

REPRODUCIBILITY OF IEMG MEASUREMENTS ON THE M. TRICEPS BRACHII

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The muscular fibre type distribution within an individual is generally thought to be an important determinant for the ability of athletic performance. To determine fibre type distribution nowadays muscle biopsies are necessary. A less painful and simplified procedure would be helpful to determine fibre type distributions on large samples of athletes.

Electromyographic (EMG) measurements represent the electrical equivalent of several physiological phenomena. Therefore, the idea of determining muscle fibre types by EMG methods has intrigued various researchers. Studies from Viitasalo and Komi (1978) as well as Moritani, Nagata and Muro (1982) indicate that there may be a connection between muscular fibre type distribution and integrated EMG (IEMG) and/or the frequency spectrum shift during fatigue experiments. One of the well-known problems in EMG measurements is the variability in signal amplitude.

Reproducible EMG measurements are, however, essential for quantitative measurements. Although EMG equipment has improved considerably during recent years representative investigations date back more than ten years (Komi and Buskirk, 1970).

The present study introduces an automated system which allows the collection and a rapid evaluation of a great amount of EMG data. This system will be used in the future to examine EMG data of a large number of subjects, from whom biopsy samples will be taken simultaneously. As a first step the system was investigated, to examine the reproducibility of IEMG measurements.

Methods

A microcomputer based measuring station was built which collects force data and surface EMG data simultaneously. After preprocessing of the raw EMG signal, a threshold-reset integrated EMG was converted by an A/D unit and the data stored in the computer's memory (Figure 1). Similarly, the force signal from a 'Kistler' transducer was collected during the measurement period (Figure 2). For the evaluation the total sums of the processed

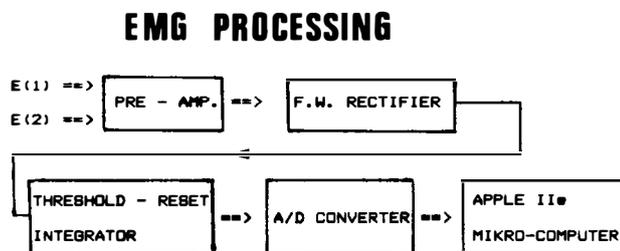


Figure 1-Block diagram for the EMG - processing.

EMG and the force across the whole measurement period were used. The EMG electrodes (Stainless steel; size: 10 mm in diameter; 30 mm apart) were fixed to a flexible piece of silicon rubber, to guarantee an easy adjustment to uneven surfaces and to allow an accurate repositioning of the arrangement of different days. The electrodes were instrumented, using miniature impedance converters (input impedance > 100 Gigaohm) which were mounted directly onto the backside of both active electrodes (bandwidth of EMG unit: 20 to 650 Hz).

FORCE PROCESSING

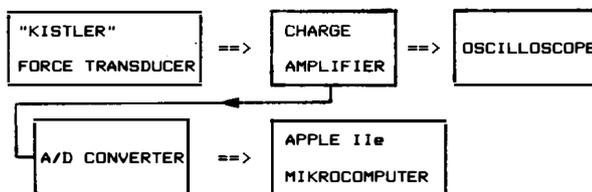


Figure 2-Block diagramm for the force-data recording.

Surface EMG of the triceps brachii was collected on 9 sport students (3 females, 6 males) on 9 different days. Measurements were taken for isometric contractions at the levels of 10, 20, 40, 60, 80 and 100% of maximum voluntary contractions (MVC). All subjects performed in each condition 5 trails (5 seconds of contraction) in sequence with a rest of 30 seconds in between. While the EMG was recorded on the triceps the subjects pulled with their wrist on a chain, which was connected via force transducer to a wall.

Both, the elbow angle as well as the angle between the upper arm and the body were adjusted and fixed to 90 degrees for each subject (Figure 3). The force level was controlled through visual feedback from an oscilloscope. Because the force signal was collected with the data acquisition system the maintenance of the force level could be examined during data evaluation.

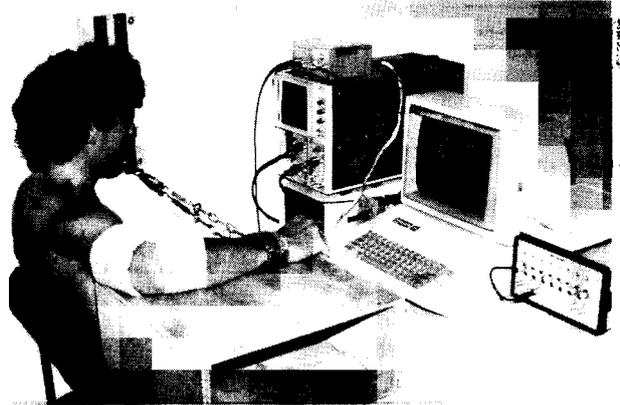


Figure 3—Measurement arrangement

Results

Figure 4, comprising the data of a total of 2430 contractions, shows the relationship between integrated EMG and force for the triceps, as it was

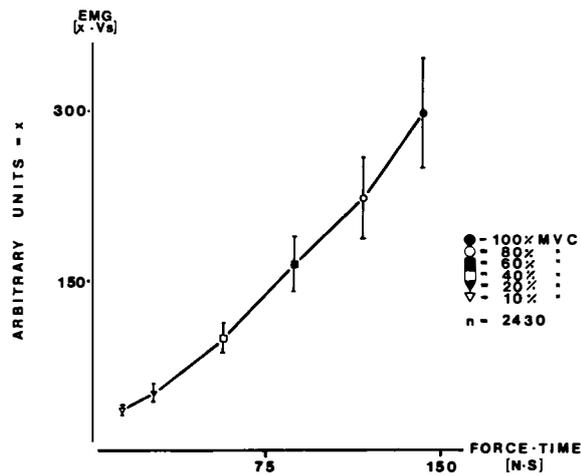


Figure 4—Relationship between integrated EMG and integrated Force (normalized to 1 second recording time).

determined as a mean from all trials per level of all subjects. The curve shows slight deviations from linearity in the lower and upper MVC level regions. The mean coefficient of correlation between integrated force and IEMG from all individuals and all days was found to be 0.99 (N=81). Table 1 lists the various coefficients of variability for intra- and interindividual comparisons. On all force levels the coefficients of variability were determined for the 5 repetitions in a single force level condition (COV-rp), for the day to day measurements within subjects (COV-dd), and for the interindividual measurements (COV-ii). Whereas only little variations were observed in the 5 repetitions on single force levels (COV-rp = 4.6-8.7%) the day to day variabilities (COV-dd = 15.6-28%) and the interindividual variabilities (COV-ii = 23.5-32.2%) showed large values. It is interesting to note that for day to day measurements the variability is decreased for the upper force levels.

Discussion

From a large sample of data it could be demonstrated that a high variability must be taken into account if measurements are made on different days on the same person or if measurements are made on different persons. These results compare to findings from Komi and Buskirk (1970), who reported reliability coefficients of only 0.69 for measurements on different days. A surprisingly low variability has been found for repetitive measurements on identical force levels within one session. A value of only 4.6% at a level of 80% MVC represents a high reliability. The high correlation coefficient of 0.99 between integrated force and IEMG suggests that similar physiological events determine the development of force not only in single subjects but as a general phenomenon for all subjects.

Therefore, the high variabilities from day to day and between subjects is more likely to be caused by changes in conductivity phenomena of body tissue rather than by physiological deviations. To be independent from alterations in the electrical environment it is suggested to concentrate on EMG parameters which are independent of the absolute recording level but are relative measures.

Table 1—Coefficients of variability for EMG measurements.

9 subjects 9 days 6 force levels	FORCE LEVELS (% mvc)					
	10	20	40	60	80	100
COV-rp (%)	8.7	6.7	7.1	5.4	4.6	5.3
COV-dd (%)	28.0	21.3	18.3	15.6	16.0	15.8
COV-ii (%)	23.5	31.0	26.5	29.0	32.0	32.2

References

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