

# ELECTRICAL ACTIVITY OF MUSCLE MOTOR UNITS WITH DISTURBED

## BLOOD SUPPLY

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Electrical activity of muscle motor units was studied by concentric needle electrodes in human subjects with normal and impaired circulation of the lower limbs. Shortening of the duration of motor unit action potentials of muscles (gastrocnemius, extensor hallucis brevis) was found when the blood supply to these muscles was disturbed, indicating a myogenic nature of the changes arising in skeletal muscles with an inadequate blood supply.

KEY WORDS: *motor units; disturbance of blood supply to muscles.*

In obliterative vascular diseases of the lower limbs some workers [7] have found no significant changes by the use of interference electromyography, whereas others [2] found an increase in electrical activity of muscles with an impaired blood supply when subjected to small loads, and a decrease in this activity with maximal loads [2, 11]. The duration of motor unit (MU) potentials of the muscles varies in different pathological states. In neurogenic atrophy the number of MUs is reduced. As a result of compensatory reinnervation of muscle fibers each unit contains many fibers scattered over a wide area. This accounts for the increased duration of the MU potential [1, 6, 13]. In primary muscular diseases the duration of the MU potential is reduced, for some of its muscle fibers undergo degeneration [1, 4, 5, 8-10].

The duration of MU potentials of the leg and foot muscles was compared in this investigation by means of concentric needle electrodes in persons with normal and impaired blood supply to the lower limbs.

### EXPERIMENTAL METHOD

Electrical activity of single MUs was investigated by Buchthal's method [4]. Sterile concentric needle electrodes were inserted into the belly of the test muscle. Potentials were recorded during weak contraction of the muscle in five different positions of the electrode (through the same skin puncture), so as to detect as many MUs as possible. For each muscle the mean duration of the MU potential was calculated for not less than 20 measurements [4] and expressed as a percentage of the age normal [3]. Electromyograms (EMGs) were recorded on a two-channel Medicor electromyograph. The winding speed of the photographic paper was 320 mm/sec. The gastrocnemius and extensor hallucis brevis muscles of both lower limbs were investigated in 45 men with endarteritis obliterans and atherosclerosis in stages II, III, and IV. Disturbances of the blood flow in the limbs were diagnosed by various function tests (rheography, occlusion plethysmography) and from the clinical picture of the disease. Altogether 113

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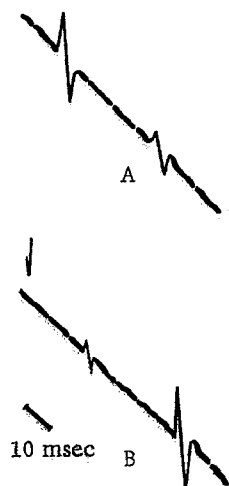


Fig. 1

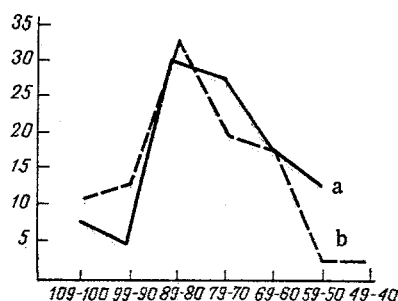


Fig. 2

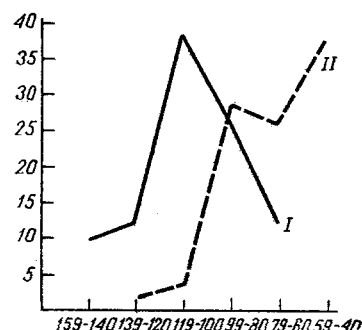


Fig. 3

Fig. 1. Action potentials of motor units of gastrocnemius muscles in persons with normal (A) and impaired (B) circulation.

Fig. 2. Distribution of duration of action potentials of motor units in gastrocnemius (a) and extensor hallucis brevis (b) muscles. Abscissa, % of age normal; ordinate, number of cases (in %).

Fig. 3. Individual histograms of duration of action potentials of gastrocnemius muscles in subjects with normal (I) and impaired (II) blood supply to lower limb muscles. Abscissa, % of age normal; ordinate, number of cases (in %).

investigations were carried out on the 45 patients. Six healthy persons aged from 23 to 50 years were used as the control.

#### EXPERIMENTAL RESULTS

The mean duration of the MU potentials in each of the six healthy subjects was normal (from 90 to 110 % relative to Buchthal's standards). The MU action potential of the gastrocnemius muscle of a healthy person is shown in EMG A (Fig. 1). Its duration was 10 msec (110 % of the expected value). The MU action potential of the gastrocnemius muscle of a patient with impaired limb circulation is shown in EMG B. The duration of the potential was 7 msec (60 % of the expected value). This result was typical, as is clear from Fig. 2a, which illustrates the combined results of measurement of the duration of MU potentials in the gastrocnemius muscles of all the patients: in the overwhelming majority of cases the duration of the MU potentials of the gastrocnemius muscles was moderately or greatly reduced (to 50% of the normal values). Only in four of the 45 patients was the duration of the MU potential within normal limits. Similar results were obtained by investigation of the duration of MU potentials of extensor hallucis brevis (Fig. 2b). No statistically significant differences were found between the degree of shortening of the duration of the MU potentials of gastrocnemius and extensor hallucis brevis.

Analysis of histograms of the duration of the MU potentials showed that in healthy subjects they reflect a near-normal distribution (Fig. 3I). This indicates that the scatter of the individual measurements was due to random factors. By contrast, the histograms for many patients were irregular in shape and sometimes had two maxima (Fig. 3II); this was evidently connected with the presence of both damaged and normal MUs. To verify this conclusion, the activity of a large number of MUs (about 50 in each case) was recorded in several healthy subjects and patients. These results showed that in the patients, in whom the mean duration of the MU action potentials was

reduced (70-80% of the age normal), besides MUs with potentials of sharply reduced duration (40-50% of the age normal), other MUs were present with potentials of normal duration (90-100%, or sometimes 120% of the age normal). The scatter of the duration of MU potentials in patients with a disturbed circulation was thus attributable to some extent to differences in the state of the MUs.

Changes in the duration of the MU potentials in the circulatory disturbances were independent of the clinical form of the disease; only a certain tendency toward more severe changes was found in atherosclerosis.

According to data in the literature [12] and results obtained in the writers' laboratory during investigation of these same patients, the resting calf blood flow was within normal limits. The circulatory insufficiency was such that during active contraction of the muscles (loading tests) the increase in blood flow in the patients was several times smaller than in the healthy subjects. Changes in the duration of the MU potentials can therefore be regarded as the result of inadequacy of the blood flow arising systematically in the course of muscular activity.

The results of this investigation confirm the myogenic nature of changes arising in the skeletal muscles in circulatory failure.

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