MECHANICAL AND ELECTROPHYSIOLOGICAL PROPERTIES OF GUINEA PIG PERIPHERAL NERVES

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The mechanical and electrophysiological parameters of the guinea pig peronial and tibial nerves were measured as part of an ongoing investigation into the mechanics of peripheral nerve stretch injury. Sciatic nerves were excised from adult female guinea pigs and were carefully separated into the peronial and tibial branches. The total excised length of these trunks was about 50 mm. The nerve trunks were oxygenated in Krebs solution prior to the time of mechanical tests. Two types of tests were conducted. In the first test, the nerve trunks were tested in simple tension at two different strain rates – 0.001 s^{-1} and 0.1 s^{-1}. The maximum tangential modulus was measured for 5 specimens for each nerve trunk and each strain rate. The Students t-test was used to determine the whether differences were statistically significant ($P < 0.05$). It was observed that the maximum tangential modulus of the peronial and tibial nerves were not significantly different for the same strain rate. However, the difference in the maximum tangential moduli at the two strain rates was statistically significant. Figure 1 shows the rate dependent stress-strain curves of the peronial nerves tested at strain rates of 0.001 and 0.1 s^{-1}.

The second set of mechanical tests consisted of stress relaxation experiments on the nerve trunks. Samples of five peronial and five tibial nerves were tested. Each specimen was loaded to an initial strain of 10%. Two different loading rates, 0.001 s^{-1} and 0.1 s^{-1}, were used to deform the specimens to 10% strain. The reduced relaxation modulus was calculated by normalizing the time varying stress by dividing each stress value by the maximum stress experienced by the nerve trunk (at the end of the 10% strain application). A two term stretched exponential curve was fit the reduced relaxation modulus curve of the nerve trunks for a relaxation period of 1500 s. It was again observed that the differences between peronial and tibial nerve trunks at the same strain rate were statistically insignificant. Figure 2 shows the reduced relaxation moduli of peronial nerves tested at 0.001 and 0.1 s^{-1}.These mechanical tests indicate that peronial and tibial nerve trunks of adult guinea pigs have similar mechanical properties, and that they exhibit significant rate dependent mechanical properties.

The electrophysiological response of mechanically loaded nerve trunks was examined using a sucrose gap chamber designed specifically for this application. The set up is a modification of the sucrose gap chamber introduced by Shi and Borgens [1]. Figure 3 shows the schematic of the entire test set up. The nerve trunk was connected to a mechanical testing machine and predetermined loads were applied to the nerve trunks by attaching a nylon string to the nerve that passed through a pulley and was then connected to the load cell of the testing machine. The drop in the compound action potential parameters, such as peak voltage and latency were observed and related to the mechanical loads applied to the nerve trunk. The critical functional tensile load of the guinea pig peripheral nerve trunk wais estimated by determining the mechanical load at which there was complete loss of compound action potential.

REFERENCE:

1. Shi, R. and Borgens, R. B., 1999, "Acute repair of crushed guinea pig spinal cord by polyethylene glycol", Journal of Neurophysiology, 81, pp. 2406-2414.

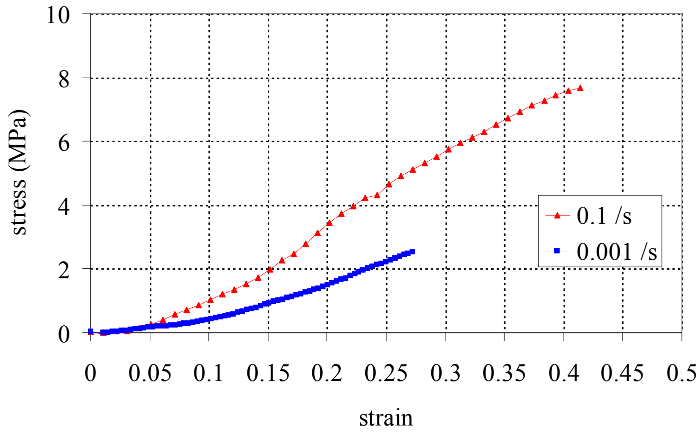

Figure 1. Stress- strain curves for peronial nerve trunks tested at two different strain rates.

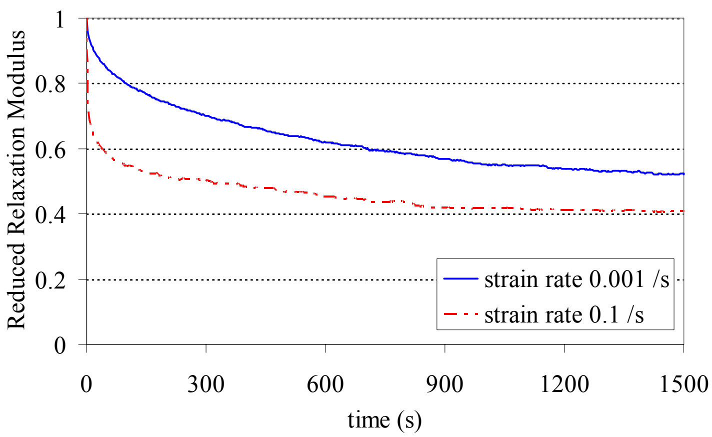

Figure 2. Reduced relaxation moduli for peronial nerves stretched to 10% strain at two different strain rates

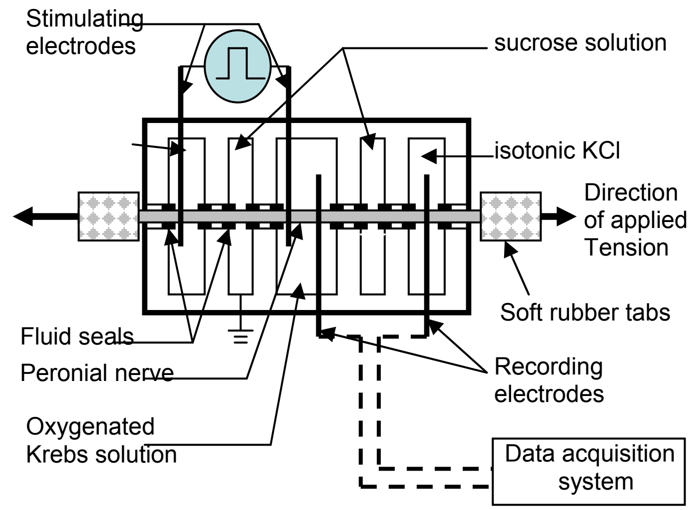

Figure 3 Combined electrophysiological and mechanical sucrose gap chamber