Title: VULNERABILITY OF SENSORY PATHWAYS TO LOCAL ANESTHETICS

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Introduction. Blockade of nerve conduction in the afferent (sensory) pathway is essential to induce successful regional anesthesia. However, the relative concentration of local anesthetics required to interrupt nerve transmission along this pathway, and likewise the vulnerability of its various structures, has not been established. Earlier studies by Frumin et al. (1) suggested the spinal ganglion as the site easier to block during segmental spinal block in man; anatomical and functional characteristics of the ganglion T cells support this suggestion (2). The purpose of this work was to investigate the vulnerability to local anesthetics of the afferent pathway outside the spinal cord.

Methods. Experiments were performed in isolated sciatic nerve–spinal cord preparations obtained from winter bullfrogs. These preparations were maintained at room temperature and perfused with amphibian Ringer's solution in a multicompartmental bath chamber made to accommodate independently the various nerve structures under investigation (peripheral nerve, dorsal root ganglion, and dorsal root). Lidocaine 5 mM freshly dissolved in the above solution and buffered to a pH of 7.0 was applied for 10 minutes to a segment (5 to 7 mm) of one of the 3 nerve structures under investigation. Following this application the preparation was allowed to recover to more than 80% of control before applying the anesthetic to a different structure and the process repeated with an identical protocol for a second and third time. The sequence of administration to the 3 nerve structures was randomly rotated at 12 different preparations. Standard neurophysiological techniques were used for amplification and display of nerve action potentials generated by two groups of A fibers: α, with conduction speed >50 m/sec and β, <50 m/sec. These potentials were recorded from the dorsal roots just before their entry into the spinal cord; stimulation was made using electrical pulses of 0.1 msec duration and suprathreshold voltage delivered through platinum electrodes to the distal end of the sciatic nerve at a frequency of 1 Hz, and increased to 30–60 Hz during short testing periods.

Results. Results (Figure) indicate that nerve fibers in the slower (>50 m/sec) conducting groups are depressed by the application of lidocaine 5 mM for 10 minutes, faster conducting fibers are little affected regardless of the site of administration. The segment containing the dorsal root ganglion is the most vulnerable structure in the afferent pathway before entering the spinal cord, second in vulnerability are the dorsal roots and last the peripheral nerve. The difference between the roots and the ganglion was greater when only first applications to these structures were compared. (Figure) Lidocaine, when placed in contact with the dorsal root ganglion blocked nerve transmission in the slower conducting fibers not only by depressing the amplitude of the action potential in response to single pulses (1 Hz), but more effectively by limiting their frequency response.

Discussion. Although this work did not study pain conducting fibers, effects in the slower conducting fibers may be considered similar to those observed in pain pathways (3). This study indicates that the sensory input to the spinal cord of the frog, especially when transmitted at high frequency and through small myelinated and unmyelinated fibers (pain type of transmission), is preferentially depressed at the dorsal root ganglion, when a low concentration of lidocaine is applied for a few minutes to short segments of the afferent pathway.

References.

*P < 0.01 when compared to other structures.