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Title : LOCAL ANESTHETIC BLOCKADE OF CANINE A- AND C-FIBERS

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INTRODUCTION. Clinical observations during local anesthetic regional blocks have indicated that in most instances sensory nerves are blocked before motor nerves. This clinical observation has been difficult to explain since empirical laboratory research in the area of differential blockade has been contradictory. The purpose of this research was to develop a method for the study of mammalian peripheral nerve *in vitro*, in order to study the effects of local anesthetics on mammalian A- and C-fibers.

METHODS. Phrenic nerves were removed from mongrel dogs being sacrificed for other research work. The nerves were desheathed, placed in a temperature controlled, multi-chambered bath, with the central end over a pair of stimulating electrodes. A constant-current square pulse stimulator was adjusted to evoke the maximum action potential (MAP). Recording electrodes were connected to an appropriate pre-amplifier, a high-low pass filter, and the evoked potentials displayed and conduction velocity measured on an oscilloscope. After a stable control MAP was obtained, the modified Krebs-Henseleit bathing solution in the exposure chamber was replaced for two minutes with the same solution containing a local anesthetic and recordings of MAPs were made every minute. Using a clinically relevant concentration ratio of 4:1 (lidocaine:bupivacaine), the time course of local anesthetic blockade and recovery of A- and C-fibers was studied. A-fibers were identified by a characteristically stable MAP having a mean conduction velocity of 47m/sec. C-fibers were identified by a generally smaller, less stable MAP having a mean conduction velocity of one m/sec.

RESULTS. The mammalian peripheral nerve *in vitro* preparation is extremely sensitive to changes in temperature. The MAP decreased and velocity changed if temperature was above or below normal canine body temperature. Therefore, all of the following observations were carefully made with the nerve maintained within 1°C of normal body temperature. The time course of local anesthetic blockade is described in the Table. The average values shown for blockade and recovery for lidocaine and bupivacaine were compared statistically using a t-test. Conduction velocity in A-fibers remained depressed after bupivacaine blockade.

DISCUSSION. In his investigation of the electrophysiology of peripheral neural conduction, Rud[1] reported that the MAP of the frog sciatic nerve preparation was optimized at the animal's normal body temperature. Rud found only a 10% depression of MAP with an increase or decrease of 7°C. In our preparation, mammalian nerves showed a distinctly more temperature-dependent response. Although the time course of onset of blockade of A-fibers was longer for bupivacaine, there was no difference in the pattern of slowing and depression of the MAP. Since the time course of blockade is concentration-dependent, it is possible to produce identical time-courses of blockade onset by adjustment of the concentrations of the two drugs. However, the prolonged recovery time and persistent depression of A-fiber conduction velocity seems characteristic only of bupivacaine in this preparation.

Our most dilute solution, bupivacaine 0.02%, provided a clear example of differential temporal blockade by blocking C-fibers within 2 minutes while requiring an average of 5.4 minutes to block A-fibers. This may conflict with the work of Gissen[2] *et al* who computed dose-response curves for fast and slow conducting fibers and projected the fast fibers should be blocked before slow fibers. Our work agrees with that of Nathan and Sears[3] who found that the greatest degree of differential blocking occurs with weaker anesthetic solutions.

TABLE: TIME COURSE OF BLOCKADE

	Lidocaine	Bupivacaine
A-Fibers		
Time to Block (min)	2	5.4*
Max % MAP Blocked	100	86
Time to Recovery (min)	19	25.4
Max % MAP Recovery	90	83
C-Fibers		
Time to Block (min)	1.5	2**

*Line avg. are signif. different ($p<0.01$).
**Bupivacaine A- to C-fiber comparison of avg. Time to Block is sig. dif. ($p<0.05$).

REFERENCES.

1. Rud J: Local anesthetics. An electrophysiological investigation of local anesthesia of peripheral nerves with special reference to xylocaine. Acta Physiol Scand 51(Supp 178):1-171, 1961

2. Gissen AJ, Covino B, Gregus J: Effect of local anesthetic drugs on fast and slow nerve fibers. Anesthesiology 51(Supp):S217, 1979.

3. Nathan P, Sears T: Some factors concerned in differential nerve block by local anaesthetics. J Physiol 157:565-580, 1961.