

VASCULAR PROBLEMS IN ORTHOPAEDIC SURGERY

By

B. EJERUP and T. HIERTONN

In the same way that the surgery of protruded intervertebral discs has radically changed the treatment and research pertaining to sciatica, so has modern vascular surgery given new aspects to injuries and diseases of the peripheral arteries, from both a clinical and research point of view. The aging and degeneration of the arterial walls can not yet be influenced therapeutically, but complications such as thrombosis, aneurysms and arteriovenous fistulae are often suitable for surgical reparation. The previous pessimistic outlook on arteriosclerosis has been replaced by a more optimistic and active attitude.

During the 10 year period that we at Norrbackainstitutet have been engaged in peripheral vascular surgery, a fascinating development in this field of endeavour has taken place throughout the whole world.

Our laboratory for peripheral vascular diseases gives us a firm basis for the team-work which was shown to be necessary.

Even if the typical arteriosclerotic cases dominate, there are a good many other "orthopaedic cases" in which assessment of the state of the circulation is essential for exact diagnosis and therapy. It is not unusual for chronic occlusive disease at the aortic bifurcation or in the iliac arteries to form basis of pain in the back and hip region, and the symptoms are misinterpreted as lumbago or osteoarthritis. Some vascular cases are also hidden among so-called foot insufficiencies. A detailed history of the pain, and simple palpation of the pulses should in the first place, give valuable information about the arterial blockage and its location.

It can be more difficult to arrive at a correct conclusion with certain congenital vascular abnormalities with local or widespread hypertrophy of one extremity and a difference in leg length. Chronic leg ulcers and chronic swelling of the legs are another field where the

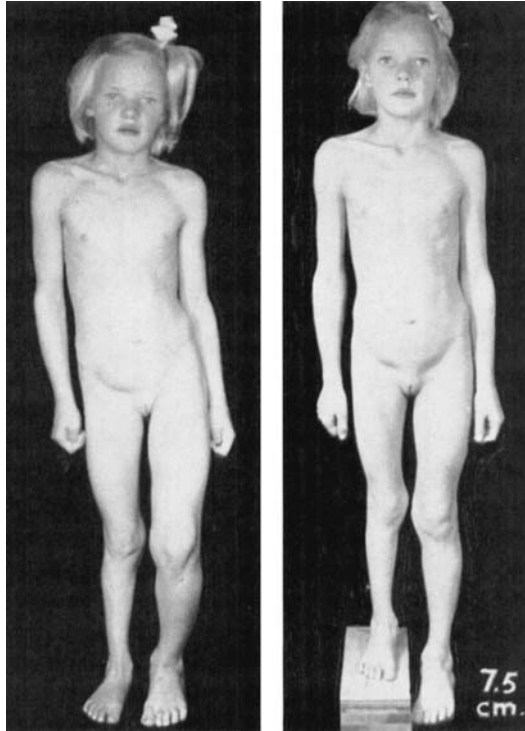


Fig. 1.

8 year-old girl admitted because of hypertrophy of the left leg.
Difference of 8 cm. in leg length. (Case 1).

arterial circulation—besides the venous and lymphatic—must be mapped out before operative treatment is undertaken. It is conceivable that in the future reconstruction may also be done on certain venous insufficiencies.

Of the many “vascular problems” which the orthopaedist meets, these which will be dealt with here are: congenital vascular abnormalities, traumatic arterial lesions, emboli and arteriosclerotic manifestations.

Congenital vascular anomalies and differences of leg length.

The orthopaedist has several methods available when it comes to equalizing leg length discrepancies, during growth or afterwards. Knowledge of the etiology is important. The congenital vascular abnormalities offer special problems, which is shown by the case related below.

OSCILLOMETRIC EXAMINATION

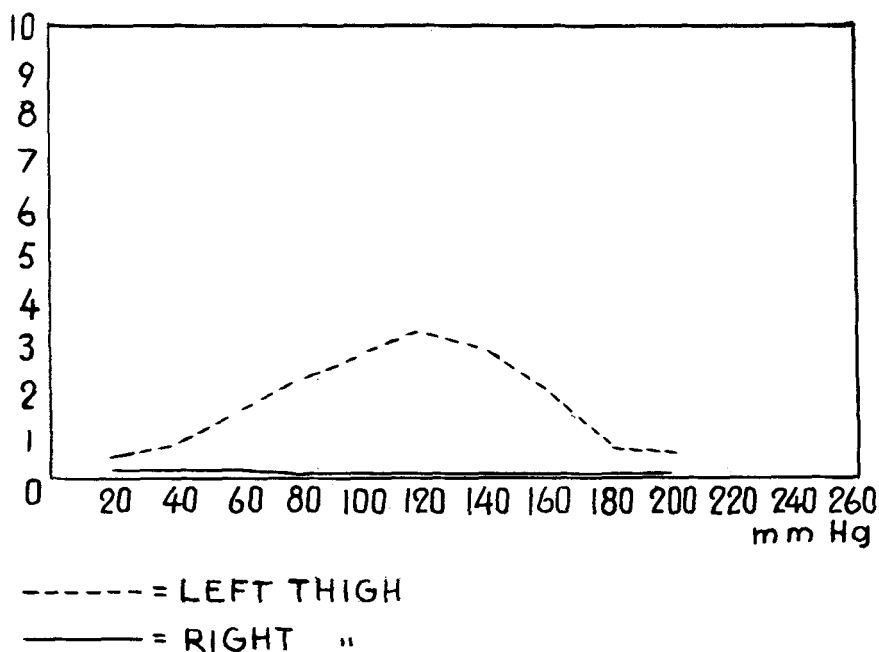


Fig. 2.

Oscillography: normal readings on the left, none on the right. (Case 1).

Case 1. An 8-year-old girl who was referred to the orthopaedic clinic because of hypertrophy of the left leg. (Fig. 1). The leg length difference measured clinically was 8 cm, and 8.5 cm according to measurement on survey roentgen films of the whole extremity. The left thigh and calf were clearly thicker. Skin temperature measurements showed no difference between the legs. The right side had no pulses in the groin, at the knee, nor on the foot. Oscillometry showed no readings on the right thigh and foreleg, and normal readings on the left side, (Fig. 2). Aortography (Karolinska sjukhuset) showed no filling of the iliac and femoral arteries on the right side. (Fig. 3). The investigation confirmed that this was not a question of hypertrophy and elongation of the left leg but rather an atrophy and delayed growth on the right side. The difference in the leg length depended on an arterial insufficiency in the right lower extremity due to a congenital aplasia of the arteries. In this case the femoral artery was lacking and therefore an arterioplasty could not be performed.

In cases of congenital hypertrophy and atrophy with different leg lengths a complete analysis including angiography ought to be done, with the thought that operable vascular stenoses and aplasias might be found.

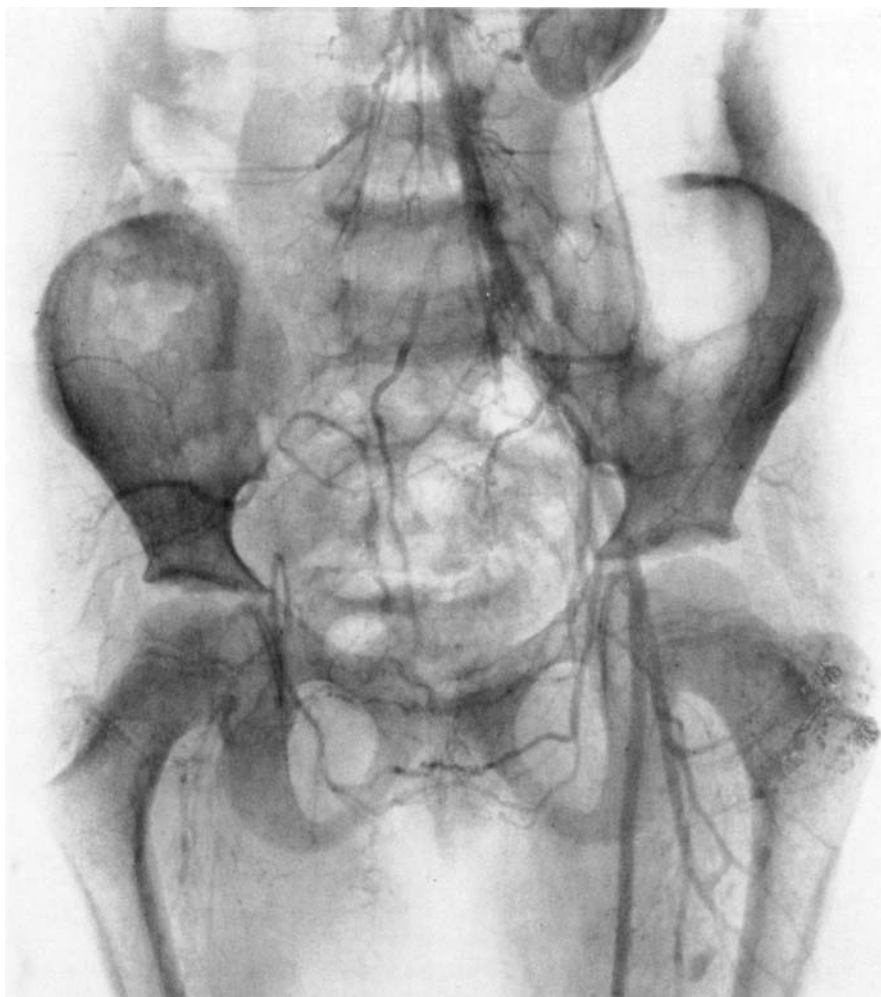


Fig. 3.

Aortography shows aplasia of the iliac and femoral arteries on the right side.
(Case 1).

Case 2. A girl of 15 years, whose right leg was thicker, warmer and 4 cm. longer than the left. In the picture (Fig. 4) taken with infrared sensitive film, an increase in the vein markings is clearly seen. Arteriovenous communications in the knee region were demonstrated by arteriography. (Fig. 5). Ligation of the arteries and local injections of sclerosing solutions diminished the swelling and the heavy feeling in the leg.

The symptoms of such vascular anomalies vary remarkably, depending on their location locally or diffusely, in the soft parts, joints,

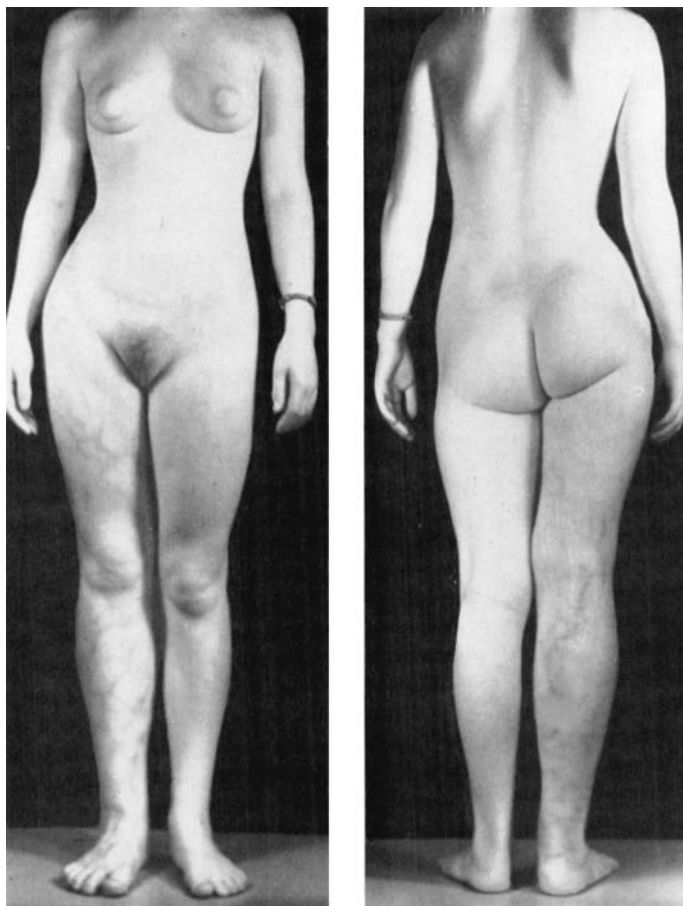


Fig. 4.

15 year-old girl with the right leg thicker, warmer, and 4 cm. longer than the left.
Observe the increased vein markings. (Case 2).

or skeleton. In one case, a circumscribed hemangioma in the suprapatellar bursa caused a peculiar overgrowth of the patella alone. In another case, the appearance of the soft tissue changes was so diffuse and malignant that amputation was considered. In a third case, hemangiomatous formations were localized to a limited part of the knee joint capsule and caused recurrent hemarthroses. The laborious diagnosis in these cases is worthwhile in order to preserve function through selective surgical interventions. The chances of interrupting a growth stimulation depend on the extent of the vascular changes and how early the diagnosis is obtained and treatment instituted.

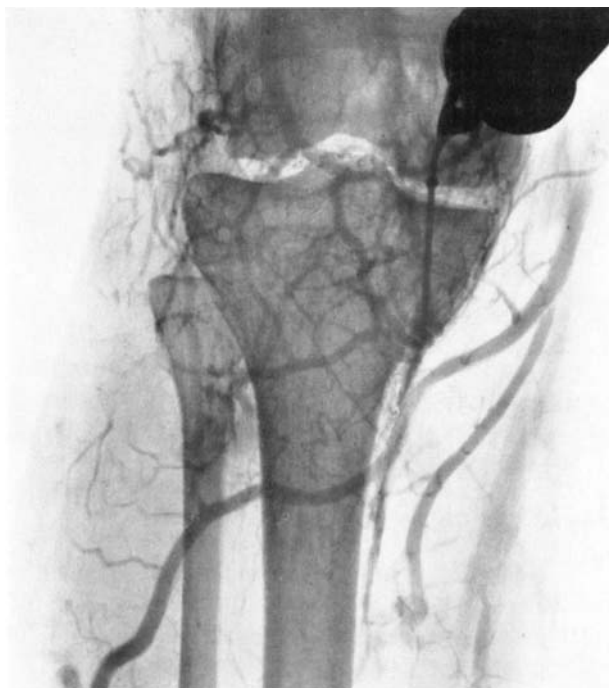


Fig. 5.

Contrast injection via the inferior geniculate artery with demonstration of the arteriovenous communication. (Case 2).

Traumatic arterial lesions.

The orthopaedist meets peripheral arterial contusions in, for example, supracondylar fractures and knee dislocations. With serious signs of ischemia, as with progressive paresis, operative treatment must not be delayed too long. Only fasciotomy and extensive liberation of the artery can save the function. A contusion of the artery is often accompanied by a thrombosis. If one can not obtain arterial flow through the damaged area, it should be excised and the arterial continuity re-established. A direct end-to-end suture is best provided the tension is not too great, in which case the defect should be bridged with a transplant.

With multiple injuries and lacerations of the artery, a reconstruction of the vascular stream can save even an apparently devitalized extremity, as shown by the following example.

Case 3. A 20-year-old boy had his right arm crushed in a press machine. Skin and muscle lacerations on the arm were dreadful, the hand was dead-white, cold,

and completely lacked sensibility and motor function. The fractured humerus lay exposed. In collaboration with the plastic surgeons at Karolinska sjukhuset an exploration was begun with great doubts and reservations. Continuity of the nerves was preserved and this was the deciding fact. The fracture was reduced and fixed by an intramedullary nail. An 8 cm. long occluded segment of the brachial artery was excised. The flow was reconstituted with an autogenous vein graft. The transplant was covered with muscle and skin as well as possible. The patient was discharged from hospital with a good circulation and a mild ulnar paresis which gradually recovered.

In some cases we have used homologous transplants and thereby saved the acute situation. Experiences from Korea with acute cases showed, however, that in the long run vein transplants are better than homologous arterial transplants and vascular prostheses. This agrees with our own experiences, (*Hiertonn 1960, Ejrup & Hiertonn 1960*).

Peripheral arterial emboli.

Regarding the peripheral emboli with grave ischemia and severe pain, the indications for operation are clear. The earlier the operation the better the result. Neglected cases with manifest gangrene offer special problems. Despite lymphangitis and pain, an arteriography ought to be done. This can namely lead to an arterial reconstruction and a secondary and more conservative amputation. Such a case will be briefly related.

Case 4. A farmer of sixty, who previously had a below-knee amputation on the left side, was admitted to the orthopaedic clinic with obvious gangrene on the right foot after a new, neglected embolus. (Fig. 6). Angiography showed an occlusion of the external iliac artery. (Fig. 7). A late embolectomy improved the circulation in the whole extremity so that the amputation could be performed at the line of demarcation. This became almost a transmetatarsal amputation which healed rather rapidly. Circulation and walking ability both became excellent.

Arteriosclerosis obliterans.

With the present tendency toward an older population, arteriosclerosis offers an increasing problem. Even now senile gangrene is a problem for the individual, the community and the doctor. The difficulty in rehabilitating the elderly above-knee amputee needs no further elucidation here. These serious ischemias require full investigation by both the internists and surgeons. Before a more or less routine above-knee amputation is performed, it is valuable to take under consideration:



Fig. 6.

Foot gangrene in a farmer of sixty years of age after a neglected embolus in the iliac artery. Previously amputated on the other side. (Case 4).

- 1) if *infection* or *ischemia* is the dominating cause
- 2) if a vascular reconstruction or a sympathectomy possibly can improve the circulation
- 3) if the circulation is sufficient for a low amputation.

We have often found that local surgical revisions, in combination with general and local treatment of infection, are worthwhile in arteriosclerotic gangrene. When the necrosis is excised and the infection brought under control the sparse circulation can be sufficient for secondary healing and amputation can be avoided. Oedema prophylaxis and treatment also have a very important place in the treatment of gangrene.

Arteriography is required to determine if a vascular reconstruction is possible, i.e., if a localized arterial occlusion is the principal factor. Even if the arteriosclerotic gangrene is a manifestation of widespread

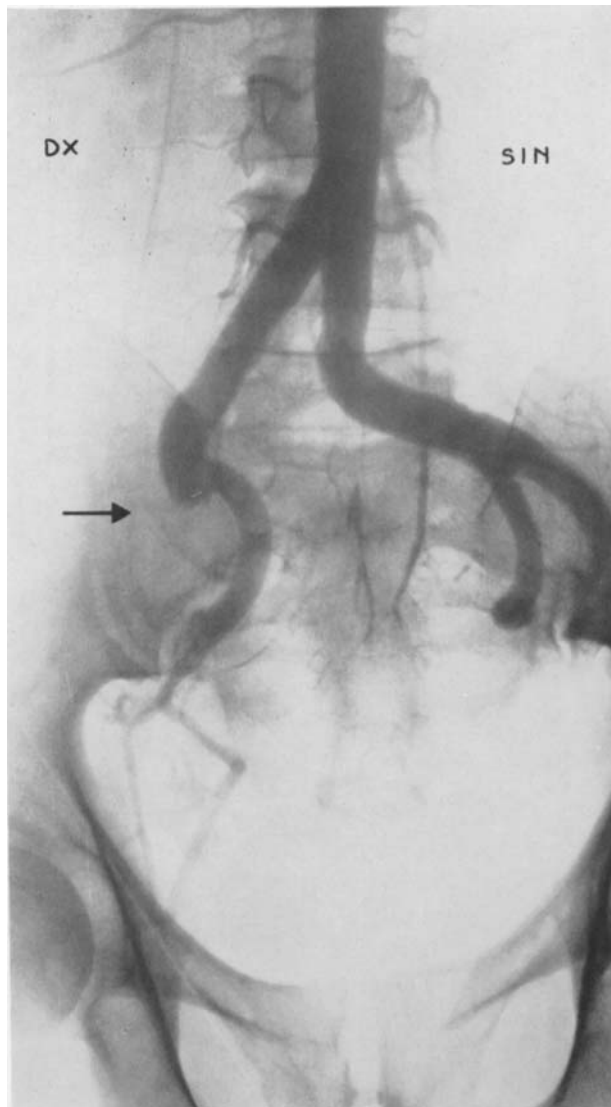


Fig. 7.

Angiography showed an occlusion of the external iliac artery and a good lumen above. This led to a successful vascular reconstruction. (Case 4).

distal occlusions, a reconstruction of a blockage in the femoral artery may produce a distal increased pressure with an improved flow through the collaterals.

We have had good use of lumbar sympathectomy in those cases with diffuse changes in the arterial system, especially where vascular reconstruction is not possible. However, it is difficult to give figures on the effect of sympathetic surgery. Lumbar sympathectomy abolishes the vasoconstrictor tonus. This is of special value in upright positions (*Ejrup* 1955), when we normally get an increased vasoconstrictor tonus.

Even if above-knee amputation is simpler and safer from a healing point of view than below-knee amputation, the rehabilitation is considerably more difficult. Assessment of the state of the circulation by arteriography, oscillography, fluorescein testing, and skin temperature measurement has resulted in several elderly patients having amputations below the knee with good results. In this connection we would like to emphasize the importance of a strictly individualized amputation level.

A study of over five hundred amputees, who were rehabilitated at Norrbackainstitutet during the years 1951–1957, showed that vascular disease was the reason for the amputation in 55 % of the cases. There is reason to hope that mechanical and medical prophylactic measures combined with increased surgical resources may reduce the frequency of severely disabled amputees.

Regarding the operative treatment of claudication cases one can resect the occluded segment and sew in a transplant end-to-end. This attends to the desire for excision of the diseased area and for improvement of the function. It has been shown, however, that more cases can be operated on, and with less risk, if one avoids resection. "By pass" without resection therefore is becoming most frequently employed. For the anastomosis one can choose an area above and below the blockage with favourable condition of the walls and where one does not need to sacrifice important collaterals.

Fig. 8 is an example of a segmental occlusion in the femoral artery and surgical compensation of the blockage by an autogenous graft, sewn in end-to-side.

New materials for arterial replacement have stimulated interest and increased resources. We have always preferred autogenous vein grafts when possible. The operated cases have been followed with objective methods of study. It is shown that a vein transplant is very reliable: 75 % functioning after 3–6 years. Beside the subjective symp-

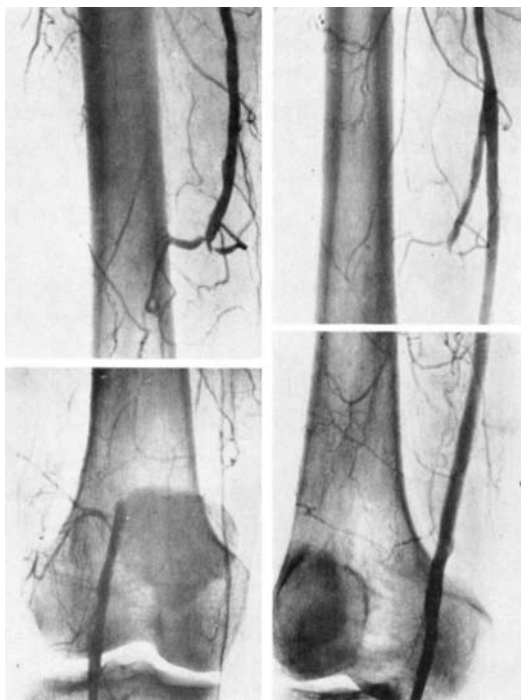


Fig. 8.

Example of a "by pass" operation. Occlusion in the adductor canal compensated by a free vein transplant from the long saphenous vein. Work test and walking ability became normal after operation.

toms and history, the testing of the walking capacity and the clinical examination with palpation of the pulses, oscillography has also been used as an objective measurement (*Ejrup & Hierton 1960*). The oscillography is performed both at rest and after controlled exercise. Fig. 9 shows before operation a long inverse recovery phase and muscle twitchings. After arterial reconstruction the curves are completely normal. Normally the inverse recovery period of the oscillogram is less than one minute. The oscillographic exercise test gives an indirect measure of the patient's capacity to increase his collateral blood flow over the resting flow and indirectly reflects the local circulatory capacity (stenosis + collaterals). For routine testing we have chosen an amount of exercise which corresponds to normal daily activity. Heavier work tests have also been used in a few cases. If the transplant becomes blocked this is reflected immediately in the exercise oscillogram by prolonged inverse reaction.

C.E.N. Born 1899.

D. Atscl obl. art. fem. sin.

Op 2.2.1956
By passing.
Free vein graft

Left ankle

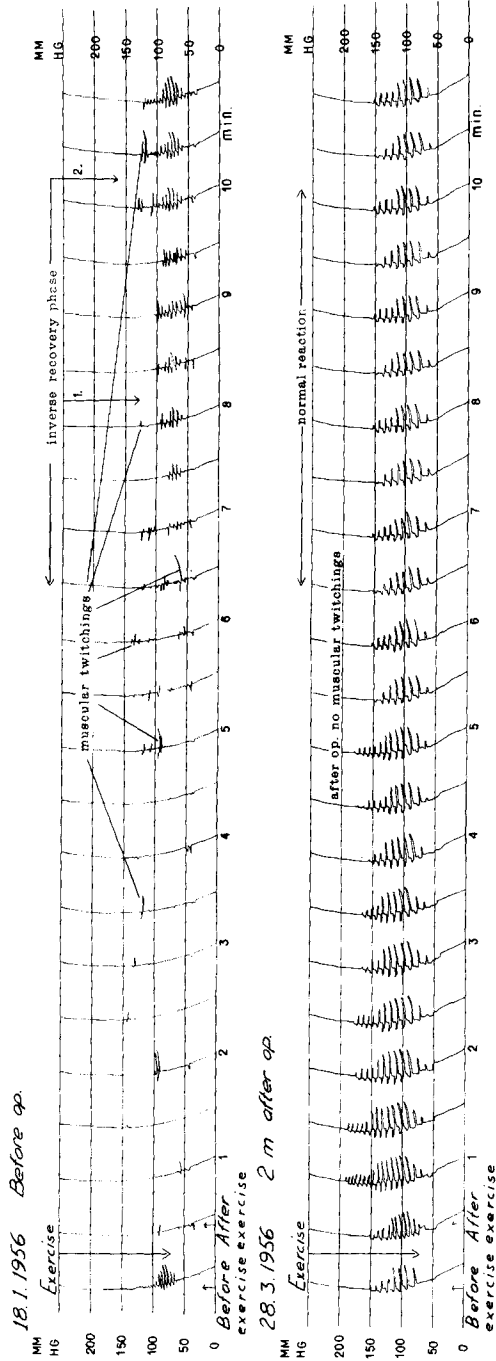


Fig. 9.

Tonosillography after exercise, before and after operation. Note normalization after arterial reconstruction.

Homologous arterial grafts, which opened the way to reconstructions on the central arteries, have also been used peripherally but are now abandoned.

Prostheses of dacron and teflon are employed more and more. Thromboarterectomy, is used with short occlusions in large calibre vessels. If a localized thrombus lies near the mouth of a large arterial branch and the arterial wall is, moreover, severely thickened, one easily gets an unfavourable stenosis after thromboarterectomy. To avoid this one can sew a "patch" into the arteriotomy opening and the patch can be of autogenous vein or of a piece of dacron.

With the above described methods of direct operative intervention in obliterative arterial diseases, aneurysms, and traumatic arterial lesions, a whole new therapy has developed. The rapid progress has, as in many other areas, a certain tendency to accelerate the clinical development and rapidly widen the indications beyond what is justified by the experimental and clinical experience with the newly developed arsenal. In this new era of vascular surgery it is specially important to counteract the tendency to exaggerate. Perhaps this can best be done by careful collaboration in pre- and postoperative assessment and continual follow-up and control of the operative results. Moreover, it is worth emphasizing that a substantial reduction in hospitalization time for vascular cases has been won by this type of teamwork before hospitalization. Many patients with the diagnosis of arteriosclerosis obliterans, even the successfully operated, receive anticoagulant therapy. It is important that this treatment is controlled very carefully and preferably by one and the same doctor. Diabetes cases with peripheral vascular changes are another example of the advantages of a close collaboration between surgery and medicine. To give the patient with stenosing peripheral arterial disease adequate care requires the combined resources of several different specialized departments and laboratories. Through our laboratory for peripheral vascular diseases we hope to contribute to the fulfillment of what the pertinent literature often claims as the need for careful and accurate follow-up examinations.

S U M M A R Y

The reason for above- and below-knee amputations in the lower extremity is in over 50 % arteriosclerosis. Rehabilitation of the elderly after high amputations is a time-consuming and difficult task.

One can expect a reduction of the number of high disabled amputees through

- 1) careful assessment of the circulatory status
- 2) infection and oedema prophylaxis
- 3) medical therapy
- 4) a strict individualization of the amputation level, and
- 5) the use of vascular surgery techniques for reconstruction in suitable cases.

Modern reconstructive vascular surgery implies a great gain even for less dramatic circulatory changes, such as intermittent claudication. Furthermore, the number of cases found suitable for surgery has been increased by the availability of new methods of operation and diagnosis. Analysis of the circulatory status is also important in discrepancies of leg length and in many obscure painful conditions of the lower extremities. There is an immediate need for investigation facilities and hospital beds for the care of peripheral vascular diseases. This is irrespective of whether the surgical treatment falls within the fields of general surgery, orthopaedics, or thoracic surgery.

RESUME

L'artériosclérose des artères des extrémités inférieures donne dans plus de 50 % de cas lieu à l'amputation. La réhabilitation des gens âgés après des hautes amputations est une tâche qui est très délicate et difficile et qui nécessite beaucoup du temps.

On peut s'attendre que le nombre des cas, invalidisés à cause des amputations ou des complications d'une amputation diminue par:

- 1) Une minutieuse estimation de l'état de la circulation ainsi que la prophylaxie d'infections et d'oedème.
- 2) Traitement médical.
- 3) Un sévère jugement de cas en cas concernant le niveau de l'amputation, et par
- 4) L'exploitation de la technique vasculaire-chirurgicale pour la reconstruction dans des cas opportuns.

Même pour des troubles de la circulation moins dramatiques comme claudicatio intermittens, la chirurgie de reconstruction moderne comporte un grand bénéfice. Au fur et à mesure que des méthodes pour diagnostique et cartographie deviennent accessible – de même que des

nouvelles méthodes d'opération le nombre des cas, favorables pour le traitement chirurgical, augmente. Aussi quand il s'agit des différences dans la longueur des jambes et des douleurs diffus dans les extrémités inférieures l'analyse de l'état des vaisseaux est très importante.

En ajoutant les insuffisances veineuses et lymphogènes dans le projet concernant les soins des maladies vasculaires périphériques on peut constater qu'il existe une très grande nécessité de pouvoir faire des recherches aussi bien d'en avoir des places pour les malades. Il est moins important si le traitement chirurgical soit placé principalement dans le domaine de la chirurgie générale, orthopédique ou thoraco-chirurgicale.

ZUSAMMENFASSUNG

Krankheiten und Schäden der Extremitätsarterien sind in über 50 % die Ursache aller Amputationen.

Die Rehabilitation von älteren Patienten nach hohen Amputationen der unteren Extremität ist eine zeitraubende und schwere Aufgabe. Man kann eine Verringerung der Anzahl von Amputationen und von Komplikationen nach Amputationen erwarten, wenn man

- 1) die Zirkulationsverhältnisse berücksichtigt und damit Infektions- und Oedemprophylaxe betreibt,
- 2) internmedizinische Behandlung durchführt (Herz-, Kreislauf- und Stoffwechseltherapie),
- 3) eine strenge Individualisierung des Amputationsniveaus einhält,
- 4) und sich in geeigneten Fällen der Rekonstruktionschirurgie der Gefässe bedient.

Auch bei weniger dramatischen Zirkulationsstörungen, wie bei claudicatio intermittens, kann die Rekonstruktionschirurgie grossen Gewinn bedeuten. Gemäss der Vertiefung der Einsichten in die Diagnostik und die Operationsmethoden hat sich die Anzahl von für operative Behandlung geeigneten Fällen vergrössert. Die Analyse der Zirkulationsverhältnisse ist auch bei Fällen mit Wachstumsstörungen und unklaren Schmerzzuständen der unteren Extremität von grosser Bedeutung.

Werden die venösen und lymphogenen Insuffizienzen mit in den Aufgabenbereich der Behandlung der peripheren Gefässerkrankungen einbezogen, ergibt sich ein grosses Bedürfnis an Krankenhausplätzen mit Spezialausrüstung. Dabei ist es von geringerer Bedeutung, ob die

chirurgische Behandlung in die allgemeine Chirurgie, die orthopädische Chirurgie oder in die Thoraxchirurgie verlegt wird.

REFERENCES

- Ejrup, B.:* Tonoscillography after exercise used as an attempt to test objectively the results of lumbar sympathectomy in peripheral arterial diseases. *Minerva Cardioangiologica Europea*, 1: 258, 1955.
- Ejrup, B. & Hierton, T.:* a) Efterundersökning av opererade claudicatiöfall. *Nord. Med.* 64: 1057, 1960.
- Ejrup, B. & Hierton, T.:* b) Functional capacity after femoro popliteal reconstruction. A follow up study after 3-6 years. *Minerva Cardioangiologica Europea*, 8: 131, 1960.
- Hierton, T.:* a) Reconstructive surgery in peripheral arterial occlusion. *Acta chir. scand.* 119: 129, 1960.
- Hierton, T.:* b) Kärleksador. Kap. IX Krigssjukvård (Ksjv) Medicinalstyrelsens sjukvårdsherbetskapsnämnd 1960.