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New Parameters for Evaluation of Blood Flow in Patients with Leg Ulcers

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Kristensen JK, Karlsmark T, Bisgaard H, Søndergaard J. New parameters for evaluation of blood flow in patients with leg ulcers. *Acta Derm Venereol (Stockh)* 1986; 65: 62-65.

Three new parameters have been introduced to provide data for quantitative evaluation of peripheral cutaneous blood flow in patients with leg ulcers. Reactive hyperemia was induced by occlusion of the blood flow for four minutes at the thigh-level. Blood flow was subsequently measured by laser-Doppler velocimetry in an unselected group of 14 patients with leg ulcers and a matched control group. The parameters used for evaluation was: 1) "peak flow" $f(p)$, 2) divided by time to "peak flow" $t(p)$, rendering a rate constant k ($k=f(p)/t(p)$) expressing the ability to increase blood flow abruptly in case of need. These parameters were all significantly reduced in the patients with leg ulcers, indicating that this simple and atraumatic technique was useful for discriminating blood flow values that may be relevant for healing time and with a sensitivity comparable to the measurements of distal systolic blood pressure. Distal systolic blood pressure measurements can still be considered to be of value when screening for arterial insufficiency in patients with leg ulcers. The values obtained were significantly lower in 36 patients with leg ulcers compared with 9 age-matched control persons. (Received May 20, 1985.)

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Leg ulcers are usually caused by a vascular disease, where venous insufficiency has been regarded the most common etiological factor, but in the individual patient several etiological factors are often operating (1). In the management of patients with leg ulcers, direct measurement of arterial function is a common procedure. Usually the preferred method only comprises measurement of the distal systolic blood pressure. However, this may be insufficient, as diastolic blood pressure was recently shown to be the determining factor governing blood flow (2). The present work was undertaken in an effort to provide data for quantitative evaluation of peripheral cutaneous blood flow in patients with leg ulcers. In addition, data have been obtained by conventional measurement of distal systolic blood pressure for comparison and for evaluation of the sensitivity of this technique.

MATERIAL AND METHODS

Thirty-six consecutive patients with ulcers of the leg (aged 58 to 89 years) and 9 age and sex matched controls (40 to 79 years) were investigated. In 14 unselected cases from the group of 36 patients and in the 9 normal persons reactive hyperemia (5) was registered after 4 min of occlusion of the circulation to the leg using a blood pressure cuff around the thigh inflated to suprasystolic level. Reactive hyperemia curves (Fig. 1) was interpreted as the peak flow value $f(p)$, the time to peak flow $t(p)$ or as the peak flow value divided by the time to peak flow

(k) (i.e. $k=f(p)/t(p)$).

Systolic toe blood pressure was measured as previously described (3, 4) using a laser-Doppler flowmeter and a miniature blood pressure cuff applied around the base of the big toe. Systolic blood

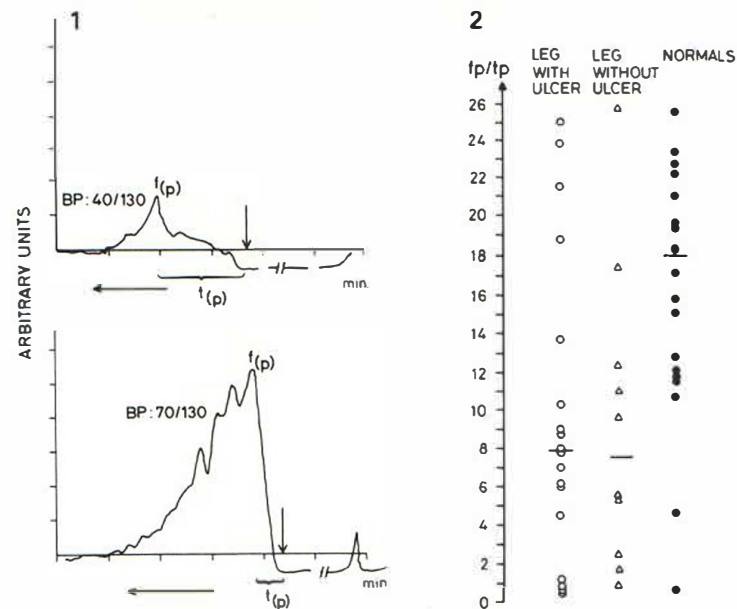
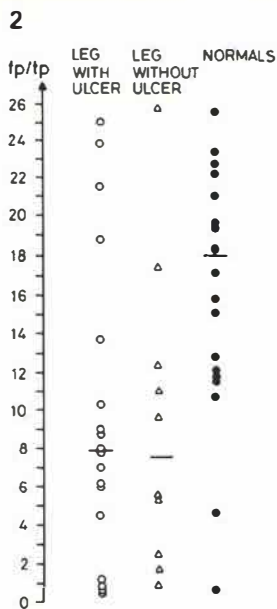


Fig. 1. Two examples of reactive hyperemia curves illustrating the differences which correlate with distal blood pressure. The parameters used for calculation of the k -value are indicated.

Fig. 2. The k -value discriminates between normal and diseased legs.



pressure was defined as the pressure of mercury in the cuff just allowing blood flow in the toe under investigation. The establishment of blood flow was seen and heard from the laser-Doppler signal (4). This value correlates exactly with the strain-gauge technique.

Statistics

The groups were compared by Wilcoxon's rank sum test.

RESULTS

Fig. 1 shows 2 examples of reactive hyperemia curves illustrating the influence of distal blood pressure on reactive hyperemia and showing the parameters measured. In Fig. 2 the results of reactive hyperemia is illustrated. The difference between controls and patients

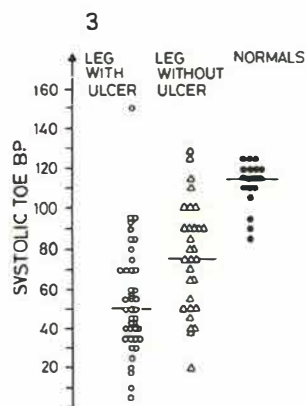


Fig. 3. Systolic toe-blood pressure. Horizontal bars denote the median value.

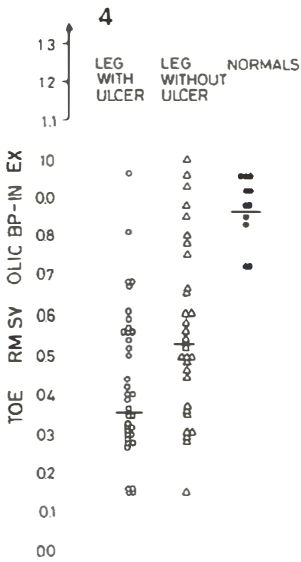
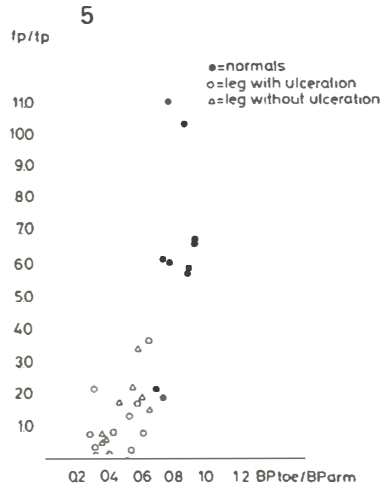


Fig. 4. The results of systolic BP-measurements are conventionally expressed as indexes of arm-blood pressure.

Fig. 5. A significant correlation between the k -value and systolic toe-BP was found.



was significant ($p < 0.01$). Fig. 3 shows the results of toe blood pressure measurements. There is a significant difference between controls and patients ($p < 0.001$). Fig. 4 shows the toe-arm systolic BP-index (i.e. BP_{toe}/BP_{arm}). There is a significant difference between controls and patients. The values for distal toe blood pressure correlated with the k -values for reactive hyperemia $r = 0.8$, $p < 0.001$ (Fig. 5).

DISCUSSION

The opinion prevails that arterial and venous ulcerations are well defined entities, while a minority of ulcers develop on a mixed venous and arterial basis. The common denominator has been tissue hypoxia. This seems to be the case where arterial pressure is severely reduced (6). In venous ulceration the hypothesis of tissue anoxia has been difficult to sustain. It was thought that stagnant blood lying within tortuous and dilated veins close to the skin might cause tissue anoxia and cell-death (7). This hypothesis could not be substantiated by blood gas analysis, but despite these difficulties the concept of anoxia caused by stasis producing "gravitational ulcers" is still taught today. A new theory has recently been advocated describing leaking of fibrinogen into the interstitial fluid, where it polymerises to form an insoluble layer of fibrin forming a barrier to the passage of oxygen (8). The nutritional state of the patient, the hemoglobin concentration and the bacteriology of the ulcerations play a role from time to time (7). The present parameters provide data, that seem relevant for tissue nutrition i.e. distal blood pressure and particularly the k -value as an indicator for the ability to increase blood flow abruptly in case of need. This k -value has not been described previously—as it has not been possible to measure this parameter using plethysmography or radioisotope-washout studies. Currently we attempt to correlate this factor to healing time, taking into account also the nutritional status of the patient.

Also from a therapeutic view it is important to know to what degree bandaging of an edematous leg decreases blood flow and blood pressure.

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Induction of UVA Pigmentation in Pressure Areas by Hydrogen Peroxide

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Tegner E, Björnberg A. Induction of UVA pigmentation in pressure areas by hydrogen peroxide. *Acta Derm Venereol (Stockh)* 1986; 66: 65-67.

Heavy external pressure, caused by the weight of the body when lying on a hard transparent surface during UVA irradiation, prevents pigmentation in pressure exposed skin areas. After percutaneous H_2O_2 administration a delayed pigmentation appeared on the pressure sites. This finding provides evidence for the role of oxygen in delayed pigmentation by UVA. *Key words: UVA; Delayed pigmentation; Pressure effects; Oxygen.* (Received April 29, 1985.)

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Areas of skin under pronounced external pressure (caused by the individual lying on the hard transparent plate of a UVA sunbed) will not exhibit immediate or delayed pigmentation from UVA (1). This results in "white spots" on the scapular region and on the medial sacro-gluteal region, a phenomenon well-known from commercial UVA tanning booths.

The absent UVA pigmentation is probably due to low concentrations of oxygen in the tissues at the pressure sites (1, 2). The aim of the present study was to investigate if H_2O_2 could replace oxygen in preparing the tissue for UVA pigmentation. Since solutions of hydrogen peroxide are unstable a new stable preparation of hydrogen peroxide, dispersed in the water phase of monoglycerides of laurin and myristin, has been used (3, 4).

MATERIAL AND METHODS

Five healthy men in the age range 22-25 years, who tan easily in the summer sun (skin types III and IV), were selected for the study.