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BELOW-KNEE AMPUTATION FOR ISCHAEMIC GANGRENE

Prospective, Randomized Comparison of a Transverse and a Sagittal Operative Technique

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In a prospective, randomized study a comparison was made of the results of primary below-knee amputation for ischaemic gangrene carried out by two methods: In 47 cases by the transverse technique with a long posterior musculo-cutaneous flap and in 41 cases by the sagittal technique using equally large medial and lateral musculo-cutaneous flaps—in both instances followed by 2 weeks in a half-open plaster cast with extended knee. The sex ratio and age distribution were the same in both groups. Minor differences in the vascular condition between the groups, assessed by the duration of rest pain, pulsation findings, extent of gangrene, and frequency of diabetes, wholly or partially equalized each other. The course of healing was the same in both groups, primary healing being attained in 38 per cent and 41 per cent, respectively ($0.70 < P < 0.80$). There was also no difference between the results as regards limb fitting, ambulation, occupational, or social status. It is concluded that the choice between the two methods can be based merely upon surgical skill and the ischaemic changes in the lower leg.

Key words: amputation; amputation stumps; gangrene; below knee amputation

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Increased longevity has entailed an increased number of lower-extremity amputations for vascular diseases (Hansson 1964). Rehabilitation is greatly facilitated by preserving the knee (Sarmiento et al. 1970). Recent advances, involving an increased frequency of below-knee as compared with above-knee amputation in ischaemic gangrene, have been obtained with improved pre- and post-operative management (plaster casts, improved and non-traumatic surgical technique, and new surgical methods).

A sagittal technique for below-knee amputations was described by Tracy (1966) and a similar technique by Persson & Sundén (1971). A few years later, Persson (1974) demonstrated the superiority of this technique over the conventional technique of using anterior and posterior flaps.

The present prospective, randomized study was designed to compare the results of below-knee amputation performed by the transverse technique using a long posterior musculo-cutaneous flap (Bickel 1943, Perry 1963, Romano & Brugess 1971) with the results of Persson & Sundén's sagittal technique.

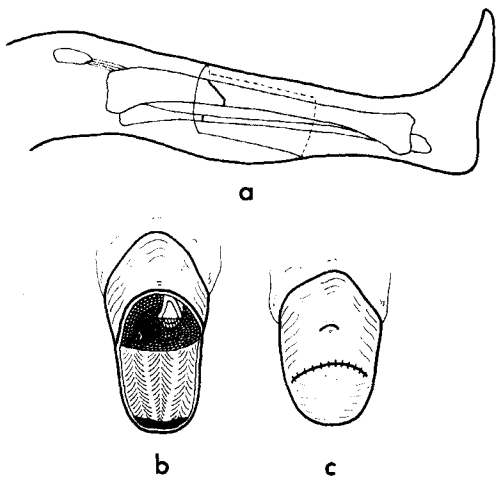

Figure 1. Transverse technique. a. Skin incision. b. Posterior flap. c. Skin closure.

MATERIAL AND METHODS

The material comprises all lower-extremity amputations done for ischaemic gangrene in the Department of Orthopaedic Surgery O, Odense Hospital, during the period June 1972 through December 1974 (Table 1). Primary below-knee amputation was performed to the widest possible extent, if the cutaneous blood supply was deemed sufficient. The primary amputation level was distributed as shown in Table 2.

Table 1. Total number of lower-limb amputations for ischaemic gangrene.

Diagnosis	No. of patients	No. of extremities
Arteriosclerosis	59	66
Diabetes	37	45
Mixed a–v insufficiency	1	1
Embolism/thrombosis	4	4
Total	101	116

Table 2. Primary level of amputation for ischaemic gangrene.

	No. of extremities	Percentage
Foot and toes	5	4
Below-knee	88	76
Above-knee	23	20
Total	116	100

Primary below-knee amputation for ischaemic gangrene was performed on 88 extremities, which form the basis of this study.

The primary below-knee amputation was done by the sagittal technique on all patients whose year of birth was an even number and by the transverse technique on all whose year of birth was an odd number. The transverse amputation (Figure 1) utilized one long posterior musculocutaneous flap and no anterior flap; in the sagittal amputation (Figure 2) equally large medial and lateral musculo-cutaneous flaps were used. In both techniques the tibia was cut obliquely and covered with muscle using chromic catgut sutures in the fascia. The skin was closed by atraumatic 3–0 nylon sutures. As little injury as possible was inflicted on the tissue—in particular the skin—for instance, by not applying forceps. A half-open plaster cast was applied, with extended knee. Suction drainage was used after transverse amputation and, during the latter year of the study period, also after sagittal amputation. The patients were allowed to sit up on the day after the operation, but further mobilization was not allowed until the plaster was removed 2 weeks later. Antibiotics were not routinely used.

Table 3 gives the distribution of the two operative techniques, the sex ratio, the mean age, and frequency of diabetes in the two groups. The age distribution is shown in Figure 3. Table 4 further demonstrates the comparability of the two groups. The transverse amputees had a somewhat longer duration of rest pain than the sagittal amputees. The sagittal group had somewhat more favourable pulsation findings than the transverse group, 27 per cent

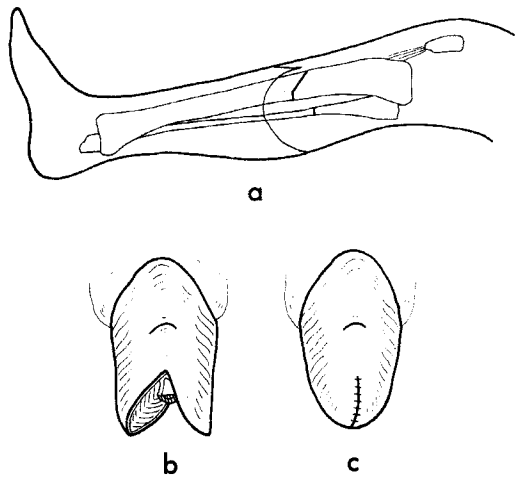

Figure 2. Sagittal technique. a. Skin incision. b. Sagittal flaps. c. skin closure.

Table 3. Primary below-knee amputation for ischaemic gangrene.

Technique	No. of extremities	Men	Women	Mean age (years)	Diabetes
Sagittal (medial and lateral flaps)	41	24	17	70.0	16 (39 %)
Transverse (long posterior flap)	47	22	25	70.5	22 (47 %)

and 13 per cent, respectively, having pulsation in the popliteal artery or distal to it. Of the sagittal amputees 34 per cent had gangrene in the ankle region or proximal to it as compared with 46 per cent of the transverse amputees. Forty-six per cent of the sagittal and 34 per cent of the transverse cases were assessed by a vascular surgeon; 22 and 13 per cent, respectively, had vascular surgery. Lastly, ambulation, occupational and social status were approximately the same in both groups.

Table 4. Duration of rest pain, extent of gangrene and lowest palpable pulse in patients treated for ischaemic gangrene by primary below-knee amputation. The figures in brackets give the absolute number of amputations within each group.

Duration of rest pain	Technique	
	Sagittal	Transverse
	(41)	(47)
No pain	10 %	13 %
	(4)	(6)
1 month	15 %	15 %
	(6)	(7)
1 3 months	46 %	23 %
	(19)	(11)
3 months	29 %	49 %
	(12)	(23)

Extent of gangrene	Technique	
	Sagittal	Transverse
	(41)	(47)
Toe and forefoot	66 %	54 %
	(27)	(25)
Ankle	22 %	38 %
	(9)	(18)
Above ankle	12 %	4 %
	(5)	(2)
Mid-leg	0 %	4 %
	(0)	(2)

Lowest palpable pulse	Technique	
	Sagittal	Transverse
	(41)	(47)
Pedal	5 %	4 %
	(2)	(2)
Popliteal	22 %	9 %
	(9)	(4)
Femoral	63 %	74 %
	(26)	(35)
Aorta	10 %	13 %
	(4)	(6)

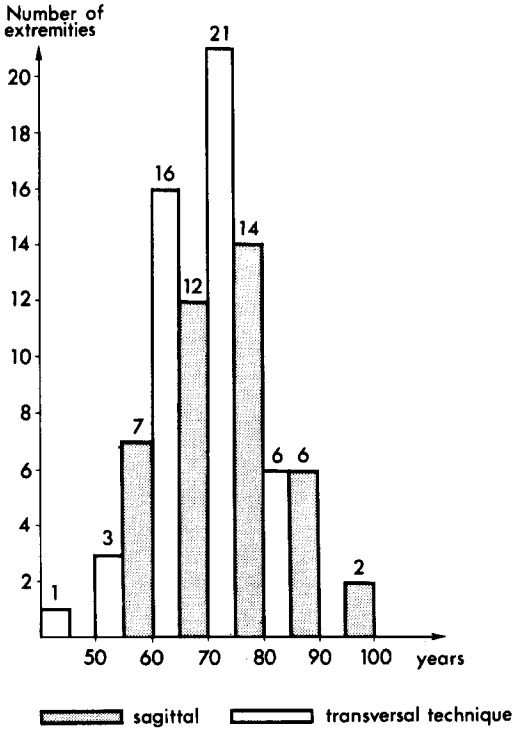

Figure 3. Age distribution of 88 patients treated by primary below-knee amputation.

Table 5. Results of primary below-knee amputation for ischaemic gangrene.

Technique	No. of extremities	Healing after primary below-knee amputation		Healing after re-amputation		Died before healing		Not healed at follow-up	
		primary	secondary	above-knee	below-knee	above-knee	below-knee	above-knee	below-knee
Sagittal	41	17* (41 %)	7 (17 %)	10	1	4	1	0	1
Transverse	47	18* (38 %)	10 (21 %)	7	4	2	3	1	2

* $0.70 < P < 0.80$ (χ^2 test).

RESULTS

All surviving patients were seen at follow-up an average of 11.7 months, range 3.5–22 months, after the amputation. Twenty had died before the follow-up examination, but the course of wound healing is known for all. There was no difference in primary or secondary healing between the two groups (Table 5).

The re-amputation rate was a poor criterion of the value of the two operative methods, as in some of the cases healing was not obtained after re-amputation.

In all, healing at the primary amputation level was attained during the study period by 61 per cent (25/41) of the sagittal amputees and by 68 per cent (32/47) of the transverse amputees, which is 65 per cent of all primary below-knee amputees, but in five of the cases healing was not obtained until re-amputation had been performed. The difference between the two groups is not significant ($0.40 < P < 0.50$, χ^2 test). The result was better in diabetics, who exhibited healing at the primary level in 82 per cent, than in the non-diabetics, who healed in 48 per cent at the primary level ($0.001 < P < 0.005$).

When considering the total material of extremities with ischaemic gangrene, the definitive frequency of below-knee amputation was 55 per cent (64/116), above-knee amputation 41 per cent (47/116), and partial foot or toe amputation 4 per cent (5/116).

The mortality within the first 3 months after the amputation was 17 per cent (8/47) among the transverse amputees as against 10 per cent (4/41) among the sagittal amputees. However, there was a corresponding imbalance in the frequency of heart disease, viz., 57 per cent and 27 per cent in the two groups.

Limb fitting was successful in 78 per cent of the sagittal and in 72 per cent of the transverse amputees. Sixty-one per cent of both groups were fitted with below-knee prostheses, but the PTB prosthesis could be used by a larger number of the transverse amputees (26/47 = 55 per cent) than of the sagittal ones (18/41 = 44 per cent) who were a little more apt to have stump complaints, especially in the form of pressure due to the situation of the scar distally over the tibial stump.

Ambulation, occupational and social status were uniformly impaired in both groups as compared with the pre-amputation condition. At follow-up, 65 per cent (57/88) of all the primary below-knee amputees were able to walk on their artificial limb, without assistance by another person. Thirteen per cent (11/88) were institutionalized, while 64 per cent (56/88) were living at home.

DISCUSSION

Several authors have demonstrated that below-knee amputation can be successfully accomplished in more patients with ischaemic gangrene of the lower extremities than previously assumed. For instance, Sarmiento et al. (1970), comparing two 4-year periods, found a significant decrease in the number of re-amputations from below-knee to above-knee level, while simultaneously there had been an appreciable increase in the frequency of primary below-knee amputations. The improvement in the results coincided with the introduction of immediate post-surgical prosthetic fitting. A similar advance was found by Persson (1974) when changing from the conventional technique of equally long anterior and posterior flaps to the sagittal below-knee amputation technique, and theoretical advantages of the new method were given part of the credit. However, both studies were retrospective and the methods compared were not used concurrently during the study period. Therefore, it cannot be ruled out that other factors may have been decisive.

The present study was designed as a prospective, randomized investigation. The assessment of the results depends upon the comparability of the two groups treated. The duration of rest pain, pulsation findings, and the extent of the gangrene afford an impression of a more favourable vascular state among the sagittal than among the transverse amputees. In return, it might be expected that the influence of this imbalance upon the therapeutic results would be wholly or partially abolished by the unequal distribution of diabetes in the two groups (Table 3), since, like Persson (1974), we found essentially better therapeutic results in diabetics than in non-diabetics and since, moreover, the pulsation findings were the same in both groups of diabetics. The latter is important, seeing that according to Moore et al. (1972) diabetics can be considered better candidates for below-knee amputation than non-diabetics only if they do not have occlusion of major vessels.

Conclusion

There was no difference in the results of below-knee amputation for ischaemic gangrene carried out by the transverse technique with a long posterior flap and by the the sagittal technique with two equally large, medial and lateral, musculo-cutaneous flaps. The choice between the two methods can be based merely upon surgical skill or upon the ischaemic changes on the lower leg.

The increased use of primary below-knee amputation for ischaemic gangrene in the elderly entails great advantages during convalescence, if it is possible to preserve the knee. But the price of this advantage is paid for by the group of patients who later must submit to above-knee amputation—in our series 24 out of 88 patients (27 per cent). Therefore, there is still a need for a method of preoperative assessment of the chances of healing and thereby a guidance in the choice of amputation level (Schousbo & Zdravkovic 1974).

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