Title: SPINAL CORD METABOLISM IN CONSCIOUS AND ANESTHETIZED RATS

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Introduction. The metabolic rate of the spinal cord in conscious animals is not well established, and metabolic effects of general anesthetics in the spinal cord are equally poorly defined. The present experiments, therefore, had a two-fold purpose: to establish normal values for rat spinal cord glucose utilization (LSGU) and to determine the effects of pentobarbital (PB) and nitrous oxide (N_2O) on the metabolic rate of the tissues of this organ.

Methods. Albino rats were lightly anesthetized (1% halothane and 70% N_2O) for tracheostomy and femoral artery and vein cannulation. Wounds were infiltrated with 0.5% bupivicaine, halothane was discontinued, and the animals were paralyzed and artifically ventilated. One group of five rats received 70% N_2O/30% O_2 from a blender calibrated with an oxygen analyzer. Another 5 animals received room air and PB, 15 mg/kg IV and supplemented as necessary. Five control rats were partially immobilized by a loosely-fitting pelvic plastic cast and allowed to awaken. Arterial blood gas tensions, pH, blood pressure, and rectal temperature were monitored. Regional glucose utilization was measured quantitatively with the 2-[^{14}C]deoxyglucose ([^{14}C]DG) method[1] in lumbar spinal cord at least 1.5 hours after discontinuation of halothane. The autoradiographs produced by the method were analyzed with the aid of a computerized image-processing system. Statistical comparisons were made with the Dunnett's test for multiple comparisons.

Results. Mean arterial pressure was lower in PB animals (96 *vs* 130 mm Hg in N_2O animals), although still within physiologic range. The data (Table 1) show reasonably uniform metabolic rates in the gray matter of control animals. Laminae I-III and X represent the regions within gray with the lowest and highest LSGU, respectively. Spinal white matter has a lower LSGU than gray; in fact, the posterior funiculus is the least metabolically active of all cord regions examined. Cord metabolism in PB-treated animals is reduced, but the change is statistically significant only in laminae IV-VI (-20%) and the lateral funiculus (-20%). In contrast, statistically significant increases in LSGU occur during 70% N_2O in laminae IV-VI, VII, X and in the anterior and lateral funiculi. It should be noted, however, that changes of potential functional significance may fail to reach statistical significance because of the rigorous statistical analysis employed.

Discussion. The present data indicate that the lumbar spinal cord is one of the least metabolically active regions in the central nervous system of the conscious rat. Indeed, cord gray and white matter utilize glucose at rates well below those of most brain structures.[1] It is possible, however, that similar experiments conducted in freely moving animals would yield slightly higher values than those reported here. Levels of spinal adenine nucleotides are similar during PB or N_2O anesthesia,[2] and yet our data show that these drugs produce opposite effects on cord metabolism. PB reduces LSGU most in laminae IV-VI, a finding which supports electrophysiologic work[3] showing these laminae to be quite sensitive to barbiturate depression. On the other hand, the data suggest that PB-induced reductions (12-20%) in cord metabolism are less profound than those which occur in the brain of similarly treated animals.[1,4] The increases in LSGU during 70% N_2O were somewhat unexpected since this agent also reduces the frequency of neuronal discharge in some cord laminae.[5] Increases in brain metabolism have, nevertheless, been reported[4] during N_2O analgesia and, although controversial, are of a similar magnitude to those reported here. Thus, while PB and N_2O produce spinal cord metabolic effects which are qualitatively similar to those in brain, the data raise the interesting possibility that the cord is somewhat less susceptible to anesthetic-induced metabolic depression.

Table 1

GLUCOSE UTILIZATION ($\mu mol \cdot 100\ g^{-1} \cdot min^{-1}$)

	Control (5)	Pb (5)	N_2O (5)
SPINAL GRAY MATTER			
Lamina(e) I - III	36 ± 2	31 ± 2	41 ± 2
IV - VI	44 ± 1	35 ± 3*	53 ± 2*
VII	46 ± 2	39 ± 3	58 ± 3*
VIII	45 ± 1	39 ± 2	61 ± 3
IX	43 ± 1	38 ± 2	57 ± 3
X	50 ± 2	43 ± 3	64 ± 3†
SPINAL WHITE MATTER			
Posterior Funiculus	18 ± 1	17 ± 1	20 ± 1
Lateral Funiculus	30 ± 1	24 ± 1*	36 ± 2*
Anterior Funiculus	26 ± 0	25 ± 1	35 ± 3*

* $p < 0.05$ † $p < 0.01$

Data represent Mean ± SEM for the number of animals in parentheses.

References

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