Title: LOCAL ANESTHETIC FREQUENCY DEPENDENT BLOCK

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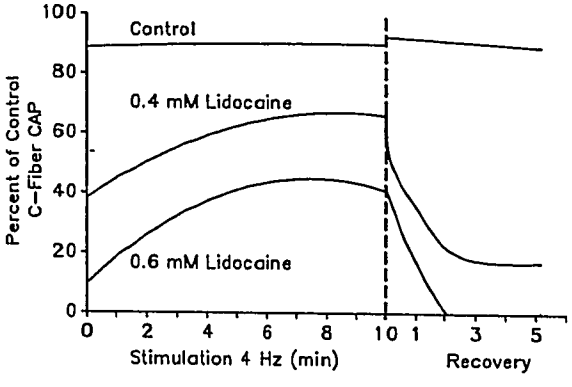
Introduction. The differential sensitivity of nerve fibers to local anesthetics is of considerable importance to the anesthesiologist. In general, the small, myelinated fibers (A-delta) are blocked at lower concentrations than the large, myelinated fibers (A-alpha and A-beta). C-fibers are blocked at about the same concentration as A-delta fibers. These conclusions are based on experiments where the nerve was stimulated at low rates -- often less than 0.1 Hz. However, the impulses in peripheral nerves are often being propagated at much higher rates. The purpose of these experiments was to determine the effect of stimulating a peripheral nerve at 4 Hz on the concentration of lidocaine required to block the different fiber types (A-beta, A-delta, C).

Methods. Eight cats were used for these experiments. They were cared for by the Department of Laboratory Animal Medicine until used. Each animal was anesthetized with 50 mg/kg ketamine, intubated and then maintained with 0.2% to 0.5% methoxyflurane delivered in 70% N_2O and 30% O_2. Venous and arterial lines were established in the jugular vein and carotid artery respectively. Arterial blood gases, body temperature, and urine output were monitored and maintained within normal limits. Systolic blood pressure was maintained between 100 and 130 torr. Approximately 5 cm of the saphenous nerve was isolated from the surrounding tissue and a plexiglass chamber slipped around the nerve. The slotted ends of the chamber were sealed with vaseline. Warm (35-36°C), oxygenated solutions of lidocaine dissolved in balanced salt solution were applied to the nerve as it passed through the chamber. The chamber was perfused at about 4 ml/min. The nerve was stimulated proximal to the chamber and the evoked compound action potential (CAP) picked up distal to the chamber by bipolar electrodes. The distance between the recording and stimulating electrodes was about 6 cm. The signal was amplified, digitalized, and then plotted. The amplitudes and latencies of the CAP's were measured from the plotted data. The A-beta and A-delta fibers were stimulated 40 times at 50 Hz. The amplitude of the first CAP of the train in the absence of lidocaine was the control value. The percent block was determined relative to this value. The C-fibers were stimulated four times at 0.5 Hz and the CAP's averaged to give the control value. The averaged amplitude of the C-fiber CAP in the absence of lidocaine was the control value. The percent block was determined relative to this value. Then the nerve was stimulated 10 minutes at 4 Hz to determine the effect of stimulation on the C-fibers. After 10 minutes, the nerve was stimulated only occasionally to follow the recovery of the C-fibers. During the 4 Hz stimulation and recovery, 4 consecutive CAP's were averaged to improve the signal-to-noise ratio. The nerve was exposed sequentially to balanced salt solution, 0.2 mM lidocaine, 0.4 mM lidocaine, 0.6 mM lidocaine, and finally balanced salt solution. The concentration of lidocaine which caused a 50% decrease in the amplitude of the CAP (half-blocking concentration) was used for statistical analysis. Data from experiments where the amplitudes of the CAP's had decreased more than 50% or the latency had increased more than 10% was not analyzed. This occurred in three cats.

Results. A-beta fibers were unaffected by stimulation at 50 Hz in the presence or absence of lidocaine. When not exposed to lidocaine, the A-delta fibers were also unaffected by stimulation at 50 Hz. In the presence of lidocaine, the CAP of the A-delta fibers was diminished slightly at 50 Hz. In the absence of lidocaine, stimulation at 4 Hz for 10 minutes caused a decrease in the amplitude of the C-fiber CAP of about 10-20%. In the presence of lidocaine, stimulation at 4 Hz caused an increase in the amplitude of the C-fiber CAP. The figure below shows a typical result.



The table shows the quantitative effects of stimulation on the blocking concentrations of lidocaine.

	Half-Blocking Concentration			
Fiber Types	A-beta	A-delta	C(0.5Hz)	C(4Hz)
Conc. of lidocaine (N=5), AVE	0.48	0.22	0.25	0.46
SD	0.08	0.04	0.06	0.11
$p < .01$			a	b
$p < .005$	b	a		b

Discussion. These experiments show that under conditions of continuous stimulation, C-fibers are as resistant to lidocaine conduction block as are large, myelinated, A-beta fibers. Certainly nociceptive information is not transmitted by a constant 4 Hz barrage. However, these experiments do show that an actively conducting nerve could overcome a local anesthetic conduction block. This might help explain some cases of tourniquet pain.