Title: AN ANIMAL MODEL OF INTRAPLEURAL ANALGESIA

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Introduction. Intrapleural analgesia is effective for postoperative pain relief following operations involving sub-costal incision [1]. In practice an epidural catheter is placed percutaneously between the visceral and parietal pleura and injected with local anesthetic as needed for pain relief. The site of neural blockade is presumed to be the intercostal nerves (IN) as they course proximally under both the overlying parietal pleura and rib. Other possibilities include pleural nerve endings, paravertebral nerve block, and subarachnoid or epidural nerve block. In order to more precisely define the site of neural blockade, we developed a canine model of intrapleural analgesia using evoked potentials (EPs) as a marker.

Methods. Three adult dogs were surgically prepared with chronic femoral arterial and venous catheters. The right seventh rib was exposed and 3 electrode pairs fastened to it with stainless steel screws and epoxy. Within an electrode pair the interelectrode distance was 5-8 mm. The distance between electrode pairs was 5-6 cm. Electrodes were similarly fastened to the ipsilateral laminae (L) of the fifth, seventh, and ninth thoracic vertebrae (T5, T7, T9). An electrode pair was also inserted into the skull overlying the contralateral sensorimotor cortex (SMC). The intrapleural catheter (IPC) was placed under direct vision over the rib. On the day of study, the dogs were anesthetized with 0.6% halothane/70%N_2O/30%O_2. The animals were then paralyzed with a loading dose of succinylcholine, followed by a constant infusion, and mechanical ventilation was initiated. Control EPs were recorded over a 1-2 hour period. For IN EP evaluations, the stimulus (2-5 mA) was applied at the T7 L and EPs measured at the distal (in relation to L), middle, and proximal electrode pairs (L to D, L to M, and L to P, respectively). In order to subsequently investigate the possible presence of a spinal component to intrapleural analgesia, additional control EPs were measured with: (1) stimulus (5 mA) at the T9 L and recording at the T5 L (L to L) and (2) stimulus at the T7 L, recording at the SMC (L to SMC). The IPC was then injected with 10 ml 0.5% bupivacaine (B). The EP measurements were repeated 30-90 min later. Experiments were done with the dog in 3 different horizontal positions: supine, IPC and rib electrodes lowermost (study-side down), and IPC and rib electrodes uppermost (study-side up).

Results. The EPs recorded on the IN (and L to L EPs) had a characteristic pattern of a small positive peak (P_1), followed by a large negative peak (N_1) and a second positive peak (P_2). Analyses were based on the maximum peak-to-peak ($P\text{-}N_1$) amplitudes and N_1 latencies. The L to SMC EP was identified by the more complex pattern commonly seen with cortical somatosensory EP analysis. As shown in the figures to the right (with the bars representing means ± SE), after IPC B administration, we observed the following IN EP changes: (1) with the dog in the study-side down position, amplitude and latency analysis indicated that virtually all of the IN block occurred at the distal electrode pair, with little or no effect at the more proximal loci; (2) in the supine position, all 3 rib loci were affected to a similar extent (although the L to D and L to M amplitudes were not significantly different from control); and (3) no IN block was observed with the dog placed study-side up. No changes in any component of the L to L or L to SMC EPs were found following IPC B with the dog placed in any position.

Discussion. In this model, IPC B produces a position-dependent IN blockade. The position dependency of the nerve block is undoubtedly a reflection of gravity-influenced pooling of the local anesthetic solution within the IP space. Thus, in the study-side down position, it was not surprising to find a substantial IN block only at the distal site - the lowest recording site of the 3 rib electrode pairs. In the supine position, pooling would be expected to occur at the proximal site - a locus through which all stimuli applied at L and recorded on the rib would have to pass. Our finding of a similar degree of IN block at all 3 sites supports this. In the study-side up position, pooling would occur away from the rib electrodes and as expected we found no change in IN EPs in this position. The preservation of L to L and L to SMC EPs, independent of dog position, argues against a component of spinal anesthesia, particularly since in preliminary evaluations, intrathecal injections of 1 ml B at the T7 level produced a complete loss of L to L and L to SMC EPs.

Reference

1. Reiestad F, and Stromskag KE: Intrapleural catheter in the management of postoperative pain. Reg Anesth 11:89-91, 1986.