

TRAUMATIC ISCHAEMIC MUSCULAR NECROSIS

By

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Ischaemic muscular necrosis due to overstrain was first described by *Severin* (1943) and *Vogt* (1943) and has thus been known for only a relatively short time. The first cases reported were localized in the m. tibialis anterior and the extensor group of the lower leg; consequently, nearly all cases published afterwards have been of this localization. However, it would seem strange if the disease did not involve other groups of muscles. Of 22 cases on record, two did certainly involve the m. peronei, but yet only the muscles on the anterior and lateral aspects of the leg. The explanation may be that this localization of the lesion is known, whereas in the presence of an analogous lesion elsewhere the possibility of ischaemic muscular necrosis is not borne in mind.

In this hospital, we have encountered a case involving the flexor group of muscles of the right lower leg.

CASE REPORT

The patient (1218/58) was a timber-yard worker, aged 57, whose past history was essentially that of good health. For many years, he had had varicose veins on both lower limbs, but these had not caused any particular discomfort. Four days before admission, he was engaged in piling timber. He was standing on a ladder between two stacks of boards, passing on boards to one of his fellow workers. He wore rubber boots, through which the rung of the ladder pressed hard against the arch of the foot. Owing to the narrow passage between the stacks, his freedom of movement was very limited, so that it was difficult for him to change the position of the feet during the work, which continued for most of the day.

The next morning (second day), he noticed a sensation of heaviness in the right foot and leg, later in the day followed by paraesthesiae of the calf muscles. He consulted his doctor and was instructed to exercise the leg, for which reason he walked about in the rooms at home; nevertheless numbness of the foot developed, but it was not accompanied by discolouration of the skin of the foot or leg.

On the third day, the tingling sensation in the foot and leg persisted, still unaccompanied by skin changes. He saw his doctor, who again recommended exercise of the leg, but now it was difficult for the patient to walk. *Only the forefoot could come into contact with the ground*, whereas the heel remained raised. Attempts at lowering the heel caused pain in the tendon of Achilles radiating to the muscles of the calf.

On the fourth day, incipient bluish discolouration of the toes and, possibly, the forefoot had developed. The patient sent for the doctor, who at once referred him to hospital for treatment.

Physical examination on admission (Jan. 3, 1958) revealed a patient, whose appearance corresponded to his age. Temperature and pulse were normal, and anoculation of the heart and lungs showed no abnormalities.

Apart from scattered varicose veins, the left lower limb was normal.

The right lower limb showed large varicose veins. The distal part of the leg was slightly cyanotic, and the cyanosis increased in severity on the foot, which showed moderate oedematous swelling, but was warm to the touch just as the left foot.—Pulsation of the dorsalis pedis artery was palpable. The toes could be moved, although to a smaller extent than on the left side. Anaesthesia of the entire foot up to the malleoli was noted, but, unfortunately, not described in greater detail. The hospital record does not contain any remarks on the calf muscles.

Jan. 4.—The discolouration of the skin of the leg and the proximal part of the foot had decreased, whereas the forefoot and the toes were darkly cyanotic, but the skin was warm to the touch.

Jan. 6.—A line of demarcation of the darkly cyanotic discolouration running at the bases of the toes dorsally and a little more proximally on the plantar surface was noticed.

Jan. 10.—An ill-defined hard infiltration was palpated on the posterior aspect of the leg; it extended from the mid-leg distally below the tendon of Achilles. It seemed deeply embedded in the musculature at the distal part of the belly of the soleus. The pulsation of the dorsalis pedis artery just over the instep was described as "strikingly vigorous."

Jan. 12.—Well-defined gangrene of the toes had developed (Fig. 1).

Jan. 22.—Incision over the infiltration of the soleus was performed. The exposed soleus revealed a firm discoloured muscular tissue (resembling boiled meat). A large incision into the aponeurosis was made, and the affected tissue removed.

Histologist's report.—The muscular tissue examined shows normal structure with retained striation, but marked oedema and hyperaemia are present. In other areas, the muscular tissue is broken up by a proliferating, markedly vascularized connective tissue with many nuclei and remnants of muscle cells and a large number of giant muscle cells. This connective tissue shows ample deposits of blood pigment, showing evidence of a previous bleeding, and some infiltration with lymphocytes and plasma cells. Most of the vessels are blood-filled, but a few small arteries show proliferation of the intima and media, which must be considered a secondary change. No specific structures are present. Thus, the tissue studied shows changes which must be assumed to be sequelae of ischaemic necrosis (Dr. Sv. Petri).

Feb. 3.—Some pus was evacuated from the wound on the leg, which then healed rapidly.

Special examinations.—Haemoglobin level 95 %; blood pressure 140/90; the urine

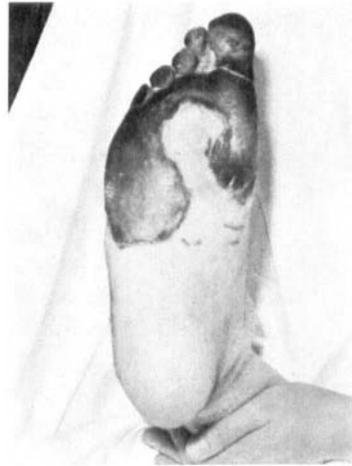


Fig. 1.

was negative for albumin and sugar; fasting blood sugar 108 mg%; ECG normal. Chest radiographs showed no abnormalities. Oscillometry showed satisfactory deflexions, equal on both sides. There was no difference in the skin temperature of the right and left legs down to the forefeet.

Feb. 8.—Arteriography, which was technically imperfect, showed a questionable small narrowing of the femoral artery in the adductor canal, good filling of the popliteal artery, which revealed a small aneurysm, and good filling of the proximal parts of the anterior and posterior tibial arteries, whereas the conditions in the lower half of the leg could not be assessed.

March 13.—Amputation of the right foot (*Lisfranc*) was performed. Fresh arterial bleeding was noticed in several places of the cut tissues, but the plantar artery was occluded by a thrombus. The skin was viable for primary closure.

Dissection of the amputated forefoot revealed a hard organized thrombus in the lateral plantar artery continuing into the plantar arch and through the first interstitial space to the dorsal aspect of the foot (*dorsalis pedis* artery). The anatomical conditions could not be followed further because of the previous surgical dissection for the formation of a suitable skin flap to cover the stump.

Histological examination showed a large arterial branch, which contained blood and, especially, a relatively fresh thrombus with moderate organization progressing from the periphery. Between the lumen and the markedly narrowed, or sometimes completely absent, tunica media, which was otherwise of normal structure, there was an irregular, dense, granular, fibrillated zone of tissue of low stainability, which represented the proliferated intima and lamina elastica interna, presumably in incipient necrosis. There were no deposits of lipoids, no distinct calcifications of the tunica media, and no inflammatory changes. Thus, the changes observed were of a fairly peculiar proliferative nature, suggesting incipient necrosis of the inner coat of the large arterial branch, fresh thrombosis and chronic periarterial inflammation. The vascular changes were not characteristic of arteriosclerosis, calcification of the tunica media or arteritis (Dr. Sv. Petri).

Primary wound healing occurred. After slow re-education of the muscles, the patient was discharged on April 19, 1958, using a walking stick and ordinary footwear.

Follow-up examination in August 1958 showed relatively good mobility of the ankle joint. The linear amputation scar showed good healing, with solid skin covering the stump. The skin colour was normal without cyanosis or other discolourations, and there were no other signs of circulatory disturbances.

It is reasonable to ask the question how ischaemic muscular necrosis due to overstrain develops. The opinion has occasionally been expressed that it is referable to infection, probably because the cases observed have been accompanied by fever. However, most authors hold the view that the disease is due to reactions of the muscular tissue to exhaustion, by which tissue fluid accumulates in muscle cells and connective tissue; at the same time small haemorrhages are caused by rupture of muscle fibres. This gives rise to an intramuscular pressure; if the muscle is compressed by a strong fascia, this pressure may exceed that of the artery or arteriole supplying the muscle, which results in ischaemia. That the symptoms usually do not develop until after the end of the work when the person comes to rest may be explained by the fact that the "muscle pump" is no longer in action.

Unfortunately, the true nature of the present case was not recognized until at a late phase of the disease, partly because the condition was first interpreted as incipient peripheral gangrene on a purely vascular basis, and partly because the past history was at first incomplete; the detailed history reported above was not secured until after the histological examination of the biopsy specimen.

The serious course of the disease with gangrene of the forefoot was due to thrombosis of the posterior tibial artery caused by compression of the vessels and nerves situated between the superficial and deep layers of the muscles of the calf. This also explains the sensory disturbances experienced by the patient during the first day. Tissue reactions in and around the m. soleus due to the necrosis may have accelerated the thrombosis.

As already pointed out, cases of ischaemic muscular necrosis outside the muscle groups on the anterior and lateral aspects of the leg have not previously been reported. However, *T. Andersen* (1955) described a case involving the m. pectoralis and serratus, but he expressed the view that this case was due to septic venous thrombosis (caused by a trauma) in analogy with thrombosis of the axillary vein. Judging from the description, his case may just as well have been one of ischaemic

muscular necrosis due to overstrain. It is therefore unfortunate that *Blandy & Fuller* (1957) recommended the introduction of the term 'march gangrene', because this may divert the attention from the involvement of other muscle groups.

Finally, it must be emphasized that acute traumatic venous thrombosis, acute traumatic arterial thrombosis and ischaemic muscular necrosis have so many features in common both with regard to aetiology and pathogenesis and in their patho-anatomical and clinical manifestations that, in future studies, it would surely be more fruitful to regard these conditions as varieties of the same disease entity instead of as three distinctly separate diseases.

The treatment consists in palliative incision as early as possible. In the present case, gangrene might have been prevented if the patient had been subjected to operation during the first, or perhaps the second, day.—Lumbar sympathetic block and arteriectomy (as in Volkmann's ischaemic paralysis) have also been recommended.

SUMMARY

A case of traumatic ischaemic muscular necrosis localized in the m. soleus is reported.

RESUME

Description d'un cas de nécrose musculaire ischémique traumatique, localisée dans le muscle soléaire.

ZUSAMMENFASSUNG

Ein Fall von traumatischer ischämischer Nekrose des m. soleus wird berichtet.

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KAOKO O. KETTUNEN: Skin Arthroplasty in the light of Animal Experiments with special reference to Functional Metaplasia of Connective Tissue.

Acta Orthop. Scand. Suppl. No. XXIX, 75 Pages, 41 Ill.

Ejnar Munksgaard, Copenhagen 1958

(Author's Abstract)

The purpose of the animal experiments carried out was to elucidate the changes which take place in an autogenous full-thickness skin graft when used as interposition material in arthroplasties in the hip joint of cats.

Thirty-seven adult cats in all were used for the experiments, on 30 of which, comprising the experimental series, a skin interposition arthroplasty was made in the left hip joint. In the operation the joint cartilage of the acetabulum was removed and a full-thickness skin graft was inserted into the acetabulum so that the epidermis faced the freshened articular surface. The control series consisted of seven cats subjected to the same operation as was carried out in the experimental series, but without interposition. The periods of observation ranged between the 7th and 240 days from the operation.

The joints operated upon were under observation macroscopically and by roentgenography. The fate of the interposition material was studied by histological, histochemical and historadiographical examinations.

The results obtained in the experiments may briefly be summed up as follows:

In the control series, in which no skin interposition was used, the articular surface mainly consisted of naked bone surface. Roentgenographically the articular space in the joint operated upon had either narrowed or partly disappeared. Microscopy showed that the granulation tissue growing from the freshened articular surface became destroyed through the effect of articular weight and function that the new connective tissue was only preserved in areas where the articular weight was slight. Under the influence of loading and function the preserved connective tissue underwent metaplastic development into cartilage. Yet the cartilage formed no continuous extensive layer to replace the articular cartilage but occurred in the form of small islets in hollows of the uneven articular surface.

In the experimental series the autogenous full-thickness skin graft

proved a very suitable material for interposition in arthroplasties. The organism tolerated the full-thickness skin graft as interposition material in the joint very well. During the two first months of observation the graft was still distinguishable. In the course of the third month of observation the interposition material was transformed into tissue which macroscopically had the appearance of cartilage; the articular surface became covered by a thin continuous layer of cartilage. The inserted skin exhibited a good vitality and tolerated the loading due to the joint well. Both macroscopically and in x-ray films the skin arthroplasty joint exhibited a development to a joint with functionally highly valuable characteristics.

Microscopically the epidermis of the skin graft was seen to degenerate owing to wear and tear of the joint and no epithelial cysts formed.

From the freshened articular surface of the acetabulum granulation tissue grew between the graft and the bone surface. The new connective tissue also replaced the disintegrating islets of epidermal cells and the degenerating subcutaneous fatty tissue. Both in the cutis and in the new connective tissue the fibrils line up parallel with the outline of the articular surface owing to the weight of the joint, during the two first months of observation. At the beginning of the third month a process of cartilaginous metaplasia manifests itself in the connective tissue used as interposition material. The metaplasia begins and reaches its most advanced stage in the weight-bearing area of the joint. At the initial stage of the process the ground substance of the connective tissue increases, the collagenous fibres break up into thin undulating fibrils which seem to disappear into the ground substance. At the same time slightly differentiated connective tissue cells may be seen in the increased ground substance, gradually transforming themselves into cartilage cells. The cartilage resulting from the metaplastic development is histologically of either fibrous or hyaline type. In the absence of loading and function of the joint no cartilaginous metaplasia takes place.

In the course of the metaplasia both metachromasia and the P.A.S. positive material increase in the ground substance. The substance staining metachromatically which was decomposed by the testicular hyaluronidase enzyme, is chondroitin sulphate A. The P.A.S. positive material was resistant to testicular hyaluronidase and malt diastase and very likely is one of the neutral mucopolysaccharides.

In historadiography the mass of the normal connective tissue mainly localizes in tissular fibrils while considerably less of ground substance

mass is seen. In the connective tissue undergoing metaplasia homogenization of the distribution of the mass was apparent. This may be accounted for, on the one hand, by the increase in the mass of the ground substance, on the other by the breaking up and merging with the ground substance of the mass of the connective tissue fibrils.

The new metaplastic cartilage showed no appreciable tendency to ossification.

The authors concludes that the autogenous whole-thickness skin graft with subcutaneous fatty tissue is eminently suitable as interposition material. The epidermis of the skin is destroyed by the weight and function of the joint and the connective tissue acting as interposition material undergoes functional metaplastic development into cartilage. If no interposition material is used, articular weight and function tend to destroy the granulation tissue growing from the freshened articular surface so that in these cases the articular surface consists of naked bone.

ERKKI KALLIO: Skin Arthroplasty of the Hip Joint and Corresponding Alloplastic Methods in the Light of a Clinical Study.

Acta Orthop. Scand. Suppl. No. XXX, 99 Pages, 38 Ill.

Ejnar Munksgaard, Copenhagen 1958

(Author's Abstract)

The object of this work was to investigate the results obtained with a new method of arthroplasty in which whole-thickness skin with fatty tissue is used as interposition material, and which has been developed in the Orthopaedic Clinic of the University of Helsinki. Follow-up examinations were simultaneously made of the patients on whom alloplastic hip arthroplasty had previously been performed in the Clinic. Since furthermore nearly all the operations had been performed by the same surgeon, this provided a good opportunity to compare the results of the recent skin arthroplasties with those of the earlier vitallium cup and endoprosthesis arthroplasties.

After a survey of the literature on arthroplasties the writer reviews the publications dealing with the use of skin for this purpose. Skin was used already earlier as an interposition material in arthroplasties but the data on these isolated cases is limited almost to brief references only. Following a chapter describing the statics and mechanics of the

hip joint the writer gives a report of his investigation. The series studied comprised all the hip arthroplasties performed in the Clinic during 7 years. In this period 171 arthroplasties were made on 163 patients, 103 of whom were women and 60 men. The oldest patient was 77 years and the youngest 12 years of age. The same surgeon performed 158 of the operations and the remaining 13 operations were made by four surgeons. The cases were distributed according to the type of arthroplasty as follows: 35 cases of vitallium cup arthroplasty, 83 cases of endoprosthesis arthroplasty, and 53 cases of skin arthroplasty. In 160 cases the indication of the operation was osteoarthritis, which in 84 cases was primary and in 76 cases secondary.

The follow-up examinations of these patients were made from 7 years to 1 year after the operation. A total of 94 per cent of the patients answered a questionnaire sent to them by the writer, and in addition 83 per cent arrived for a personal follow-up examination. The mean length of postoperative hospital treatment in the total series of 171 arthroplasties varied from 5 to 6 weeks in the three arthroplasty groups. The least number of complications during this period occurred in the patients with skin arthroplasty, in whom the incidence was 11.3 per cent. There was no case of infection in this group. The endoprosthesis group included the only fatal case in the series, in which thromboembolism caused the patient's death 3 weeks after operation. Postoperative complications occurred in 15.6 per cent of the patients in this group, whereas in the vitallium cup arthroplasty group they occurred in 22.8 per cent.

Independent of the method of operation used, two-thirds of the patients stated that they were either satisfied or very satisfied with the result. An affirmative reply to the question whether the new joint felt natural was given by 81 per cent of the 52 patients with skin arthroplasty, 60 per cent of the 75 patients with an endoprosthesis and 44 per cent of the 34 patients with a vitallium cup who replied to the questionnaire. Work had been resumed on the average 6 months after operation. Nearly all the patients had resumed their previous occupation, a few young patients had learned a new occupation, and some of the older patients were pensioned.

Absence or definite relief of the preoperative pain was reported by 62 per cent of the skin arthroplasty group, 65 per cent of the vitallium cup group, and 87 per cent of the endoprosthesis group. The mobility of the hip joint was studied in the light of Gade's mobility index figures. Approximately the same mobility value was found in the three groups of

patients at the follow-up examination independent of the preoperative mobility of the joint. In cases in which the hip before operation had been quite stiff it was after operation as mobile as the hips which initially had better movement. In the latter cases the mobility had not notably increased. The movements of the hip joint when the patient began weight-bearing improved slightly in the course of one year but then remained practically unchanged. The increase in the mobility was very similar in the three types of arthroplasty, the initial mobility being about doubled. The increase was 24.7 in the skin arthroplasty group, expressed in Gade's mobility index figures, 22.7 in the vitallium cup group, and 25.9 in the endoprosthesis group. Trendelenburg's symptom was positive at the follow-up examination in only 6 per cent of the patients.

In the patients with skin arthroplasty no new osteophyte formation was seen in the femoral head, and in only 4 cases they had developed on the rim of the acetabulum. After vitallium cup and endoprosthesis arthroplasties there was marked formation of osteophytes. In about every fifth patient with skin arthroplasty the joint space had become more distinct during the first year after operation. It is regarded as possible that also on man the skin under favourable conditions may, due to function, develop into metaplastic cartilage, as has been shown by Kettunen in animal experiments in our Clinic. It was an interesting observation that a control roentgenogram in which the hip joint appeared unfavourable did not always signify an unsuccessful arthroplasty. Clinical experience definitely indicates that whole-thickness skin may safely be used as interposition material and that there is every reason to develop arthroplasty further on this biological basis. However, the interposition material as such is only one of many factors influencing the results of an arthroplasty.