COMPARISON OF GLOBAL AND LOCAL ELECTROMYOGRAPHY

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In global recording of the EMG the frequency with which disturbances characteristic of lesions of segmental motoneurons are detected is just as high as if the EMG is recorded locally, and in some cases it is actually higher.

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Muscle potentials can be recorded in two principal ways: locally, using needle electrodes of small area and with a short interelectrode distance, and globally, using electrodes of large area and large interelectrode distance. Choice of recording method is determined by the purpose of the investigation. The electromyogram (EMG) obtained by local recording characterizes changes in single motor units, while the global EMG records changes in a large number of motor units. Characteristics of the two methods of recording have been described on many occasions [1-5]. However, few special investigations have been devoted to the comparative analysis of global and local EMG recordings [6-8]. In this paper the results of local and global electromyography on the same patients are compared.

EXPERIMENTAL METHOD

The test object consisted of severely atrophied muscles of 22 patients with amyotrophic lateral sclerosis, in whom reduced fluctuations of potential (type II in Yusevich's classification) were detected during tonic and voluntary contractions. Under these conditions the probability of recording muscle potentials, arising in the same source by both types of recording electrodes simultaneously during different function tests, was increased. A concentric needle electrode with a core 0.1 mm in diameter and with an external diameter of 0.65 mm and a skin electrode consisting of two disks, 10 mm in diameter, with an interelectrode distance of 22 mm, were used. Recordings were made on "Disa" and "Biofizpribor" electromyographs. The needle electrode was inserted close to the skin electrode to a depth of 5-10 mm.

EXPERIMENTAL RESULTS

In the comparative analysis of the overall intensity of muscle electrogenesis the disturbances determining the general pattern of the EMG were basically similar when the different methods were used to record biopotentials from severely damaged, atrophied muscles (Fig. 1). The frequency with which pathological EMGs characteristic of lesions of the segmental motoneurons were recorded during the various function tests, as Table 1 shows, was the same when recorded by the global method as by the local method, or actually higher (Table 1). The distribution of pathological forms of muscle electrogenesis differed with the two types of recording. The predominant disturbance of electrogenesis was slowing of the rhythm of the waves, and this was more marked in the local EMG. In addition, by the use of needle electrodes it was easier to record potentials of fibrillations and other forms of denervation activity, which could not always be detected by surface electrodes. This may perhaps be connected with the fact that the structure of the global EMG is mainly determined by interference between potentials of muscle fibers located near the surface [12], and for that reason low-amplitude denervation potentials generated by muscle fibers located deeper cannot be detected by surface electrodes even of the highest sensitivity [13].

The principal electrographic criteria of anterior horn lesions of diagnostic importance in globally recorded EMGs were potentials of fasciculations and slow rhythmic activity at rest and during tonic reactions, and also a reduced EMG of voluntary contraction, in agreement with data in the literature [4, 5].

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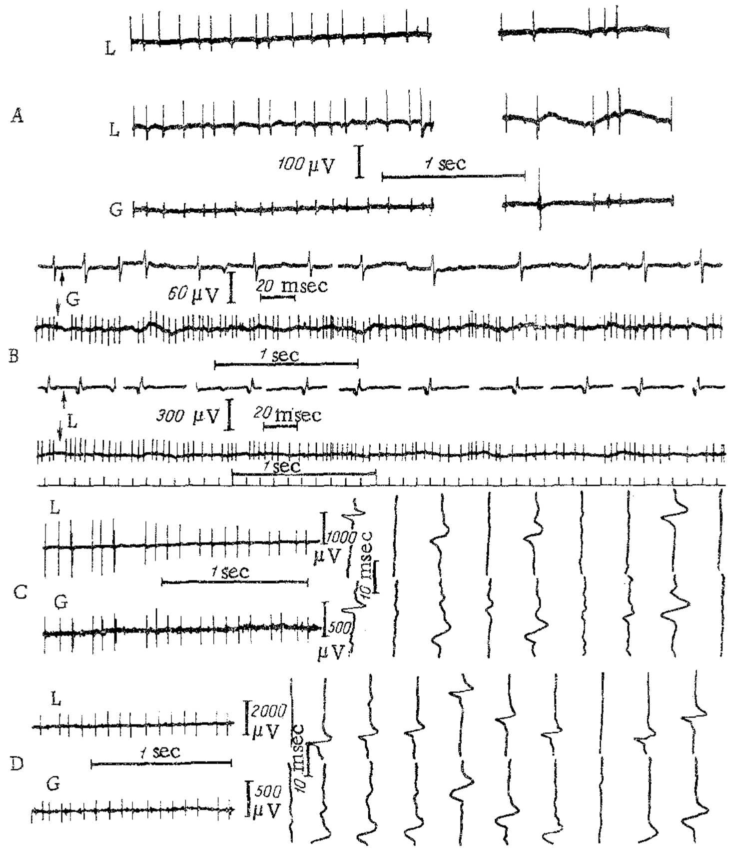

Fig. 1. EMG recorded by the local (L) and global (G) method. A) EMG of left extensor digitorum communis during weak voluntary extension of the hand and fingers; B) EMG of the first interosseous muscle of the left hand during synergic changes in tone recorded continuously (channels 2 and 4) and interruptedly (channels 3 and 1); C-D) EMG of left (C) and right (D) extensor digitorum communis during maximal extension of the hand and fingers recorded continuously (on the left) and interruptedly (on the right).

TABLE 1. Frequency of Recording of Pathological EMGs from Atrophied Muscles by Different Methods

Function test	Number of EMGs	Global recording		Local recording	
		absolute	%	absolute	%
Rest	41	26	63	22	54
Respiratory and synergic changes of tone	41	38	93	31	75
Voluntary contraction	41	41	100	41	100

Hence, it may be concluded from these results that global electromyography yields adequate information when used for the investigation of patients with severe lesions of the segmental apparatus of the spinal cord.

In the case of interrupted photographic recording, the different parameters of individual waves or of rhythmic series could be determined sufficiently accurately in both globally and locally recorded EMGs. The question of the duration of the waves under pathological conditions when the two methods of recording are used was of special interest.

An increase in the duration of the waves by 3.2 msec was observed by global recording compared with local. The mean duration of the motor unit potentials with surface recording was 10.28 ± 0.38 msec, and with needle recording 7.11 ± 0.3 msec ($P < 0.01$). The results of this investigation agree with data in the literature concerning a possible increase in duration of globally recorded muscle potentials under normal conditions [6, 8]. The increase in duration of the waves with global recording may be associated with high dispersion of the interference potentials, caused by the great interelectrode distance and the considerable area of recording, and also to some extent by the "shunting" properties of the tissue (skin, subcutaneous cellular tissue [8-11]).

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