Title: CRITICAL BLOCKING LENGTH AS RELATED TO CONDUCTION VELOCITY

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Introduction. The length of nerve fiber exposed to local anesthetics is a well known variable during blockade of nerve transmission. Large myelinated fibers require that a minimum of 3 nodes of Ranvier, or 3 to 5 mm of nerve, be exposed to these drugs (1). In clinical practice, local anesthetics are applied to nerve trunks made of numerous fibers wrapped by various sheaths. Under these circumstances a longer segment, depending on the internodal distance, must be exposed to obtain blockade. The length of this segment has not been studied and frequently is neglected as one important variable in experimental protocols; thus, it is not surprising that the concentration of lidocaine required for a given nerve block varies from 0.25 to 20 mM(2).The objective of this work was to study the critical blocking length in nerves exposed to a concentration of lidocaine which when applied to a segment 5-7 mm long (theoretically containing more than 3 nodes of Ranvier) produced only minimal effect on slow (<50 m/sec) and none on faster (>50 m/sec) conducting fibers.

Methods. Sciatic nerves from winter bullfrogs having a diameter of approximately 1.0 mm were placed in a bath of amphibian Ringer's maintained at room temperature and buffered to pH 7.0. This bath was divided into 4 compartments for the application of local anesthetics; two additional compartments located at each extreme were used respectively for stimulation and recording through platinum electrodes inmersed in mineral oil. Three of the 4 bath compartments accommodated segments of the nerve approximately 6 mm long; in the 4th compartment a much longer segment could be contained. Fresh solution of lidocaine 5 mM was prepared from its hydrochloride salt, dissolved in Ringer's and buffered to a pH of 7.0. The anesthetic was applied for 10 minutes, first in one of the small compartments to a 6 mm segment of the nerve, followed by washout and application to segments of 12 mm (2 compartments) and then of 18 mm (3 compartments). The preparation was washed and the anesthetic applied to the larger compartment where it covered approximately 40 mm of the nerve. In a few experiments, this sequence was changed without significant effect. The nerve was stimulated with suprathreshold voltage at a frequency of 1 Hz, increased to 60 Hz during short testing periods. Recording and amplification of surface compound action potentials was made using standard neurophysiological technics. Amplitude of potentials generated by fibers conducting at different speeds were measured and divided in two groups: Faster (>50m/sec) and slower (<50 m/sec)conducting fibers.

Depression of the various segments by lidocaine was expressed as percentage change from control and analyzed for statistical significance using paired t test.

Results. Maximum depression of the slower fibers was obtained with lidocaine applied to a nerve segment 18 mm long; the faster conducting fibers required application to a nerve segment 40 mm long to obtain similar results (Table).

Discussion. Slower myelinated fibers are smaller with shorter internodal distances and therefore easier to depress with a concentration of local anesthetic that may not affect faster fibers. It follows that this difference should not exist if a segment of the nerve long enough is exposed to this anesthetic concentration. In these experiments, we have found the critical blocking length (80% depression in 10 minutes), for fibers conducting at <50 m/sec to be much longer than the length predicted from internodal distances; by doubling this critical length, the anesthetic produced the same depression in faster (>50 m/sec) conductivity fibers. The degree of depression for both groups was not significally different. Raising the drug concentration should reduce, and lowering should increase the critical length within some theoretical limit given by effects on single fibers. These results show the importance of standardizing experimental protocols when referring to potency of a given anesthetic over different groups of nerve fibers in a nerve trunk.

References.1. Franz DD and Perry RS: Mechanisms for differential block among single myelinated and non-myelinated axons by procaine. J Physiol. 236:193-210, 1974.
2. Covino, B and Vasallo H: Local anesthetics Grune and Stratton, New York, 1976. pp 43.

Depression-% of Control (S.D.)

Speed	> 50 m/sec		< 50 m/sec	
Freq. Stim	1Hz	60 Hz	1 Hz	60 Hz
6 mm	100.5 (2.47)	100.5 (2.47)	53.25 (7.71)	37.0 (11.44)
12 mm	86.5 (3.01)	79.0 (6.26)	46.5 (15.06)	24.0 (19.61)
18 mm°	90.75 (4.05)	80.75 (7.65)	15.0 (10.85)	4.5 (4.5)
40 mm*	13.25 (7.72)	0	18.25 (12.29)	0

°P .01 for fibers 50 m/sec when compared to 6 mm.
*P .01 for fibers 50 m/sec when compared to 18 mm.