The Ultrasonic Measurement of Upper Arm Muscle and Fat Area

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Introduction

The aim of the study was to validate ultrasound (US) as a method of assessing nutritional state, as anthropometric measurement can produce an error of up to 33 % in different observers. One of the main reasons for poor results is the variation in the measuring point chosen by each observer. Our special interest was therefore to find a definitive measuring point using US.

(3) CTscanning (Siemens S2):

midarm area (MAA): planimetry,

midarm bone area (MABA): planimetry,

midarm muscle area (MAMA): planimetry,

midarm fat area (MAFA): $MAA - MABA + MAMA$.

Results

Methods:

Midarm muscle area (MAMA) and midarm fat area (MAFA) determined by anthropometric assessment were compared with ultrasound planimetry, using CT scanning (CT) as the standard.

Three groups of subjects were examined:

15 normal subjects, weight range 50–95 kg,

11 over- or underweight patients, weight range 33–112 kg, and

30 patients, aged 22–86 years, weight range 33–130 kg, measured by US at the insertion of the deltoideus muscle as our point of reference.

Methods of Measuring

(1) Anthropometry:

midarm circumference (MAC): tape,

triceps skinfold (TSF): Holtain caliper,

MAMA and MAFA calculated by the Heymsfield equations.

(2) Ultrasound (Picker LSC 7000):

MAMA: planimetry,

MAFA calculated by using cylinder formula which based on radius measurements by US.

For the correlations in the 3 groups of subjects see table 1. Repeated measurements at the insertion of the deltoideus muscle of 10 persons from group b by 3 different observers reduced the margin of error to 8.4%.

Length and breadth diameters of each muscle group (extensor and flexor) were multiplied as parameters of each muscle area and the areas then added:

Correlation of muscle areas by US: 'diameter area' vs. planimetry: $r = 0.964$.

Correlation of MAMA-US (diameter) vs. MAMA-CT: $r = 0.835$ (fig. 3).

In order to obtain data not only on the quantity but also on the quality of the tissue, US histograms were made from 26 patients, which up to the moment have only permitted a rough differentiation of tissue. We are working on ways to improve this method.

Conclusions

US as a direct method of measurement is suitable for establishing the nutritional state of a patient. Almost equally good results in the calculation of the MAMA can be obtained more simply

MAMA-US

MAMA-CT

50

100 cm²

Fig. 1. MAMA-US vs. MAMA-CT, 30 subjects; measurement at the insertion of the deltoideus muscle as reference point.

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Table 1. Correlations of the determination of muscle and fat areas in the different groups; US versus CT, anthropometry versus CT

Correlations of muscle areas on left upper arms

Correlations of fat areas on left upper arms

15 normal-weight subjects (50–95 kg) MAMA-A vs. MAMA-CT: $r = 0.864$ MAMA-US vs. MAMA-CT: $r = 0.908$

11 over- or underweight patients (33–112 kg) MAMA-A vs. MAMA-CT: $r = 0.889$ MAMA-US vs. MAMA-CT: $r = 0.937$

30 Patients, weight range 33–130 kg, 'reference point group' MAMA-A vs. MAMA-CT: $r = 0.568$ MAMA-US vs. MAMA-CT: $r = 0.848$ (fig. 1)

MAFA-A vs. MAFA-CT: $r = 0.861$ MAFA-US vs. MAFA-CT: $r = 0.845$

MAFA-A vs. MAFA-CT: $r = 0.961$ MAFA-US vs. MAFA-CT: $r = 0.969$

MAFA-A vs. MAFA-CT: $r = 0.969$ MAFA-US vs. MAFA-CT: $r = 0.905$ (fig. 2)

MAFA-CT

2

MAFA-US

100

50

150 cm

Fig. 2. MAFA-US vs. MAFA-CT, 30 subjects; measurement at the insertion of the deltoideus muscle as reference point.

Fig. 3. MAMA-US calculated by using diameters vs. MAMA-CT, 30 subjects; measurement at the reference point.

with the use of diameters than by planimetry. The US method can be used to determine the relationship between the dimensions of bone, muscle and fat. A better qualitative analysis of tissue can be obtained by pictographic examination using US.