TITLE: The Differential Effects of Isoflurane/Nitrous Oxide on Posterior Tibial Somatosensory Evoked Responses of Cortical and Subcortical Origin

AUTHORS: D. E. Wolfe, M.D. and John C. Drummond, M.D.

AFFILIATION: Departments of Anesthesiology, Veterans Administration Medical Center, La Jolla, University of California at San Diego, and U.S. Naval Hospital, San Diego.

Introduction: Posterior tibial somatosensory evoked responses (PTSSER's) have been widely employed to monitor spinal cord function intraoperatively. The most commonly used techniques entail the recording of responses of cortical origin using electrodes applied to the scalp.[1] Anesthetic agents, especially volatile anesthetics have repeatedly been demonstrated to cause considerable degradation of SSER wave forms of cortical origin.[2] By contrast, SSER's of subcortical origin have been shown to be more resistant to the effects of anesthetics, and the use of subcortical PTSSER's for intraoperative spinal cord monitoring has been proposed.[3] The following study was undertaken to systematically evaluate the relative effects of a volatile anesthetic, isoflurane, on PTSSER wave forms of cortical and subcortical origin.

Methods: With Human Studies Committee approval, ten adult subjects free of neurologic disease were studied. Induction was accomplished with thiopental 4-6 mg/kg and succinylcholine 100 mg. Thereafter, anesthesia was maintained with isoflurane and 60% nitrous oxide. Platinum needle electrodes were used to stimulate the posterior tibial nerve adjacent to the medial malleolus. 250 constant current impulses of 100 μsec duration delivered at 3.1 Hz were averaged for each SSER. SSER's were simultaneously recorded from four electrode montages placed according to the International 10-20 system as follows: Cz'-FPz (Cz' is 2 cm posterior to Cz), Cz'-C2S (second cervical spinous process), Cz'-LM (linked mastoid processes), FPz-C2S. Replicate SSER's were examined for reproducibility. Positive deflections were labeled P0, P1, and P2. P0 (approximate post-stimulus latency 34 μsec) is of subcortical origin. The later waves are of cortical origin. The amplitude of wave forms was measured from the positive peak to the subsequent negative deflection (labeled N0, N1, and N2). PTSSER's were recorded during administration of 0.5 MAC isoflurane/60% nitrous oxide, 1.0 MAC/60% nitrous oxide and 1.5 MAC/60% nitrous oxide. Thereafter nitrous oxide was omitted and recordings were repeated during 1.5 MAC isoflurane/O2 and 1.0 MAC/O2. Constant end tidal concentrations were maintained for 15 minutes prior to each determination. Data were analyzed using a repeated measures analysis of variance and paired t-tests.

Results: Each 0.5 MAC increment of isoflurane resulted in significant ($p<.001$) and substantial decreases in the amplitude of the wave forms of cortical origin. Elimination of 60% nitrous oxide during 1.5 MAC isoflurane anesthesia resulted in a significant recovery ($p<.04$) in the amplitude of these wave forms. The amplitude of the subcortical wave form (P0 - N0) was not statistically altered by changes in either isoflurane or nitrous oxide. The effect of isoflurane and nitrous oxide on latencies was minimal.

Discussion: The data confirm that isoflurane and nitrous oxide cause significant reductions in the amplitude of somatosensory evoked responses of cortical origin. These data support the notion that responses of subcortical origin are more resistant to the effects of anesthetic agents than are those which arise in cortical generators. Subcortical responses to posterior tibial stimulation can readily be recorded from vertex to linked mastoid or vertex to upper cervical spine montages. This investigation suggests that the use of subcortical responses during intraoperative spinal cord monitoring may reduce the incidence of SSER misinterpretation related to anesthetic induced variations in the recorded wave form.

References:
1. Grundy BL. Anesthesiology 58:72-87, 1983. 2. Peterson DO, Drummond JC, Todd MM. Anesthesiology 65:35-40, 1986. 3. Lueders H, et al. Spine 7:110-115, 1982.

AMPLITUDES (uV) OF POSTERIOR TIBIAL SOMATOSENSORY EVOKED RESPONSES DURING ANESTHESIA WITH ISOFLURANE/N2O AND ISO/O2

		0.5 MAC/N2O n=10	1.0 MAC/N2O n=10	1.5 MAC/N2O n=8	1.5 MAC/O2 n=8
P0-N0	Cz'-FPz	-	-	-	-
	Cz'-C2S	.50 ± .19	.53 ± .23	.48 ± .22	.47 ± .21
	Cz'-LM	.39 ± .18	.40 ± .17	.39 ± .15	.35 ± .16
	FPz-C2S	.58 ± .22	.57 ± .26	.55 ± .22	.49 ± .25
P1-N1	Cz'-FPz	1.21 ± .67	*.63 ± .55	.28 ± .29	.67 ± .53
	Cz'-C2S	.98 ± .64	*.60 ± .36	.26 ± .22	.66 ± .42
	Cz'-LM	1.05 ± .66	*.62 ± .39	.30 ± .24	.69 ± .41
	FPz-C2S	-	-	-	-
P2-N2	Cz'-FPz	1.02 ± .66	*.44 ± .41	.18 ± .22	.41 ± .34
	Cz'-C2S	.97 ± .67	*.44 ± .39	.19 ± .25	.40 ± .37
	Cz'-LM	.99 ± .70	*.43 ± .37	.18 ± .22	.42 ± .30
	FPz-C2S	-	-	-	-

Values are mean ± SD. n=number of subjects at each anesthetic level. * indicates level at which significant ($p<.05$) difference from baseline (0.5 MAC/N2O) first occurred.

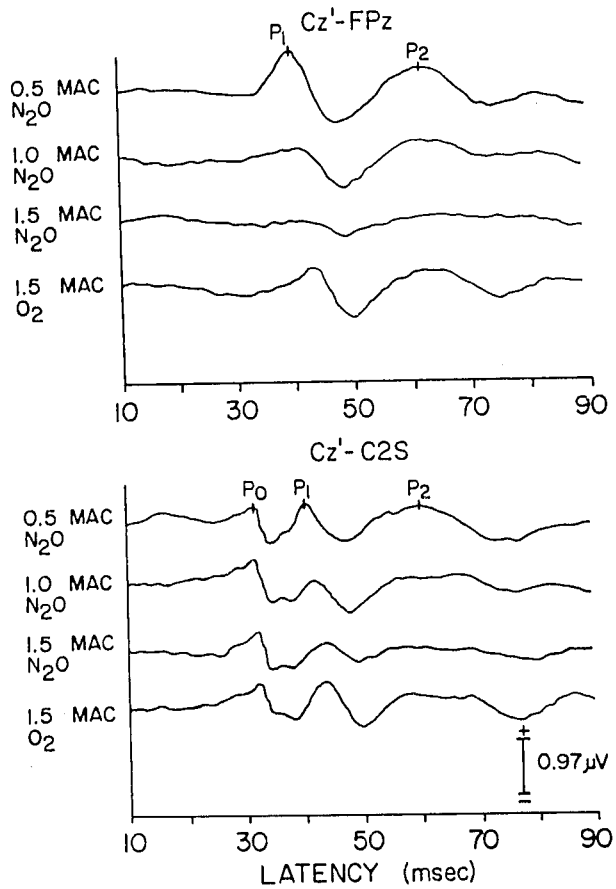

Figure. PTSSER's recorded simultaneously in the Cz'-FPz (top) and Cz'-C2S (bottom) montages during anesthesia with isoflurane/N2O and isoflurane/O2.