

LOCAL BLOOD PRESSURE IN CHRONIC LEG ULCERS

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Abstract. The local arterial blood supply was evaluated according to clinical criteria in 30 consecutive patients with chronic leg ulcers. Separately, the blood pressure was measured at the ankle level with both strain gauge plethysmography and a Doppler ultrasonic method. In patients with clinical signs of arterial obliterative disease the systolic ankle pressure and the ankle/arm systolic pressure ratio were lower than in patients without such signs. In none of the patients was the local pressure decreased to such a degree that ischemia was the main cause of the ulcer, nor was gangrene imminent. Hence, success or failure of skin grafting or conservative treatment depends primarily on factors other than the nutritive flow, when the perfusion pressure is above 70 mmHg, as in the present study.

Key words: Strain gauge; Doppler; Leg ulcers; Skin grafting

In chronic leg ulcers the success of either conservative treatment or skin grafting depends on a number of factors, such as sterility, local metabolism in the affected region, and blood supply. Many of the patients are elderly, and an inadequate arterial perfusion could be suspected to be a decisive factor in some instances. With marked ischemia the revision of the ulcer and skin grafting will be unsuccessful, leaving the patient in a worsened condition. The arterial blood supply has been the subject of study in only a few published reports on patients with chronic leg ulcers. Therefore, the objective of the present work has been to study how often ischemia is of clinical significance in consecutive patients with leg ulcers. Furthermore, the aim of the study was to demonstrate a simple methodology for evaluation of the condition.

MATERIAL AND METHODS

Thirty-two consecutive patients admitted to the department of dermatology for treatment of chronic leg ulcers were examined. There were 24 women, aged 39-84 (mean 72) years and 8 men, aged 52-78 (mean 68) years. Two

patients were eventually excluded from the study: one woman failed to report for the follow-up investigation and another developed gangrene leading to amputation of the examined lower limb during the period of investigation. The remaining 30 patients, 22 women and 8 men, were investigated according to the following protocol. First they were classified *clinically* into the following three groups: venous leg ulcers (16 patients), arteriosclerotic leg ulcers (3 patients), and combined venous/arteriosclerotic leg ulcers (11 patients).

The criteria for the venous group were varicose veins, dilatation of the small veins and venules, oedema, haemosiderin pigmentation, eczematous changes, atrophie blanche, chronic lymphoedema, pachyderma, recurrent cellulitis, ulceration on location of the medial malleol, and of incompetent communicating vein and normal pulses.

The criteria for the arteriosclerotic group were intermittent claudication, burning pain in the feet, absent or reduced pulses, pallor, cyanosis, thickening of the toenails, pulp atrophie, ulcerations at locations other than the medial malleol region. When features from both above-mentioned groups were present, the ulcers were classified as belonging to the combined venous-arteriosclerotic group.

Four patients had previously been operated on for varices and insufficient communicants, and 2 patients had on an earlier occasion undergone femoral endarterectomy.

Microbiological examinations. The bacterial flora and its resistance to antibiotics was determined. It consisted of *Staphylococcus aureus*, *Staphylococcus albus*, beta-hemolytic streptococcus, *Pseudomonas aeruginosa*, *Streptococcus faecalis* and *Proteus*, quite in agreement with other studies (5).

Blood pressure and weight were checked. Three patients with known arterial hypertension were regulated with diuretics and/or betablockers or methyl dopa with blood pressure 180/90, 150/100, 200/100 mmHg respectively.

Routine blood and urine chemistry revealed no associated diseases except in 2 patients with known diabetes mellitus adequately treated with tolbutamide. Five of the 30 patients had a subnormal zinc value of 8-9 $\mu\text{mol/l}$ (normal range 10-19 $\mu\text{mol/l}$) in spite of a normal plasma albumin of 35-39 g/l (normal range 35-40 g/l). To ensure optimal healing (1) these patients received zinc substitution with peroral zinc sulphate 220 mg three times daily for a month. All responded to therapy with normalization of serum zinc.

X-ray-examination of the chest and the soft tissue of the lower extremities for the detection of crural arterio-

sclerosis were performed. Seven of the patients had calcifications of the arteries. 2 of the patients were clinically classified as belonging to the venous ulcer group, 2 to the arteriosclerotic group and 3 to the combined group. Three patients had a phlebography due to previous thrombophlebitis. In one patient flow was decreased in the deep veins and in 2 there was no filling of these.

Measurement of local blood pressure was performed in the 30 patients, when they entered the project and again 3 months after skin grafting or healing during conservative treatment. In the cases of therapeutic failure the final measurements were performed after 6–12 months. The arterial blood pressure was determined by strain-gauge technique (4) at the ankle level and by ultrasonic Doppler technique (6) also at the ankle level. The local blood pressure was related to the systemic blood pressure by an 'ankle/arm index', i.e. the pressure at the ankle level as a percentage of the systolic blood pressure in the arm.

Treatment

Patients with infected ulcers were treated with antibiotics according to the microbiological pattern. Patients with clinically venous or combined venous and arteriosclerotic ulcers were provided with an elastic bandage (Dauerbind®). Five patients had to be relieved of the bandage, as they developed ischemic leg pains.

Topical treatment. All patients were treated with topical preparations. Compresses were used in large, secreting and infected ulcers. Necrotic and fibrinous ulcers were treated with streptokinase-streptodornase solutions (Varidase®, Lederle). Disinfection with 0.1% silver nitrate and 0.2–0.5% chloramine solutions was used as standard treatment and before skin grafting. Carbowax 1500 with 0.1% chlorhexidine was used when ulcers were diminishing, covered with granulations, or when compress treatment was impossible due to advanced age or infirmity. When relevant, Terramycin-Polymyxin B® ointment (Pfizer) was used. Hypostatic eczema was treated with local steroids, namely hydrocortisone butyrate lotion (Locoid®, Gist-Brocades), Flubenisolone valerate lotion (Celeston valerat®, Schering Corp.), and Triamcinolone ointment (Kenalog®, Squibb).

Skin grafting. All patients without immediate signs of spontaneous healing according to anamnestic history or a few weeks observation period were offered skin grafting. This treatment was performed in the Department of Plastic Surgery after dredging and pre-treatment with topical preparations, and when infection had been controlled. Revision of the ulcers was performed, including bleeding and followed by split-skin grafting with the femur as donor site. Sixteen of the patients acceded; 4 of these had previously experienced successful skin grafting.

RESULTS

There was an excellent agreement between the systolic blood pressure at ankle level estimated by strain-gauge and by Doppler technique, as shown in Fig. 1. Fig. 2 shows the ankle/arm blood pressure

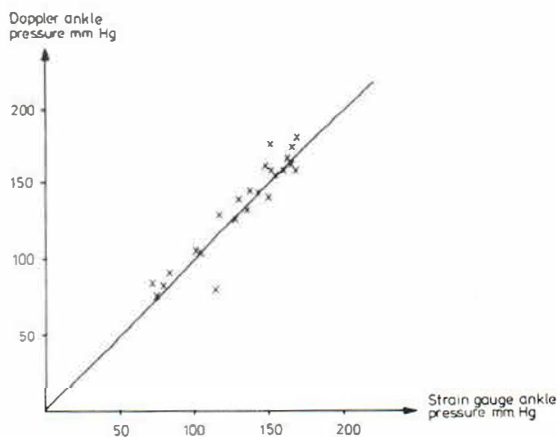


Fig. 1. The comparison between the systolic ankle blood pressure estimated by Doppler and strain-gauge technique: $y = 1.3548 + 1.0027X$, $r = 0.94$, $p < 0.001$.

index of the three clinical groups. The index was significantly lower in the group clinically judged to be suffering from mixed arteriovenous insufficiency than in the group of pure venous insufficiency. Since there were only 3 patients in the arterial group, no statistical calculation could be applied, but the tendency to even lower values is evident. Fig. 3 shows the ankle blood pressure in absolute values in the three groups. The same statistical differences between the absolute values of the clinical groups were present as between the ankle/arm blood pressure index. In contrast, there were absolutely no differences in indices or absolute pressures between skin grafted or conservatively treated patients within each group. Combining the data of Figs. 2 and 3 demonstrates that in all groups there were patients with a considerable and pathological pressure gradient from the arm to the ankle, indicating obstructive arterial disease. The lowest ankle blood pressure, however, was 70 mmHg and was found in the group of patients with arterial obstructive disease.

Tables I and II relate the ankle/arm pressure index and the ankle blood pressure to the response to treatment in the skin-grafted as well as in the conservatively treated patients. All the patients examined had a perfusion pressure above 70 mmHg, high enough to ensure adequate nutritive blood supply. The patients in the two treatment groups, skin grafting versus conventional topical treatment, had the same local blood pressure, and the success or failure of healing by either method

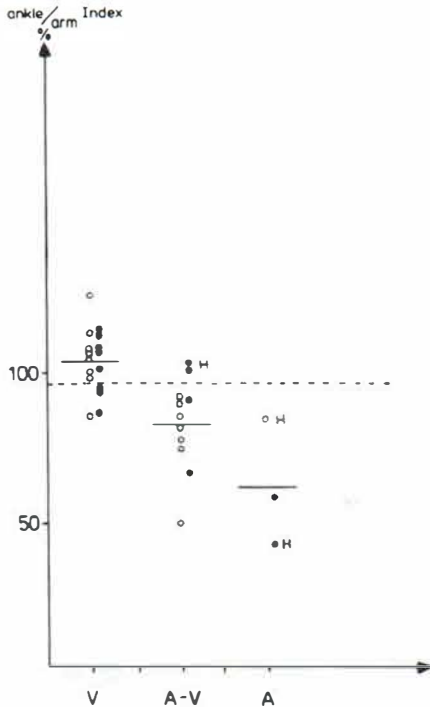


Fig. 2. The ankle/arm blood pressure index of the three clinical groups. O, indicates skin grafting, and ●, conservative treatment. H, arterial hypertension; V, venous group; A-V, combined arterial-venous group; A, arterial group. The dotted line at 97% indicates the limit between normal and subnormal perfusion. The lines in the two clinical groups are the mean values, $\bar{x}_1=151.3$, $\bar{x}_2=118.2$ and $\bar{x}_3=108.7$ respectively. There is a significant difference between the indices in the venous and arterial-venous groups, $s_1=21.5$, $s_2=33.9$, $t=2.479$, $p<0.05$.

was not related to selection of patients with higher nutritive blood pressure in the skin-graft group. The only patient in whom skin grafting failed completely, was a 39-year-old woman with a post-thrombotic

Table I. Ankle/arm index

Systolic blood pressure at ankle level as a percentage of systolic blood pressure of the arm.
Numbers in parentheses are numbers of patients

	Skin grafting	Conservative treatment	Total
Complete healing	90 (11)	79 (4)	(15)
Range	50-126	43-112	
Partial healing	98 (4)	101 (8)	(12)
Range	86-113	87-114	
Failure	98 (1)	80 (2)	(3)
Range		67-93	
Total	(16)	(14)	(30)

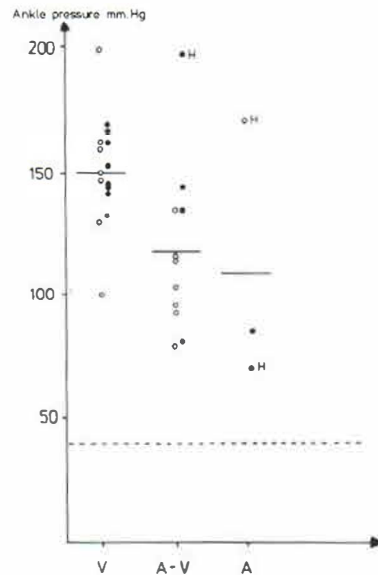


Fig. 3. Systolic blood pressure (mmHg) in the three clinical groups. Same signs as in Fig. 2. The dotted line at 40 mmHg is the gangrene limit. The lines in the three clinical groups are the mean values $\bar{x}_1=103.6$, $\bar{x}_2=83.2$, and $\bar{x}_3=62.3$ respectively. There is a significant difference between the systolic pressures in the venous and arterial-venous groups, $s_1=10.5$, $s_2=15.4$, $t=1.67$, $p<0.05$.

venous ulcer, confirmed by phlebography, normal systemic blood pressure, and an ankle/arm index of 98% with rejection at four attempts of skin grafting.

As seen from Tables I and II, only 4 (29%) of the 14 patients left to spontaneous healing during conventional topical treatment, healed completely, while 8 (57%) showed partial healing and 2 no healing. It was a consistent feature that healing time and the necessary hospitalization was longer for the conservatively treated group (Table III).

Table II. Systolic blood pressure at ankle level, mmHg

Numbers in parentheses are numbers of patients

	Skin grafting	Conservative treatment	Total
Complete healing	130 (11)	108 (4)	(15)
Range	88-200	70-143	
Partial healing	146 (4)	158 (8)	(12)
Range	135-151	135-198	
Failure	100 (1)	113 (2)	(3)
Range	100	80-145	
Total	(16)	(14)	(30)

Table III

	Skin grafting	Topical treatment
Duration of leg ulcers before project	22 mo. (N=16) (3 mo.-10 y.)	21.3 mo. (N=14) (1 mo.-10 y.)
Time for healing	1.4 mo. (N=15) (0.75-3.5 mo.)	7.6 mo. (N=4) (4-12 mo.)
No healing	18 mo. (N=1)	12.1 mo. (N=10) (7-18 mo.)

DISCUSSION

It is remarkable that there was a high success rate in the group of chronic leg ulcers treated with skin grafting despite the venous, arterial or combined venous/arterial genesis; 69% healed completely and 25% healed partially with only small defects. Even the patient with an ankle/arm index of 50% healed, but in this case the ankle pressure was as high as 88 mmHg. The only failure was the 39-year-old woman with post-thrombotic syndrome, while the 2 patients with previous endarterectomy succeeded.

It can be concluded from this study that even in a consecutive series of patients with chronic leg ulcers, skin grafting is rarely, if ever, prohibited by concomitant occlusive arterial disease, since a perfusion pressure above 40 mmHg has been shown to be adequate to supply the tissues, ensure healing and combat gangrene (2). The negative factors of importance may be infection, local venous congestion and acidosis with accumulation of lactic acid in the tissues. The venous ulcers are frequently characterized by hard fibrous tissue in the vicinity of the ulcers, of varying dimensions, which may be related to the local metabolic disorders. Tissue repair and regeneration in fibrous ulcers are often moderate or absent. Therefore skin grafting should be preceded by surgical revision or excision of the fibrous ulcer, inducing copious bleeding.

It is quite obvious from the symptoms of some of the patients that compressive and/or elastic bandages may aggravate pre-existing obliterative disease of the arterial tree.

Further studies are warranted to determine the ischemic effect of such bandages, which might be harmful even in some patients who do not complain of crural pain. For such studies and for the routine clinical monitoring of patients suspected of having an arterial component in the chronic leg ulcers, the ultrasonic estimation of blood pressure by the Dopplette or any other device is simple and easy. In those few cases where the local blood pressure is lower than about 40 mmHg, other techniques such as strain-gauge measurements should be preferred, since other studies have shown that at such low levels the ultrasound methods are unreliable.

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