Healing Rate of Skin Ulcers

Sir,

Interferometry for measuring the surface area and volume of ulcerous skin lesions, as described by Altmeyer et al. (1), may evolve into a useful tool in quantifying healing, such as before and after application of trophic factors. A working hypothesis is needed to place observations on healing rates into a conceptual framework. There are at least 2 problems: 1) healing may not be uniform over the full extent of the lesion, and 2) exquisite accuracy in repeat measurements may be required to distinguish between competing descriptions of the healing process. We illustrate these two points.

A first assumption is that since nutrients are delivered across the surface of the lesion, the rate of change of volume over time should be proportional to the surface area.

$$d(\text{volume})/dt = \text{surface area} \quad (I)$$

Since many ulcerous lesions can be approximated as a depression corresponding to a hemisphere, we can utilize values for the volume of a hemisphere and its surface area. Substituting into equation (I) and integrating yields:

$$R = kt \quad (II)$$

The prediction is that the radius changes linearly with time. This is consistent with the values shown below Fig. 5 in the report of Altmeyer et al. on the depth of the lesion and is shown in our Fig. 1.

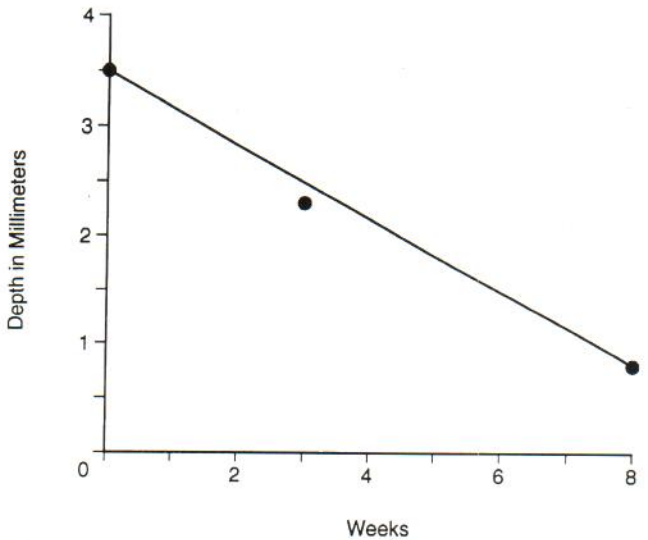

Fig. 1. The change in radius (depth) of an ulcerous lesion versus time, using values given below Fig. 5 of Altmeyer et al.

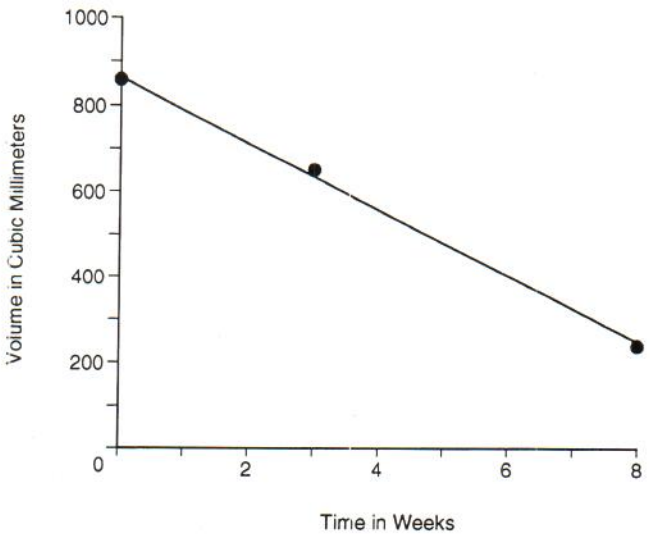

Fig. 2. The change in volume of the ulcerous lesion versus time.

This, however, must be viewed in apposition to the observation of Altmeyer et al. that the overall volume of the lesion decreased linearly with time (plotted as our Fig. 2). For unevenly surfaced lesions, a simple geometric model may not be adequate and/or parts of an ulcerated lesion may be healing at different rates.

As with other biologic phenomena, distinguishing between descriptions based on only a few observations may be difficult or impossible. As an example, consider a spherical lesion with healing (radius change) directly proportional to time at 2, 3, 4 and 5 intervals. The descriptive equation of the volume of a sphere is proportional to radius cubed. However, the resulting points for volume versus time are fit by a linear equation with a correlation coefficient of 0.97. Hence, we look for further progress in the area of interferometric measurements but urge caution in their interpretation.

REFERENCE

1. Altmeyer P, Erbler H, Krömer T, Duwe HP, Hoffmann K. Interferometry: a new method for no-touch measurement of the surface and volume of ulcerous lesions. Acta Derm Venereol (Stockh) 1995; 75: 193–197.

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In Response to the Letter to the Editor by R. P. Spencer

In our paper the results of the evaluation of interferometry, a technique developed for engine building, are presented. With regard to ulcers of the lower leg and follow-up of healing of an ulcer, the accuracy and reproducibility of interferometry is demonstrated and compared to established standardized methods like planimetry and measurement of the volumes of ulcers using casts.

First of all, we would like to thank Dr. Spencer for his constructive and original contribution to the interpretation of parameters obtained by interferometry in wound healing. The description of wound healing processes by mathematic models is an interesting and promising approach.

However, as far as the examples in our publication are concerned, presently no formula can be derived expressing the correlation between the parameters measured using interferometry. Which of the three parameters volume, surface and depth is most suitable to quantify healing depends on the individual ulcer. We believe that simple geometrical models, like spheres, pose problems when describing wound healing processes as they neglect the biological individuality of lesions. Exact quantification of healing processes requires the measurement of volumes, surface and depth as well as area of the lesions using planimetry.

Interferometry is a valuable technique to quantify wound healing of ulcers without touching the surface. Effects of different therapeutic regimens on healing can be studied.

For the development of geometric models for evaluation of wound healing the correlation of objective and reproducible measurement parameters with clinical data like etiology, location, healing stage and treatment is necessary in a great number of objects, e.g. using silicon casts of ulcers. This could be provided in a multicenter study under standardized conditions, comparing several therapeutic approaches by means of interferometry.

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