Title: ANESTHESIA PROTECTS AGAINST SPINAL CORD INJURY IN THE RAT

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Introduction: Although anesthesiologists frequently manage patients at risk for spinal cord injury, the interaction between specific anesthetic regimens and spinal cord injury has not been evaluated. In this study, we evaluated the effect specific anesthetic regimens had upon neurologic outcome when administered during spinal cord injury.

Methods: Following approval by the Institutional Animal Studies Subcommittee, male, Sprague-Dawley rats (n=140) of similar weights were surgically prepared as follows: Day 1-placement of a subarachnoid catheter in the spinal canal.(1) Day 2-with normal neurological function verified, a balloon tipped catheter was placed in the epidural space via a midline laminotomy at L_{2-3} with the balloon at the thoracolumbar junction. A tail artery catheter was inserted. This procedure lasted 30-45 minutes and was followed by a 120 minute anesthetic recovery period, during which normal neurologic function was verified. Each rat was then randomly placed in one of the following groups: 1) Fentanyl-57 ug/kg and Nitrous Oxide-65%, 2) Halothane-1.33-1.44% end-tidal, 3) 5% Lidocaine-30 ul administered via the subarachnoid catheter, or 4) Awake. Physiological parameters (pH, $PaCO_2$, PaO_2, mean arterial pressure [MAP], serum glucose, hematocrit, and temperature) were monitored. When anesthesia was established the epidural balloon was inflated with a constant volume of air (0.1 ml) over randomly varying times (0, 3, 6, 9, 20, or 35 minutes). Each rat was evaluated daily by a blinded investigator, for the presence or absence of hind-limb paralysis through 7 post-insult days. Statistical analysis was performed on the physiological data using Dunnett's t-test comparing treatment groups (anesthesia) to control (awake). Dose-response curves were constructed on post-insult day 7 by plotting the duration of balloon inflation versus the percentage of rats that remained paralyzed.(2) Treatment groups were compared to control by analyzing the curves for slope and potency differences by group t-tests.

Results: Minor differences in the physiological data were observed (see table 1); with the awake group demonstrating the most optimal data (↑MAP, ↓glucose). There was a significant right shift in the dose-response curve for each anesthetic group as compared to the awake curve. This right shift demonstrates spinal cord protection by all three anesthetic regimens (see figure 1). $P < 0.05$ was used as significant.

Discussion: Differences in the physiological variables may have contributed to the differences from control of each anesthetic dose-response curve. However, the current study did not attempt to control these variables beyond maintaining them within clinical ranges. Also, if the anesthetic group physiological variables had been improved (↑MAP, ↓glucose) to equal the awake group, greater anesthetic protection may have been observed. Of interest is the observation that the fentanyl group demonstrated the greatest degree of spinal cord protection. This would seemingly contradict previous observations that narcotic antagonists provide spinal cord protection, and by inference narcotic anesthesia is detrimental.(3) Further studies are indicated to elucidate whether the anesthetic protectant effects are due to physiological variables, anesthetic regimens, or other as yet unknown pathologic interactions.

	A	H	F	L
MAP (mm Hg)	110 ±13	91 ±10*	108 ±9	100 ±19*
Hematocrit (%)	42 ±2	40 ±3*	42 ±2	41 ±4
Glucose (mg/dl)	150 ±11	163 ±28	209 ±47*	164 ±36

Table 1-Physiological Differences (mean ±SD). *Indicates a significant difference ($p<0.05$) from control. Anesthetic groups: A-awake (control), H-halothane, F-fentanyl/nitrous oxide, and L-lidocaine.

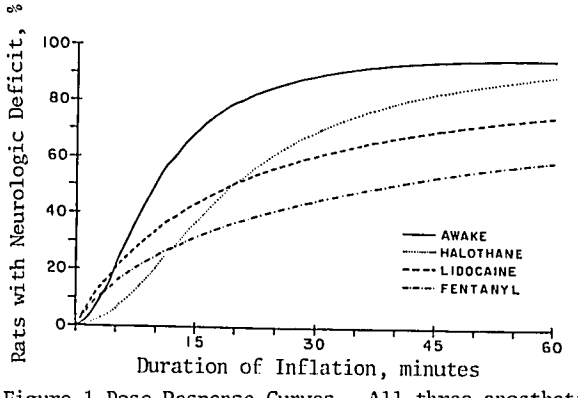

Figure 1-Dose-Response Curves. All three anesthetic regimens demonstrate spinal cord protection as compared to awake controls ($p<0.05$).

References
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