Title: KETAMINE ENHANCES SOMATOSENSORY EVOKED POTENTIALS IN MAN BUT FAILS TO PREVENT THE DEPRESSANT EFFECT OF NITROUS OXIDE

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Introduction: Many commonly used anesthetics affect human somatosensory evoked potentials (SSEPs) by depressing amplitude and prolonging latency to varying degrees. This can interfere with effective recording of SSEPs especially when it is desirable to monitor cortical responses. Only one anesthetic, etomidate, is known to enhance cortical SSEP amplitude consistently(1). It is conceivable that other anesthetics may have similar properties and could therefore be utilized to facilitate intraoperative SSEP monitoring. The facilitatory property of ketamine (K) anesthesia on intraoperative SSEPs during correction of scoliosis surgery has been mentioned (2), but systematic data regarding the interaction of K and SSEPs have not been reported previously. In an effort to identify anesthetics with potentially SSEP enhancing properties, we studied the effect of K with and without the addition of nitrous oxide (N2O) on human median nerve SSEPs.

Methods: With institutional approval and informed consent, 16 neurologically normal patients (ages 25-46 years) undergoing elective pelvic and abdominal procedures were studied. All patients were premedicated with lorazepam 2-4 mg PO at least one hour prior to induction. Anesthesia was induced with K (2 mg/kg IV bolus) and maintained by continuous infusion of K at a rate of 30 µg/kg/hr, nondepolarizing neuromuscular blockade (atracurium) and 100% oxygen. IV Labetolol was administered when blood pressure exceeded 200/100 (3 patients). SSEPs were recorded immediately preinduction and at 2, 5, 10, 15, 20 and 30 minutes postinduction (PRE, T2 - T30). With surgical incision, which occured in all cases within 5 minutes of T30, N2O (70 % inspired) was added, using a 10 l/min total gas flow. SSEP recordings were continued at 1, 5, 10 and 15 minutes after N2O was introduced (T30, N1 - N15). Thereafter, N2O was discontinued for 15 minutes and SSEPs were recorded at 5 minute intervals (OFF5-OFF15)). Throughout the study period ventilation was controlled to maintain end-tidal carbon dioxide tension (ETCO2) between 28 and 32 mmHg. Adequate oxygen saturation (>95% by pulse oximetry) of was ensured at all times.

SSEPs were elicited by unilateral median nerve stimulation and were simultaneously recorded from surface electrodes at Erb's point, the second cervical vertebra and the contralateral cortex (C3' or C4'), using standard stimulus and recording parameters. The waveforms of interest consisted of a negativity at approximately 10 msec (Erb's), 14 msec (CIIs), and 19 msec (N1) followed by a positive deflection at 21 msec (P1). Trough-to-peak amplitude was measured using the respective waveform peaks immediately following Erb's, CIIs and N1. Central conduction time (CCT) was obtained from the CIIs-N1 interlatency difference. With each SSEP recording, mean systemic blood pressure (MBP), heart rate (HR), pharyngeal temperature (T), ETCO2 and N2O (ETN2O) tensions were measured. Care was taken not to cool the stimulated extremity. The data were evaluated using a repeated measures analysis of variance and the Newman-Keuls procedure for multiple comparisons.

Results: Mean SSEP latency and amplitude, MBP, HR , T and ETCO2 appear in tables 1 and 2. MBP and HR increased significantly after ketamine. SSEPs were recorded without difficulty throughout the study period. With the exception of a small increase in the Erb's latency, mean cortical and noncortical latencies remained unchanged with K and K+N2O, as did CCT. Cortical amplitude after K increased significantly by approximately 16%, ranging from 7-73% at T5 and from 6-68% at T30. The addition of 70% N2O resulted in an immediate decrease in mean cortical amplitude by approximately 50%, which recovered rapidly on discontinuation of N2O but failed to reach pre-N2O baseline (see figure) .

Discussion: The data indicate that K, when used as the sole anesthetic, enhances the cortical amplitude of human median nerve SSEPs for at least 30 minutes. The effect observed with N2O added to K is consistent with previously known effects on cortical SSEPs by N2O alone. Therefore, K was ineffective at preventing the depressant effect of N2O on cortical SSEP amplitude. While K is rarely suitable as a sole anesthetic for patients with central nervous system disease, combinations of K with other anesthetics could be advantageous in certain situations(3,4). Further studies of anesthetic regimens incorporating K are needed to investigate whether this agent can counteract the tendency of other anesthetics to depress the cortical SSEP and therefore facilitate the monitoring of intraoperative SSEPs.

References:

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Fig.: EFFECT OF KETAMINE AND 70% N2O ON CORTICAL AMPLITUDE (Mean±SD)

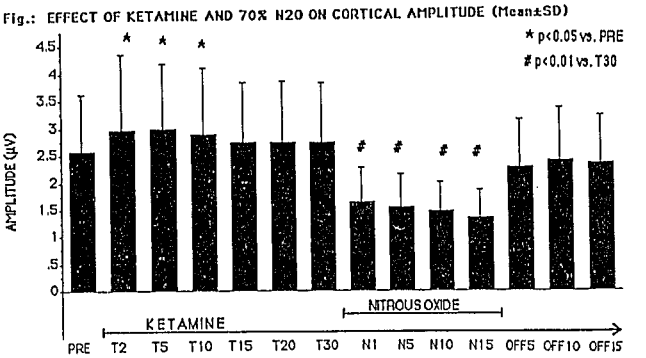

Table 1: LATENCY, AMPLITUDE AND PHYSIOLOGIC DATA AFTER KETAMINE

n=16	PRE	T2	T5	T10	T15	T20	T30
Latency(ms):							
Erbs	10.2±0.9	10.5±1.0*	10.5±1.0*	10.5±1.0*	10.5±1.0*	10.5±1.0*	10.5±1.0*
CIIs	13.4±1.0	14.5±1.1	13.4±1.3	13.5±1.2	13.5±1.2	13.5±1.2	13.54±1.18
N1	18.6±1.3	18.6±1.2	18.6±1.3	18.6±1.2	18.7±1.2	18.7±1.2	18.7±1.2
P1	21.6±1.1	21.4±1.3	21.3±1.2	21.4±1.2	21.4±1.3	21.4±1.3	21.3±1.2
CCT	5.2±0.7	5.2±0.4	5.1±0.4	5.2±0.5	5.2±0.4	5.2±0.4	5.2±.5
Amplitude(µV):							
Erbs	2.55±1.26	2.26±1.21	2.28±1.13	2.25±1.14	2.10±0.94#	2.07±0.89#	2.03±0.89#
CIIs	2.41±0.87	2.21±0.96	2.21±0.94	2.28±0.86	2.21±0.90	2.25±0.85	2.20±0.88
N1-P1	2.56±1.05	2.97±1.39*	2.98±1.20*	2.90±1.22#	2.75±1.09	2.76±1.12	2.74±1.11
MBP(mmHg)	92±11	110±13*	119±13*	117±10*	114±9*	111±7*	109±10*
HR(b/min)	79±17	92±18*	100±20*	106±18*	102±16*	100±16*	95±18*
T(C)	-	36.4	36.4	36.4	36.4	36.5	36.4
ETCO2(mmHg)	-	29±2	31±2	32±3	32±3	31±2	30±2

*p<0.01 vs PRE #p<0.05 vs PRE

Table 2: LATENCY, AMPLITUDE AND PHYSIOLOGIC DATA WITH 70% N2O ADDED TO KETAMINE

n=16	T30	N1	N5	N10	N15	OFF5	OFF10	OFF15
Latency(ms):								
Erbs	10.5±1.0	10.5±1.0	10.49±1.0	10.4±1.0#	10.4±1.0*	10.4±1.0*	10.4±1.0#	10.4±1.0*
CIIs	13.5±1.2	13.5±1.1	13.4±1.2*	13.4±1.1*	13.3±1.2*	13.3±1.1*	13.3±1.1*	13.4±1.1*
N1	18.7±1.2	18.6±1.2	18.7±1.4	18.4±1.3	18.6±1.4	18.6±1.2	18.6±1.1	18.7±1.2
P1	21.3±1.2	21.4±1.3	21.4±1.3	21.3±1.3	21.4±1.2	21.2±1.1	21.3±1.1	21.4±1.2
CCT	5.2±0.5	5.3±0.4	5.3±0.6	5.0±0.6	5.2±0.5	5.3±0.5	5.3±0.4	5.3±0.4
Amplitude(µV):								
Erbs	2.03±0.89	1.98±0.94	2.09±0.87	2.17±0.90	2.10±0.94	2.30±1.14	2.46±1.29	2.47±1.36
CIIs	2.20±0.88	1.98±0.80	2.17±0.79	2.15±0.73	2.21±0.79	2.40±0.82	2.36±0.88	2.37±0.85
N1-P1	2.74±1.11	1.64±0.63*	1.55±0.61*	1.47±0.63*	1.35±0.52*	2.28±0.87*	2.42±0.97*	2.35±0.89*
MBP(mmHg)	109±10	107±9	107±8	104±13	104±10	102±12	100±11	102±12
HR(b/min)	94±18	90±15	85±16	81±18*	80±15*	89±18	88±18	86±16
T(C)	36.4±0.5	36.4±0.5	35.4±0.4	36.3±0.5	36.3±0.5	36.2±0.4	36.2±0.5	36.3±0.5
ETCO2(mmHg)	30±2	32±2	32±2	31±2	30±2	28±2	30±2	30±2

*P<0.01 vs. T30 #p<0.5 vs T30