

An index to measure the healing potential of ischaemic ulcers using Thallium 201

M. E. SIEGEL, C. A. STEWART, F. W. WAGNER, Jr. and I. SAKIMURA

University of Southern California School of Medicine, Rancho Los Amigos Hospital, California

Abstract

Prediction of healing of ulcers in ischaemic limbs can preclude unnecessary treatment for ulcers that cannot heal. Non-invasive methods are of marked value as the ischaemic limb is susceptible to further ulceration from local skin penetration. Relative hyperemia of the ulcer was measured by scintillation count over the ulcer and at points 2.5 cm from the edge of the ulcer. Relative hyperemia was determined by dividing the count per unit area of the ulcer by the counts per unit area of the surrounding tissue. All ulcers with a relative hyperemia over 1.5 healed.

Introduction

Ischaemic changes of the lower extremities leading to ulceration, infection, and gangrene now account for 70-90% of lower limb amputations in the United States. These surgical procedures account for approximately 0.5% of all operations performed (Warren and Kilhn, 1968).

In the past 30-40 years there has been a marked shift in the ratio of above-knee to below-knee amputations. At one time 80% of all amputations for lower limb ischaemia were performed above the knee. With the increasing recognition of the importance in the aged of the knee joint for prosthetic ambulation the ratio has been reversed and now 80% of ischaemic amputations are performed below the knee with better diagnostic procedures. More procedures are being done at the ankle and foot level (Wagner, 1977, 1978).

The two diagnostic questions facing the team caring for a patient with an ulcer in a dysvascular limb are:

1. If ablation is necessary at what level will a surgical procedure heal?

At Rancho Los Amigos Hospital the ischaemic index measured with Doppler ultrasound has provided a reliable indicator in the 87%+ range (Wagner, 1977, 1978). Further studies of nutritive skin flow are now being carried out with intravenous fluorescein measured with a fiberoptic dermofluorometer.

2. Can the patient heal the ulcer and avoid ablation?

If the ulcer can be healed with local means such as Povidone Iodine, walking casts, or with minor local procedures the patient has been saved the major disability of an amputation.

To determine healing potentials in patients with ulcers in an ischaemic limb, peripheral vascular perfusion was measured with Thallium 201 administered intravenously. It has been shown that in the heart, skin, and skeletal muscle Thallium 201 distribution represents the fraction of cardiac output to that tissue and is thus related to regional blood flow (Strauss et al, 1975, 1977).

Invasive studies with Tc-99m-labeled microspheres administered intra-arterially showed a significant relationship between the ability to develop an inflammatory response with its associated hyperemia and the ability to heal an ulcer (Siegel et al, 1975). Because of the intra-arterial invasive nature of the test it has not been accepted by primary physicians. The same response appears to be measurable with intravenously administered Thallium 201.

Materials and methods

Ten diabetic and three non-diabetic patients were selected who had non-infected ulcers on the

All correspondence to be addressed to Dr. M. E. Siegel, University of Southern California School of Medicine, Los Angeles County USC Medical Center, Rancho Los Amigos Hospital, Downey, California, 90242, USA.

foot, ankle, anterior skin or calf. The patients had not had previous ulcers and there was no radiographic evidence of osteomyelitis or soft tissue gas. At a resting state 1.5 mCu of Thallium 201 were given intravenously. Point counting for 60 seconds was performed 5 minutes after injection directly over the ulcer and at 3 points 2.5 cm. from the edge of the ulcer over normal appearing tissue. A 2.54 cm×1.27 cm pinhole-collimated scintillation detector was used and the output fed to a pulse height analyzer with digital readout. Healing ulcers produced a readout of 15–20,000 counts per minute, but with non-healing ulcers the counts would go below 1000 per minute. The counts per unit area in the ulcer were then divided by the counts per unit area in the surrounding tissue. This ratio was used as an index of the relative hyperemia of the ischaemic ulcer.

Results

Of the 13 patients 10 were diabetics treated with insulin or oral hypoglycemic agents. Six of these healed, four did not and required amputation or excisional foot surgery. Two of the three non-diabetic patients healed, one required amputation. A ratio or index of 1.5 is taken as the minimum hyperemic response necessary for healing. Seven of the patients had an index over 1.5 and all healed. Six of the patients had an index less than 1.5 and only one of these healed. The mean relative hyperemia of the healed patients is 2.8 ± 0.5 , and of those who did not heal is 0.9 ± 0.6 . The range of values was from 0.2 to 4.2.

Discussion

Criteria for prediction of healing of ischaemic ulcers may expedite a needed amputation or avoid an unnecessary one. The presence of a relative hyperemia greater than 1.5 was shown to have a significant relationship to healing of such ulcers and thus a predictive value. Intravenously administered Thallium 201 has been shown to be a suitable means for measuring this hyperemia.

$$\text{Adequate relative hyperemia} = \frac{\text{activity per unit area ulcer}}{\text{activity per unit area of surrounding tissue}} \rightarrow = 1.5$$

REFERENCES

- SIEGEL, M. E., WILLIAMS, G. M., GIARGIANA, F. A., WAGNER, H. N. (1975). A useful, objective criterion for determining the healing potential of an ischaemic ulcer. *J. Nucl. Med.*, **16**, 993–995.
- STRAUSS, H. W., HARRISON, K., LANGAN, J. K., LEBOWITZ, E., PITT, B. (1975). Thallium 201 to myocardial imaging. Relation of Thallium 201 to regional myocardial perfusion. *Circulation* **51**, 641–645.
- STRAUSS, H. W., HARRISON, K., PITT, B. (1977). Thallium 201: non-invasive determination of the regional distribution of cardiac output. *J. Nucl. Med.*, **18**, 1167–1170.
- WAGNER, F. W. (1977). Amputations of the foot and ankle: Current status. *Clin. Orthop.*, **122**, 62–69.
- WAGNER, F. W. (1978). Orthopedic rehabilitation of the dysvascular lower limb. *Orthop. Clin. North Am.*, **9**, 325–350.
- WARREN, R., KILHN, R. B. (1968). A survey of lower extremity amputations for ischaemia. *Surgery*. **63**, 107–120.