intention in all recently severed tendons. It is not advisable to deal with cases of old tendon wounds especially those in horses. Trials can be made for freshment of suspicious or contaminated tendon wounds in donkeys and mules, as they are susceptible to some extent to wound infection. This was ensured in two cases. Generally, it was found that the tendon healing was completed 4 weeks post-operatively, similar results were also reported by KEOWN (1972) and BOLZ *et al.* (1975).

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The symptoms observed were generally the same as described by FORSSELL (1915), KEOWN (1972) and BOLZ *et al.* (1975). Complete rupture of the flexor tendons leads to loss of support of the fetlock joint. FORSSELL (1915) demonstrated the greatest lack of support to the fetlock occurring after cutting the SFT, but it was manifested from our observations that this occurred after severance of the suspensory ligament. This was also supported by KEOWN (1972).

KEOWN (1972) and BOLZ *et al.* (1975) emphasized the difficulty of suturing transected tendons. The first author mentioned that in most cases the tendon heal without suturing by granulation tissue formation. The technique described in this investigation proved the easy suturing of the two severed tendon-ends after partial flexion of the fetlock joint. Also Dexon proved to be a strong absorbable suture material without causing any reaction or side effects, provided that the operated limb must be protected by a plaster cast for 4 weeks.

Histopathologically, both recent and old flexor tendon wounds started healing process at the same time. There were post-operative haemorrhage, oedema and leukocytic infiltration. These results coincided with those of BUCK (1953), ARNER *et al.* (1959) and ASHEIM (1964). Tenocytes derived from the peritenon or as differentiated primitive mesenchymal cells were observed, similar results were also found by BUCK (1953). The histological picture in old injured tendons showed increased number of neutrophiles and macrophages, the blood capillaries were severely dilated with perivascular infiltration and oedema rich in plasma protein separating the collagen bundles which delayed healing.

From the above mentioned results, one could state that about one month after operation complete healing of recent tendon-wounds occurred, while the old wounds were still not in complete healing with areas of suppuration.

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Fig. (1): A hind limb of a donkey with complete accidentally transected SFT and DFT.

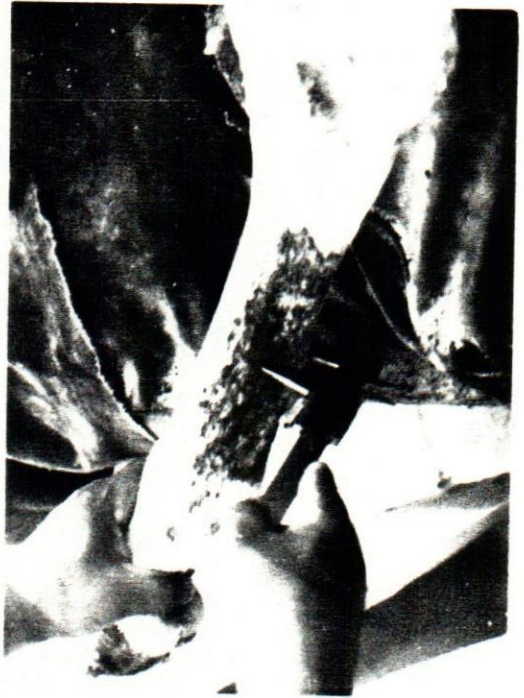


Fig. (2): A hind limb of a donkey 7 days post-operatively showing moderate thickening of the flexor tendons.



Fig. (3): A hind limb of a horse with old contaminated wound of the flexor tendons both SFT & DFT showing unhealthy hypergranulation tissue formation.



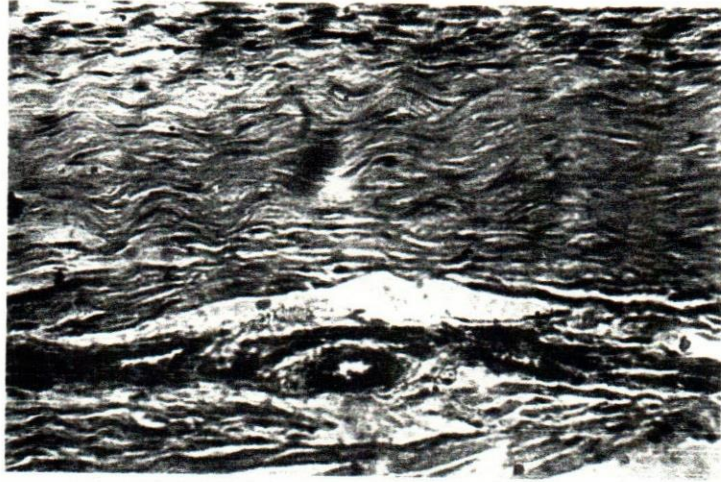


Fig. (4): Newly formed wavy bundles. Complete healing of recently severed tendon 15 days post-operatively.
H. & E. X 200

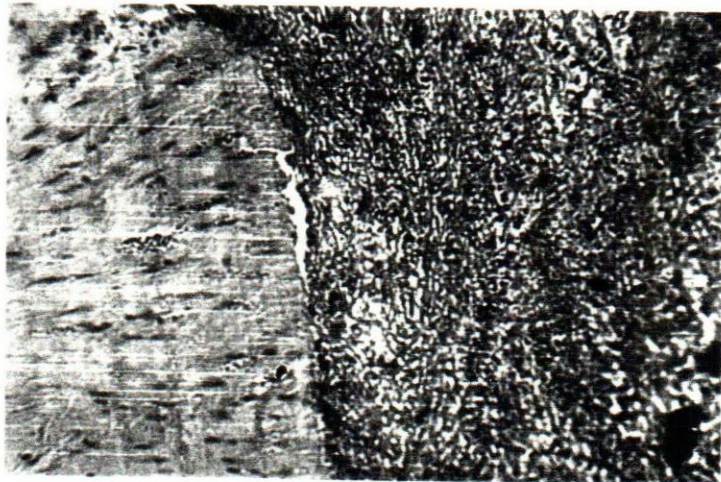
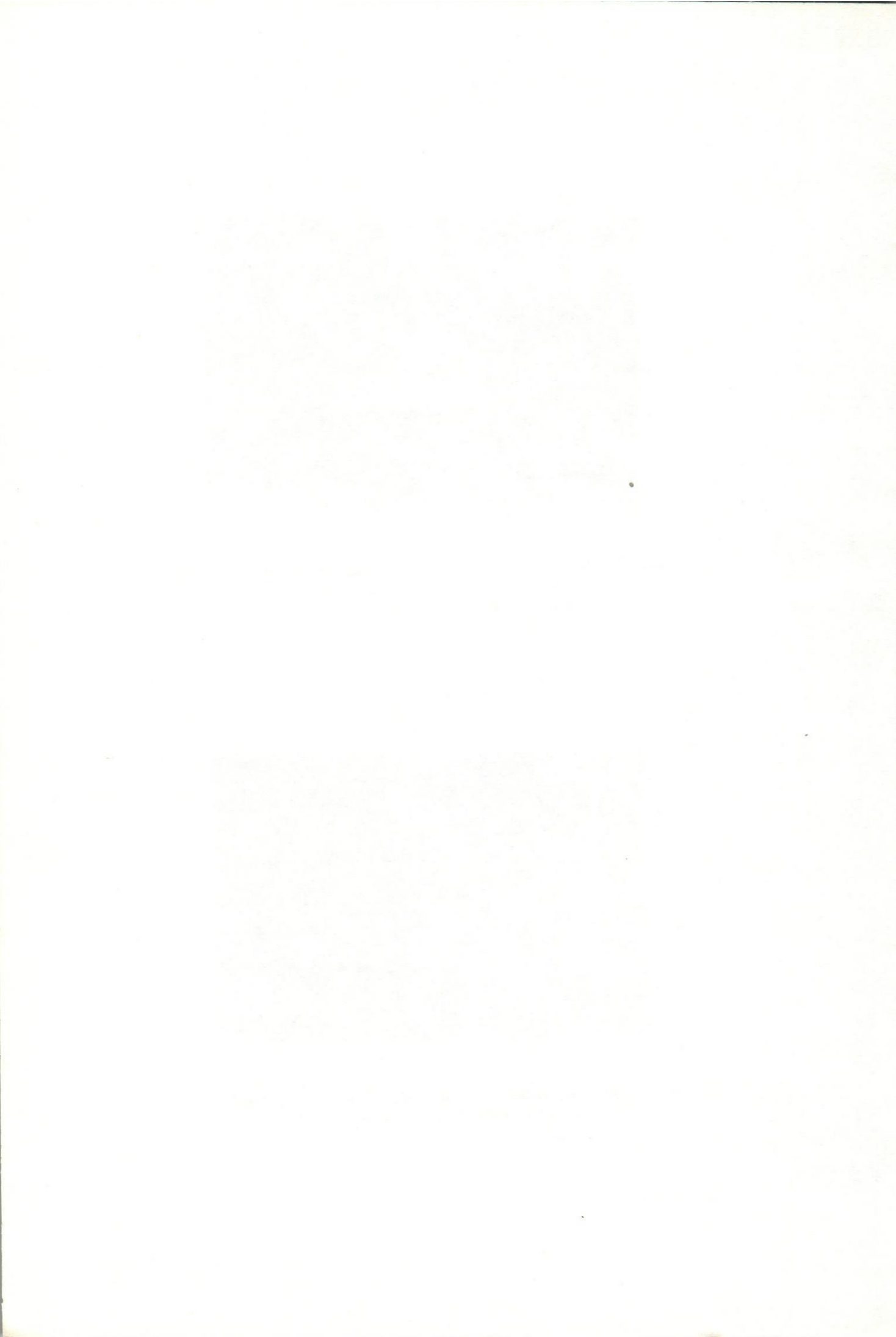


Fig. (5): Vascularisation of the clotted blood (early organization) in a recent tendon wound 15 days post-operation.
H. & E. X 200



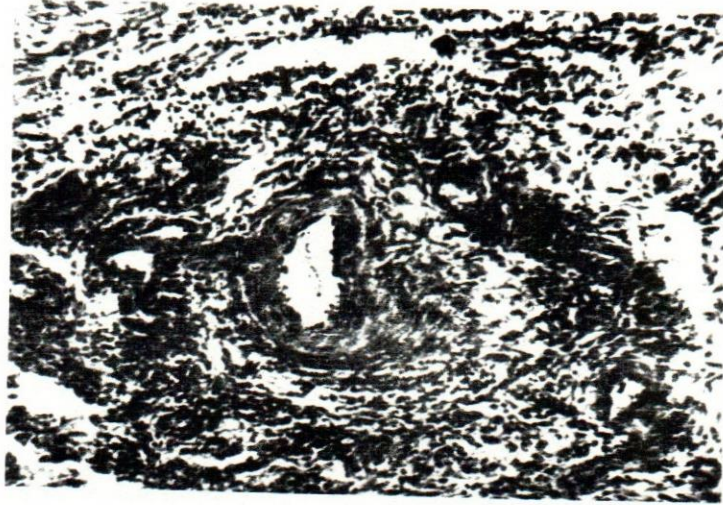


Fig. (6): Old contaminated wound, notice thickening of the blood vessel wall with periceptitation of acidophilic materials and perivascular infiltration.
H. & E. X 200



Fig. (7): Old contaminated tendon wound, notice infiltration of tendon fibers with inflammatory cells.
H. & E. X 200

