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TRANSMETATARSAL AMPUTATION IN DIABETIC GANGRENE

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The arteriosclerotic changes in the extremity vessels in patients with diabetes mellitus often differ from the vascular changes of senile arteriosclerosis. Diabetic arteriosclerosis especially affects the small vessels of the skin and muscles, whereas the large vessels do not exhibit sclerosis and occlusion of the lumen until later.

Therefore, diabetic gangrene has a more favourable prognosis, since owing to the better central circulation in the limb there is a chance of healing after conservative treatment of the gangrene and removal of the devitalized tissue.

In diabetes mellitus neuropathy with chronic ulcerations may cause infection and destruction of the forefoot. This is the cause in 20 per cent of the diabetic gangrenes, whereas the remaining 80 per cent are due to arterial insufficiency.

In cases with necrosis of one toe, healing may be observed following amputation of this one toe, especially when there is a local cause of the gangrene, e.g. by pressure of the shoe or the sequelae of direct injury. If such a cause cannot be demonstrated, if several toes are involved, or if the necrotic changes extend to the metatarso-phalangeal joint and the interstitial space between the metatarsal heads, healing is seldom obtained after amputation of a toe, and in that event a more proximal amputation has to be done. The same applies to gangrene of the great toe, as amputation of this toe affords a poor functional result. In such instances there is a possibility of amputation through the distal part of the metatarsus. A foot treated by transmetatarsal amputation usually permits normal walking and does not require special shoes.

The main advocates of transmetatarsal amputation in diabetic gangrene are McKittrick and his associates of the New England

Deaconess Hospital, Boston, who have reported their results in several publications.

Among 215 cases they obtained primary healing in 155, but 24 patients later had a more proximal amputation because of pain. The functional result was good in all the healed cases (1949).

After 133 transmetatarsal amputations in 122 patients, Root (1948) reported absence of healing in 22. Three healed secondarily, whereas 19 underwent amputation at the femur. The longer the diabetes had lasted the greater was the risk of non-healing in elderly patients. Otherwise, prognostic information could not be had preoperatively, neither from the pulse findings nor from the presence of diabetic complications.

In 38 cases of diabetic gangrene, Silbert (1954) found primary healing in 12, whereas 11 had to undergo re-amputation at a more proximal level. It was concluded that the best condition for healing following amputation of the forefoot was a demarcated gangrene affecting the toes. The infection has to be controlled, and there must be a good collateral circulation.

Warren et al. (1952) reported healing in 19 out of 43 cases (44 per cent), Herman (1962) in 6 out of 11. The mean stay in hospital was 13 weeks. In continuation of McKittrick's studies Wheelock et al. (1957, 1961) have published the results of transmetatarsal amputations in 433 patients with diabetic gangrene. Primary healing was obtained in 83 per cent. There were only 5 postoperative deaths, but 69 patients died within the first 2 years after the operation. Out of the 336 patients who survived for more than 2 years, 63 per cent exhibited a well-healed amputation. In 50 per cent of the cases in which there was no palpable pulsation distal to the femoral artery, the transmetatarsal amputation failed to heal. Among cases with a palpable popliteal pulse, 30 per cent failed to heal, whereas only 4 per cent poor primary results were found among those with a palpable pedal pulse.

Becker-Andersen & Moe (1963) found primary healing after transmetatarsal amputation in 10 cases of diabetic gangrene and secondary healing in 1. However, at follow-up 2 years after the operation the result was good in only 8 patients, the others having permanent complaints of pain. No patient was subjected to re-amputation.

MATERIAL AND RESULTS

During the period 1958–1967, 35 patients with diabetic gangrene have been treated by transmetatarsal amputation in Surgical Department 9 of the Copenhagen City Hospital. As 2 of the patients had bilateral amputation, a total of 37 amputations were performed. One patient died of cardiac arrest 2 days after the operation.

Two weeks to 9 months after the primary amputation, 14 patients underwent more proximal amputation because of lacking healing and progressing gangrene—3 on the lower leg, 8 at the knee, and 3 at the femur. In one patient the disarticulation at the knee did not heal, so that femoral amputation was carried out. After primary healing of the transmetatarsal amputation, one patient later developed gangrene and had femoral amputation 9 months after the primary operation. The other re-amputations were performed an average of 6 weeks after the transmetatarsal amputation and healed primarily.

Of the remaining patients 9 died during the follow-up period from 6 months to 4 years, average $2\frac{1}{2}$ years, after the operation. From interviews with their next-of-kin, data from other hospitals, and perusal of death certificates obtained from the Medical Statistics Office of the National Health Service, it was found that no further amputations had been carried out on these patients.

Thus, out of the 36 patients who were discharged from hospital 22 healed, 4 of them secondarily after wound infection lasting for 6 weeks to 4 months.

All the surviving patients have been examined a minimum of 2 years after the amputation. In all cases the scar was devoid of reaction, smooth, and without neuroma tenderness. All the patients were able to walk freely without shoes and could wear ordinary shoes, only stuffing the shoe with cotton wool. No patient had needed a special prosthesis to fill out the toe of the shoe.

All the operated cases were divided into good and poor groups and were thereafter assessed on the basis of various factors which might be imagined to influence the ultimate result.

Table 1.

Results	No. of patients	♂	♀	Right	Left	Duration of diabetes in years			Diabetic complications	Insulin	
						< ½	½–4	> 4		+	÷
Good	22	15	7	13	9	1	6	15	10	15	7
Poor	14	8	6	8	6	2	2	10	2	7	7

Table 2.

Results	Blood supply		Age			Gangrene of			Most distal pulse		
	good	poor	50-59	60-69	> 70	1 toe	2 toes	more	foot	poplit.	femur
Good	12	4	4	8	10	14	2	6	7	2	11
Poor	5	9	2	6	6	10	1	3	3	3	7

There is no essential difference in the distribution by sex, age, and side affected between the good and poor cases. The duration of the diabetes did not appear to have influenced the result, but there was a relatively larger number of good cases among those treated with insulin.

There was no difference in the number of good and poor results between cases having gangrene of one, two, or more toes.

Preoperatively, the femoral pulse in the groin, the popliteal pulse, and the pedal pulse were assessed in 33 limbs. Among the cases with a palpable pulsation in the pedal arteries 7 amputations healed, but among the 18 in which there was no pulsation distal to the femoral artery, 11 healed.

Arteriography was not performed, and only 10 patients were assessed by oscillography or rheography. In 8 cases there were signs of occlusion of the femoral artery. 6 of these cases healed, whereas 2 had to undergo femoral amputation because of progressing gangrene. The remaining 2 cases, with favourable rheographic curves, healed.

In the present series preoperative assessment of the extent of the gangrene or of the circulation could not afford prognostic data and thus could not confirm previous studies (Wheelock et al. 1957). On the other hand, the clinical evaluation of the bleeding from the operative field affords a hint as to the result, healing occurring in 12 out of 17 cases with satisfactory bleeding, whereas it failed in 9 out of 13 with poor bleeding.

TECHNIQUE

Preoperatively the diabetes must be well-controlled, and infection, if present, must have been controlled by antibiotics administered for a day or two before the operation and continued until 3 days after. The operation is carried out under general anaesthesia, but regional anaesthesia may be used.

A solid plantar flap is prepared, from distally to the metatarsal heads, comprising the skin, subcutis, and fascia. Dorsally, the skin is

incised so that a smaller flap is shaped, but this flap must not be detached from the underlying structures, as it is thin and poorly vascularized. Grasping the skin edge with instruments should be avoided, and the skin sutures must be applied from the dorsal flap to the plantar flap in order not to pull the thin dorsal skin loose, when the needle is being passed through. The metatarsal bones should be cut 1–2 cm proximal to the heads and the ends rongeuired smooth. All vessels must be ligated, and the wound is closed by catgut in the fascia and nylon in the skin, without drainage.

The patients are kept in bed for 3 weeks after the operation. One week after the amputation the dressing is changed and the wound inspected. On this occasion a decision is made concerning a possible more proximal amputation in the event of infection or signs of progressing gangrene. The sutures are removed 3 weeks after the amputation, and now the patient is allowed to walk in ordinary shoes and is discharged.

DISCUSSION

The peripheral localization of the arteriosclerosis in diabetic gangrene and the late occlusion of the central extremity vessels afford a possibility of a more conservative treatment than can be offered to patients with senile arteriosclerotic gangrene.

In gangrene of the toes of diabetic patients in whom a local cause is demonstrable, e.g. direct pressure by the shoes, a blow, especially when the patient's foot has been trodden on, or after inexpert treatment of ingrown nails or callosity over the joint, there is a chance of healing after local amputation of a toe.

In cases of spontaneous gangrene of the toes healing is rarely obtained by toe amputation. As in these cases there is also a risk of spread of infection and gangrene to the metatarsus, primary transmetatarsal amputation is preferable.

Out of the 36 cases of forefoot amputation reported in the present paper, 22 healed. Sex, age, or duration of diabetes do not afford prognostic data concerning the possibilities of healing, but the skin of the forefoot must be viable and infection, if any, must be controlled. Cases showing satisfactory fresh bleeding from the operative wound stand a greater chance of healing than cases in which the distal vessels are occluded.

Preoperative arteriographic mapping had not been done in the present series. It is interesting to note that 11 patients, who did not

have pulsation distal to the femoral artery, healed primarily and obtained a good result of the transmetatarsal amputation.

SUMMARY

In 36 cases of diabetic gangrene of the toes transmetatarsal amputation was performed. 22 healed, whereas in the other cases re-amputation at a more proximal level was required.

The high healing rate is due to a distal localization of the arteriosclerosis and a local external cause of the necrosis. This is unlike senile arteriosclerotic gangrene, in which there is often occlusion, even of the major extremity vessels. A conservative approach is of great value in diabetic gangrene. In selected cases the prognosis is favourable, and the patients have but few complaints after transmetatarsal amputation.

At the time of the operation the diabetes must be well-controlled and the gangrene demarcated. A gentle technique is necessary, and this applies especially to the skin on the dorsum of the foot. Satisfactory bleeding from the operative field affords the best chances of healing.

REFERENCES

- Becker-Andersen, H. & Moe, N. (1963) Om forfodsamputation og knæledsdisartikulation i behandlingen af underekstremitetsgangræn. *Nord. Med.* **70**, 827.
- Hermann, B. E. (1962) Transmetatarsal amputation in arteriosclerotic diabetic gangrene. *N. Y. St. J. Med.* **62**, 1432.
- McKittrick, L. S., McKittrick, J. B. & Risley, Th. S. (1949) Transmetatarsal amputation for infection or gangrene in patients with diabetes mellitus. *Ann. Surg.* **130**, 826.
- Root, H. F. (1948) Factors favoring successful transmetatarsal amputation in diabetes. *New Engl. J. Med.* **239**, 453.
- Silbert, S. & Haimovici, H. (1954) Criteria for the selection of the level of amputation for ischemic gangrene. *J. Amer. med. Ass.* **155**, 1554.
- Warren, R., Crawford, E. S., Hardy, I. & McKittrick, J. B. (1952) Amputation for diabetic gangrene. *Surgery* **31**, 132.
- Wheelock, F. C., McKittrick, J. B. & Root, H. P. (1957) Evaluation of the transmetatarsal amputation in patients with diabetes mellitus. *Surgery* **41**, 184.
- Wheelock, F. C. (1961) Transmetatarsal amputation and arterial surgery in diabetic patients. *New Engl. J. Med.* **264**, 316.

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