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Muscle blood flow after amputation

Increased flow with medullary plugging

At below-knee amputation for arterial insufficiency in 31 patients, the muscle blood flow of quadriceps and triceps surae was measured by clearance of ^{99m}Tc pertechnetate pre- and postoperatively. In 15 patients, myoplastic amputation was performed and in 16 patients the medullary cavity of the tibial stump was plugged with cortex of the removed bone as well. Plugging caused a two-third increase in muscle blood flow.

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In an animal study, Hansen-Leth (1976) found that muscle blood flow (MBF) increased after amputation with myoplasty, and that MBF was still further stimulated after osseous plugging of the medullary cavity. We have studied whether medullary plugging induces an increase in MBF in below-knee amputation in man.

Patients and methods

Thirty-one patients (32 legs) underwent below-knee myoplastic amputation because of severe arterial insufficiency. The amputation was performed between the proximal and medial third of the lower leg, using a long posterior musculo-cutaneous flap and suture of muscles and fascia. In 16 patients osseous plugging of the medullary cavity of the tibia was carried out as well, the plug being made of the cortex of the removed bone.

The control and plug groups were comparable regarding age, sex and number of diabetic patients, and there was no difference in the pre-operative muscle blood flow (MBF) of the ischaemic legs (Table 1).

All patients received standard postoperative care and rehabilitation.

MBF was assessed by measuring the clearance of 200 μC ^{99m}Tc pertechnetate injected centrally in the quadriceps and the triceps surae muscles of both legs (Cutajar et al. 1971, Appleberg & Lewis 1975). As this method fails to provide a true picture of the MBF in resting muscle (Tønnesen 1969), muscle hyperaemia was produced by adding 100 μg histamine to the isotope depot (Lindbjerg 1965). The MBF was determined in all patients pre-operatively and 3 weeks postoperatively; in 22 patients the MBF was determined 12 weeks postoperatively as well. The calculations of blood flow were performed as described by Lassen et al. (1964).

For statistical analysis, the Mann-Whitney test was used.

The clinical course was not different between the two groups, nor was any difference found between diabetic and non-diabetic patients. No infections were seen, and in all patients healing occurred primarily. In two cases a minor,

Table 1. Myoplastic below-knee amputation without (control) and with medullary plugging.

Control				
72 (58–91)	15/16	10	7	7.84
Plug				
71 (59–91)	16/16	11	6	5.75

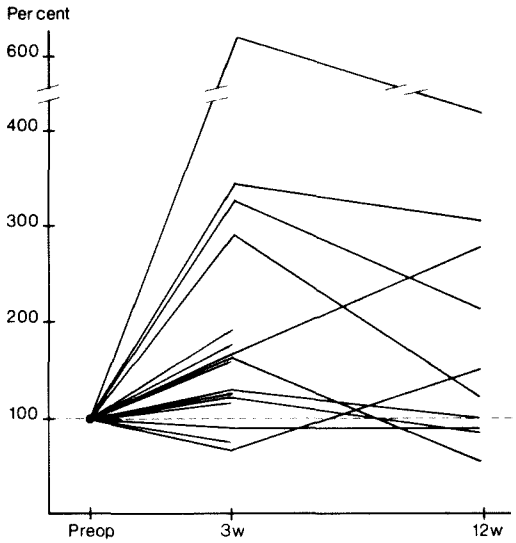

Figure 1. Amputatio cruris myoplastica with plugging of the medullary cavity. MBF of the ischaemic lower leg preoperatively (= 100 per cent), in the third and twelfth postoperative week (n = 16).

dry sore developed at the tip of the amputation stump causing delayed healing.

In the control group, the 3-week median MBF was 97 per cent (interquartile range 85–130 per cent) of the pre-operative MBF of the lower leg. No changes of MBF were found in either the femur or the contralateral leg.

In the plug group, 13 of 16 patients responded with an increase in the MBF of the lower leg postoperatively, one patient showing an extreme increase of 620 per cent (Figure 1). The median increase of 163 per cent (interquartile range 122–193 per cent) was significant ($p < 0.01$), compared with both the pre-operative MBF and the postoperative MBF in the control group. The postoperative MBF in the femur of the amputated leg was not increased.

The individual changes in postoperative MBF were not found to be correlated to the magnitude of the individual pre-operative MBF in either group. No difference in changes in MBF could be demonstrated between diabetic and non-diabetic patients.

Discussion

Previous experiments and clinical investigations have shown that amputation induces hypervascularization in the amputation stump (Hulth & Olerud 1962, Dederich 1963, Langhagel 1968, Hansen-Leth & Reimann 1972, Itohara 1972). This is caused by a local reaction to the trauma and by healing processes of soft tissue and bone (Wray 1964, Ray et al. 1967). A further explanation may be that the blood supply to the amputated leg is not reduced to the same extent as is the amount of tissue left after amputation (Hansen-Leth 1982). These arteriographic observations do not directly permit interpretation of increased MBF. However, increased MBF in the amputation stump has been demonstrated in radioisotope clearance studies (Hansen-Leth 1976).

The postoperative increase in MBF in the group with medullary plugging is in accordance with previous experimental findings (Hansen-Leth 1976). Closure of the medullary cavity normalizes the intraosseous pressure and improves the venous return from the stump (Dederich 1963). Bone healing in the unplugged stump is analogous to healing of a fracture (Hulth & Olerud 1962), but plugging the medullary cavity changes the healing process. It produces a greater periosteal reaction and increases the vascular reaction in the surrounding muscles.

In addition to the postoperatively increased MBF in the amputation stump, an increased cutaneous blood flow and an increased skin perfusion pressure has been found, both being closely related to the healing of the amputation stump (Holloway & Burgess 1978, Holstein et al. 1979). The correlation between MBF and cutaneous blood flow, however, is obscure, as is the influence – if any – of medullary plugging on cutaneous blood flow.

The clinical significance of the increased MBF after myoplastic amputation with medullary plugging remains uncertain.

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