ELECTROMYOGRAPH WITH DIGITAL DISPLAY OF THE NERVE CONDUCTION VELOCITY AND THE LATENCY PERIODS

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SUMMARY

In the last 20 years the measurement of bioelectrical activities of muscles (EMG) and nerves (ENG) has become an important method in the diagnosis of peripheral neurological functional lesions as well as in rehabilitation.

This contribution reports on the development of an electromyograph that simplifies especially the measurement of the nerve conduction velocity and the latency period. Further requirements were simplification of operation, compact dimensions and a low price.

In comparison to other methods used so far this device interprets the triggered potentials electronically and immediately indicates the latency period. If the response is not accepted as typical by the equipment the user receives hints for further operations and the indicated latency period blinks. In addition, the observation of the electromyogram on the scope is always possible, thereby enabling a visual control of the results. The conduction velocity is calculated and indicated directly after feeding the distance between the stimulation points into this apparatus.

INTRODUCTION

The measurement of EMG and ENG in diagnostics has become very important. This indication applies presently to all kinds of lesions in the region of peripheral neurons, neuromuscular transmission apparatus and the muscular system. The method of examination thereby permits for example, the exact differentiation between neurogenic and myogenic processes in existing pareses and makes the topographical correlation of lesions on peripheral neurones possible. It also permits accurately aimed statements on pressure lesions from a prognostical point of view. Depending on the type of examination, various electrodes are used for the derivation of useful potentials. Pricipally, needleelectrodes are differentiated from surfaceelectrodes.

Usually, display units are used for the demonstration of potentials. Some of the available display units on market store the information. In order to enable the doctor have a rather unsteady but approximately permanent picture with those devices which do not store potentials, a stimulation impulse is triggered every second, for example by the determination of NCV.

CONSTRUCTION AND PERFORMANCE

The here introduced myograph, developed at the Institute for Biomedical Engineering of the TU Berlin, has a digital memory with a capacity of 1024 x 8 bit. It enables to measure the EMG and ENG

with surfaceelectrodes and needleelectrodes. Besides, it offers the possibility of measuring the nerve conduction velocity quickly and comfortably with a minimum strain to the patient.

The first figure shows a set of the hitherto produced myographs with a monitor which, by manufacturing in series, is integrated in the unit. On the left hand side is the stimulator with an adjuster for the duration and amplitude of the impulse. In the middle an equipment with indicating and operation elements for the determination of the nerve conducting velocity. On the right hand side of the apparatus, the EMG/ENG amplifier with calibrated adjusters for amplification and registering. The stepping line of peripheral nerves is used for the examination of neurogenic changes. The nerve conducting velocity and latency periods are very important for the examination of peripheral nerves.

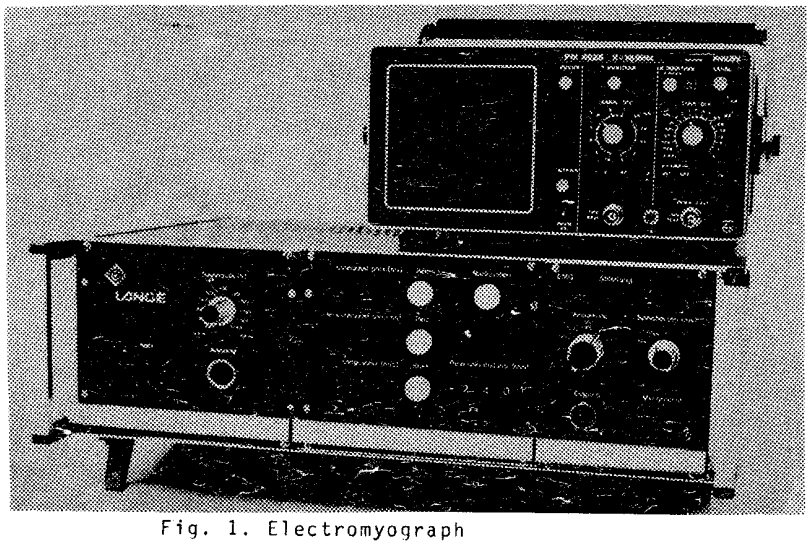

Fig. 1. Electromyograph

The basis of this concept lies in the electronical interpretation of the EMG-signal by the determination of the motor nerve conduction velocity in order to enable an immediate digital indication of the latency period in ms, as well as the immediate digital indication of the nerve conduction velocity in m/s on feeding in the distance between the stimulation points. The result of the electronical interpretation is optically displayed for the doctor.

Figure 2 shows the block diagram of the instrument. The stimulator and the stimulating electrode of the nerve under examination are triggered by external control. Simultaneously, an electronical counter is started. Impulses are hereby added up and indicated every 0,1 ms. The input-signal is transmitted through the EMG-electrode and the amplifier to the signal preparation.

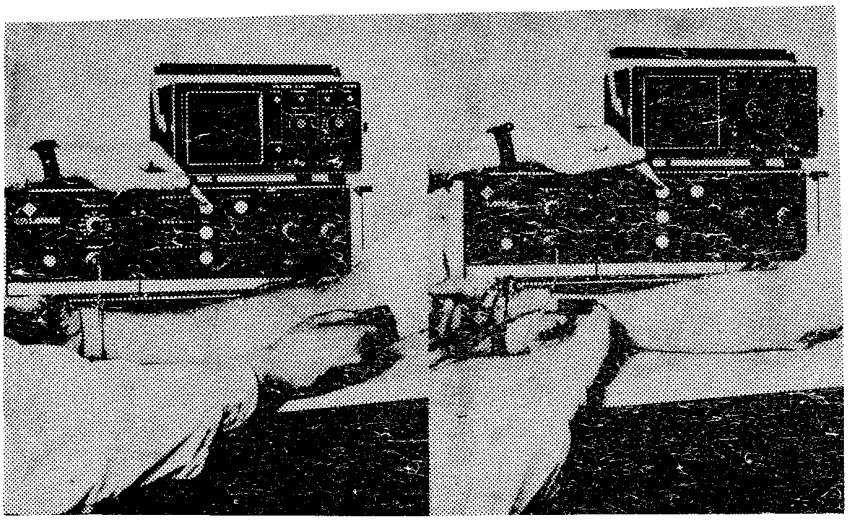

Fig. 3. Determination of the Proximal Latency Period

Fig. 4. Determination of the Distal Latency Period

Two indications are possible through the device:

a) Should be recognized the derived potential from the instrument as typical, the respective stimulation button lights and the latency period would be indicated. Simultaneously, the registered EMG shows up on a monitor thereby enabling an immediate visual control.

b) Should be recognized the derived potential from the instrument however as non-typical, the indicated value of latency period would blink and the user recieves references through light emitting diodes on the EMG-amplifier. The digitally registered EMG response is also immediately visible and the user could decide if the indicated value should be used in determining the nerve conduction velocity.

Circumstances permitting, the measurement should then be repeated with various parameters.

Figure 4 shows the measuring arrangement for the determination of the distal latency period. The period plays a very important role in the diagnosis for example, in that of the circumscribed lesions as well as of the carpal canal syndrome (usual values up to 4,5 ms, by the carpal canal syndrome up to 10 ms). The distal latency period is then substantially extended. The spatial distance between the stimulating and the recieving electrodes has to be fixed. In order to enable a comparison of results, the same fixed distance should always be chosen, for example 6 cm.

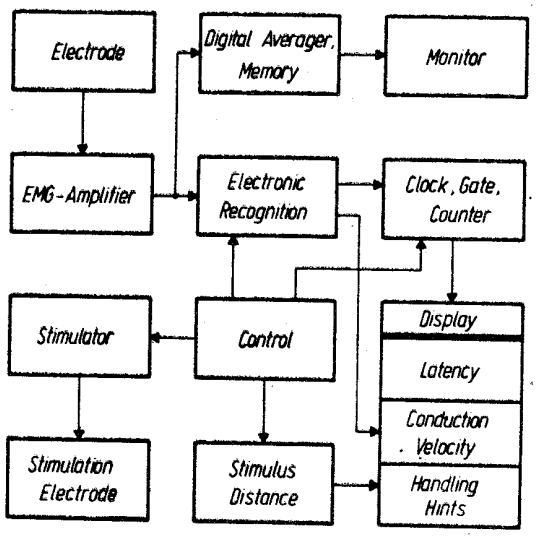

Fig. 2. Block Diagram

An active electrode is hereby chosen in order to minimise disturbances as much as possible. The EMG-amplifier suppresses the stimulating artefacts and amplifies and rectifies the signal. Along with the emission of the stimulating impulse, the interpretation of the resulting signal is released. This has two major functions:

1) Stopping of the counter when the resulting signal appears and
2) Communicating of the result of the interpretation through light emitting diodes to the user.

On determining the proximal and distal latency periods, the distance between the stimulation points is fed in. The NCV, which is immediately indicated in m/s, is then calculated as the ratio of the distance between the stimulation points to the difference in the latency periods.

Figures 3 and 4 both show the schematic for the determination of the nerve conduction velocity of N. medianus. The nerve to be examined is stimulated by the previously mentioned stimulator and the stimulating electrode. The impulse runs through the nerves to the respective mescle, in this particular case, to the Musculus opponens pollicis. The response is then recieved through the EMG-electrode, amplified and further processed. The response is displayed on the screen and the latency period digitally indicated. Moreover, references on the measurement are given to the doctor through light emitting diodes.

This has been an example for the determination of the motor nerve conducting velocity. Figure 5 shows the response of an N. medianus to a distal stimulation.

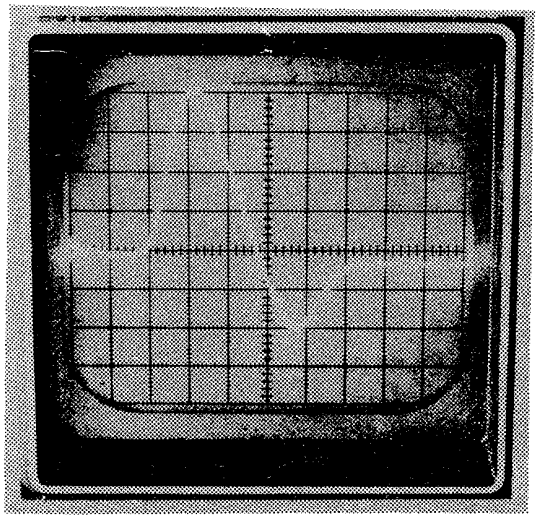

Fig. 5. EMG Response

CONCLUSION

The determination of the nerve conducting velocity is relatively easy, because of the availability of the muscular action potential, which normally has an amplitude of 5 - 20 mV and only exceptionally gets below 0,2 - 0,5 mV because on pathological conditions.

The hitherto usual instruments comply generally with requirements which, from the technical point of view, are relevant to the myographical investigations. The operational comfort of the instruments however have hitherto been more or less neglected, thereby neglecting the necessary requirements of the medical user who could easily be distracted, by the large number of operating elements, from the actual problem.

Especially in the determination of the motor nerve conduction velocity, the hitherto offered solutions have not been satisfied, in which case a considerable relief is given to the examining doctor by an electronical determination of the latency periods of the evoked responses.

REFERENCES

(1) Hopf, H. C., Struppler, A., "Elektromyographie", Stuttgart, Thieme, 1974

(2) Thoden, U., "Diagnostische Möglichkeiten der Elektromyographie", Elektromedica 44 (1976), pp. 140-144

(3) Ludin, H.-P., "Praktische Elektromyographie", Stuttgart, Enke, 1976

(4) Assmus, H., Penzholz, H., "Das Karpaltunnel-Syndrom", Deutsches Ärzteblatt 25 (1976), pp. 1665-1671