Simultaneous Measurement of Thickness and Compressibility of a Skin Fold

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Introduction

The thickness of a skin fold is usually measured with mechanical instruments such as a vernier caliper or a skin fold caliper [4].

A problem encountered when using such mechanical instruments is the fact that there actually is no definable skin fold thickness because skin can be compressed. Even the manipulation necessary to create a skin fold causes a deformation. The pressure needed for measuring skin fold thickness with a mechanical instrument also changes the fold. Application of constant pressure has been used to avoid this difficulty. However, it must be noted that compressibility of skin shows individual variation so that identical pressure can have a variable effect on skin fold thickness depending on skin plasticity.

Skin folds can best be formed on the volar aspect of the forearm and on the dorsum of the hand since there is only little subcutis and the epidermis is loosely attached to the underlying tissue.

The smaller the distance between opposing skin pushed together to form a skin fold, the smaller the amount of subcutaneous fat grasped in the process. Skin fold thickness measurements referring to physiologic and pathologic conditions of the dermis should include as little subcutaneous fat as possible. For this reason, application of the skin fold method is limited to certain areas of the body.

Method

It is clear from the above that exact measurement of a particular skin fold is impossible because the formation of such a fold is a dynamic process. It is, however, possible to calculate the diameter of a skin fold. We have developed a method that utilizes continuous compression of a skin fold over a defined time span [9–11]. The decrease of skin fold thickness caused by compression is measured at certain intervals, i.e., every 5 s in most cases. Compression of the skin fold is terminated after 25–30 s. Entering the measured points in a coordinate system (x-axis equals time) produces a typical asymptotic curve. The curve can be transformed into a straight line by using a logarithmic time axis. This straight line can be described by the equation \( y = a - bx \). The intercept \( a \) with the y-axis is taken as a measure of the skin fold thickness in millimeters.

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Due to the logarithmic transformation of time axis or y-axis, \( a \) is defined at \( \log 1 = 0 \), i.e., 1 s. The line is characterized by the slope \( -b \). The value of \( b \) is taken as a measure of the compressibility of the skin and also characterizes the thinning of the skin in time (mm/log t). Figure 1 shows an example of the measuring procedure.

This method allows simultaneous determination of two characteristics of the skin: (1) compressibility (C) and (2) skin fold thickness (SFT). This is why the method has been designated the CR method.

**Equipment**

Originally, a light metal clamp that works like a pair of scissors (Fig. 2a) was used. Both tips are tapered to prevent slipping of the instrument on the skin surface. A metal spring is installed in the levering point so that 5.50 p/mm\(^2\) (measured at the tips) must be applied in order to close the instrument. One of the handles is equipped with a gauge (Mitutoyo, Japan) whose pin is pressed inwards when the jaws of the instrument are closed. Values read from the gauge are converted by means of a conversion factor and indicate how much the tips of the jaws are open at a given point of time. The distance of the tips equals the diameter of the grasped skin fold and can be read in mm\(^{-2}\).

Later, the instrument was improved (Fig. 2b). The tips were equipped with rectangular, exchangeable, small blocks. With the help of double-sided adhesive tape the open instrument was attached to the skin so that slipping was effectively prevented. A locking screw was fixed to one of the handles that facilitated various degrees of opening of the jaws. An electronic displacement transducer (Sylvac, Switzerland) was used instead of a gauge. In addition, a switch was installed for the control of start and end of the measuring procedure. During measuring, electronic impulses from the transducer are transmitted to an electric circuit that is connected to a plotter (printer) which automatically prints out the distance of the tips every 0.16 s.