ELECTROMYOGRAPHIC CHANGES IN THE DENERVATED FROG MUSCLE

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ABSTRACT

The biphasic (amplitude: 0.76–1.0 mv) EMG of frog's gastrocnemius muscle increases with stimulus strength, with a plateau at strengths exceeding 7 V. Nerve-crushing or sciatectomy reduces EMG activity, but the percentage decrease is inversely proportional to stimulus strength. It is suggested that these EMG reductions affect the mechanics of muscles.

INTRODUCTION

ELECTROMYOGRAPHIC (EMG) patterns of several muscle disorders are well known[1]. However, studies on EMG patterns of experimentally denervated muscles are scanty[1,2], although they resemble atrophied and dystrophic muscles in several respects[3]. The present study reports the EMG patterns of the frog gastrocnemius muscle denervated for 25 days.

MATERIALS AND METHODS

Adult frogs, *Rana cyanophlictis* (15 to 16 g body weight), were sciatectomized either partially or totally for 25 days as described earlier[4]. In each case the contralateral innervated (left or right) leg served as control. Partial sciatectomy involved the crushing of 1 cm sciatic main nerve, while the total sciatectomy was achieved by sectioning 1 cm sciatic nerve at its root[4].

The EMGs were recorded using conventional electrophysiological methods. While a pair of platinum electrodes on the surface of the exposed mucle served as recording electrodes, another pair of Ag-AgCl electrodes were used for stimulation. A Nihon-Kohden polygraph system (Japan) was employed for recording purposes, with AB 620 preamplifier (Nihon-Kohden, Japan).

RESULTS

The EMG of normal frog's gastrocnemius is not different from the pattern obtained for other vertebrate muscles[2,3]. Normally, it is a biphasic wave of 0.76–1.0 mv in amplitude. It is observed that stimulus strength increases the amplitude of EMG but the plateau of activity is established at stimulus strengths exceeding 7 V (figure 1). Both the nerve-crushed and sciatectomized muscles exhibited this phenomenon. The quantum of EMG activity is obviously less in the denervated muscles than in their contralateral counterparts. However, the decrease is relatively smaller in nerve-crushed muscles than in totally denervated muscles (figures 1a and b). The percentage decrease in the electrical activity on nerve-crushing or sciatectomy is invertionally proportional to stimulus strength (figures 2a & b). From figure 2, it seems clear that the fibres which get recruited at relatively lower stimulus strengths become disfunctional to a greater degree, when compared to the fibres which get recruited at higher levels of stimulus strengths. This can be inferred from the fact that the percent difference in the amplitudes of EMG between control and denervated muscles at higher stimulus strengths is not as great as it is at lower stimulus strengths.

DISCUSSION

A comparison of EMGs in atrophic disorders of muscles with results in the present study indicated that the impairment of lower motor neuron functions seems a common feature occurring in both the experimental and clinical muscle disorders[3]. Furthermore, the present results indicate that nerve-crushing as well as total sciatectomy lead to lesions in the innervating muscle[5]. The results also suggest that to a certain extent, interferences related to the electrical activity of other limb-muscles are minimal in the frog unlike in the mammalian muscle. Mammalian muscles, particularly those at limb joints, are known to increase their electrical activities when a limb muscle is stimulated[6,7]. The decrease in the electrical activity of frog gastrocnemius following denervation could be due to a fall in membrane conductance[8]. In the denervated frog muscle, potassium conductance is reduced[9], while in mammalian muscles, both potassium and chloride

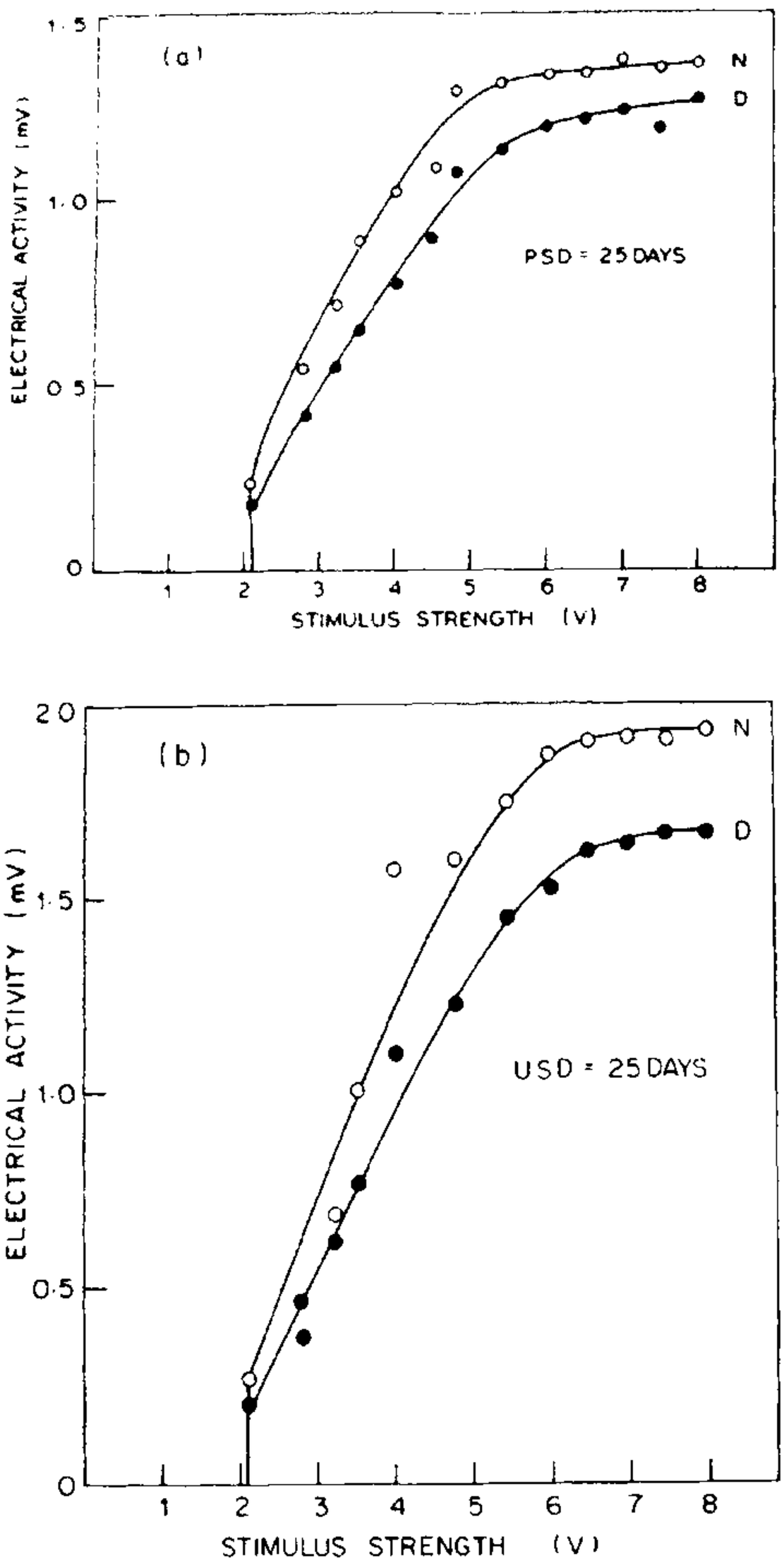

Figure 1. Effect of stimulus strength on the electrical activity (amplitudes of EMG) of normal (N) and denervated (D) gastrocnemius muscle of frog subjected to sciatectomy for 25 days. (a) Partial sciatectomy (PSD). (b) Unilateral sciatectomy (USD).

conductances are lowered[10]. The present results make it clear that, although the EMG pattern of frog muscles remains the same as that of mammalian muscles, the former differs in quantitative aspects from the latter, especially after denervation. The EMGs of denervated frog-muscles showed a significant reduction in amplitude, stable discharge frequency and prolonged spike

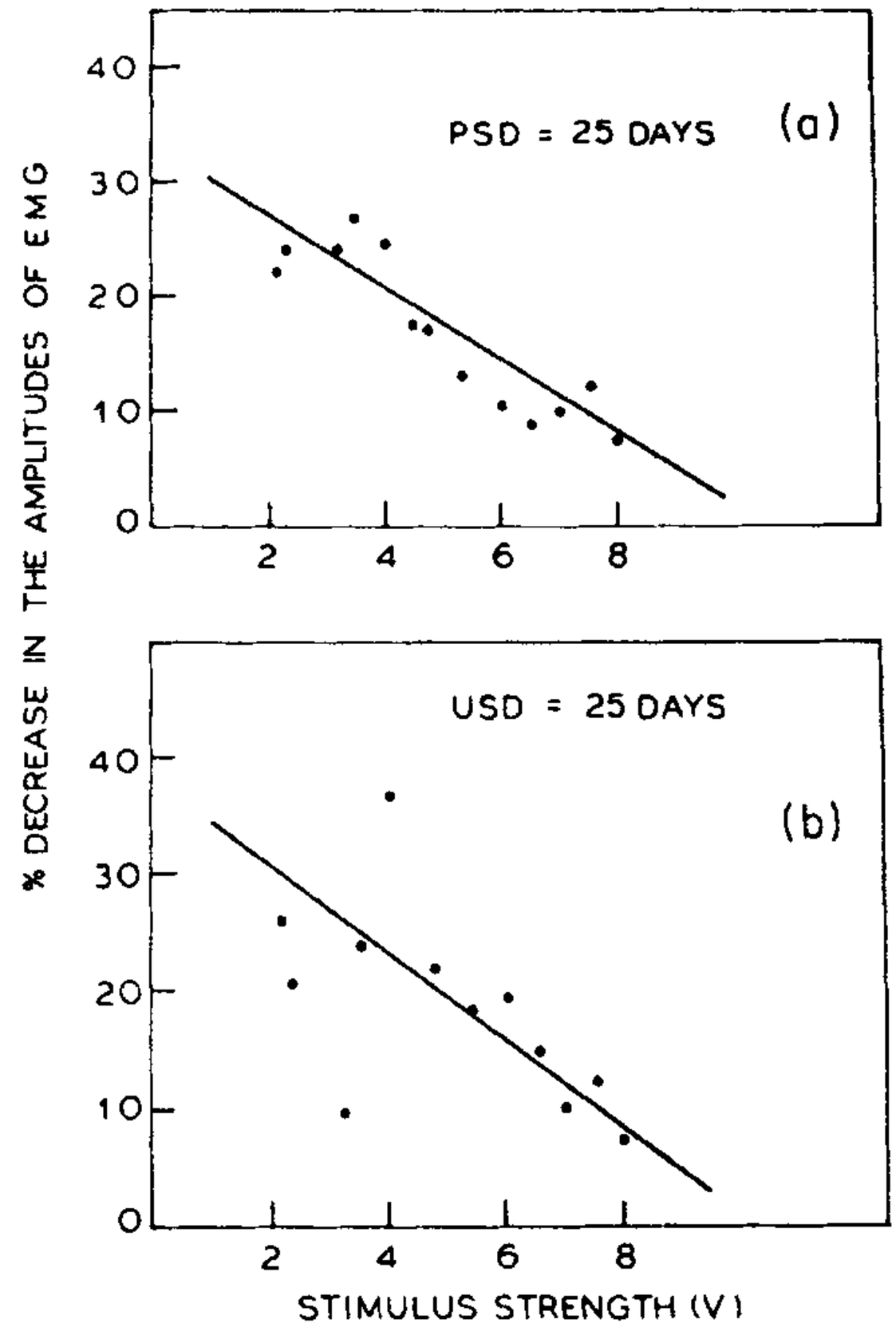

Figure 2. Relationship between stimulus strength and per cent decrease in the amplitudes of EMG (electrical activity) in gastrocnemius muscle of frog subjected to a partial sciatectomy and unilateral sciatectomy for 25 days. (a) PSD, partial sciatectomy; (b) USD, unilateral seiatectomy

intervals in contrast to those of mammalian muscles[5,7]. Reduction in electrical activity of the muscle on denervation has a bearing on its mechanical properties.

More importantly, the present study has brought out a curious phenomenon of differential sensitivity of different muscle fibres in so far as their electrical activity is concerned to denervation; the fibres which get recruited at lower levels of stimulus strength are affected to a greater extent than the fibres having a higher threshold. Significantly, the histological and electron-microscopic studies in fact show that the two fibre types (type I and type II) which differ in their diameters are affected to varying degrees on denervation[12,14]. The factors leading to this differential sensitivity must await further study and may prove useful in understanding neurogenic muscle disorders.

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NEWS

ROBOTS ON THE CONSTRUCTION SITE

The use of a robot on one of the construction sites of Leningrad released a whole column of mechanisms. It can dig trenches, load panels and serve them to assemblers, lay in underground lines and weld pipes, put reinforcements and put up poles. The two-hand manipulator mounted on the under-carriage of a mass-produced excavator has been taught all these operations at the Lenstroirobot association.

Prof. Yovgoni Yuryevich, a leading expert of Leningrad in robotics and engineering cybernetics, called the new manipulator the beginning of using robots in the building construction and municipal services abounding in manual labour.

The robot operating on the welding-jigs of the Baltiisky shipyards now is hanging upside-down, now moves up a vertical wall in the compartments of ocean-going liners. Like a beetle, stirring the feeler-aerials the robot-washer is moving along the dirty glass of the shop bays, leaving behind a clear strip.

The wide use of robots in Leningrad yields a great saving and social effect. It is expected that the share of manual labour in the region will be reduced by 10 per cent by 1990. (*Soviet Features*, Vol. XXIV, No. 169, November 14, 1985)