

Title: CAN THE EEG BE USED TO MONITOR ANESTHETIC DEPTH FOR ALFENTANIL WITH N<sub>2</sub>O?

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Excessive interoperative anesthetic depth resulting in postoperative respiratory depression is a major clinical limitation of narcotic:nitrous oxide anesthesia. Scott et al<sup>1</sup> have shown that alfentanil (AF) plasma concentrations (C<sub>p</sub>) can be related to the degree of EEG slowing measured with power spectral analysis. The present study determined if clinical hemodynamic measures of AF anesthetic depth are correlated to the degree of EEG slowing as measured with the spectral edge frequency (SE = 95% of EEG power) or median frequency (MF = 50% of percentile of power) during perioperative surgical stimuli.

**Methods.** After informed consent, 15 ASA I or II female patients undergoing lower abdominal gynecology surgery were studied. Following 10 mg IM diazepam premedication, anesthesia was induced with a computer driven infusion pump (TIAC, Janssen Scientific) that achieved a predicted AF-C<sub>p</sub> of 500 ng/ml. Succinylcholine (1 mg/kg) was given for tracheal intubation and ventilation with N<sub>2</sub>O (70%) was performed. After 5 min of drug administration laryngoscopy and intubation were performed. A response to perioperative stimulation was defined as 1) systolic blood pressure > 15 mmHg over pre-operative baseline, 2) heart rate > 90 beats/min, 3) somatic responses of voluntary movement, 4) lacrimation, flushing or tearing. The AF-C<sub>p</sub>'s were maintained with TIAC and increased in steps of 50 ng/ml if one of the above clinical signs were evident. If the patient had no response to the perioperative stimuli during a 15 min interval, the AF-C<sub>p</sub> were allowed to decline in steps of 50 ng/ml.<sup>2</sup> A 4-lead EEG montage was continuously recorded for subsequent offline Fourier waveform analysis. Systolic blood pressure and pulse were recorded from a radial arterial line. Frequent arterial blood samples were obtained for measurement of AF-C<sub>p</sub>. The presence or absence of the above clinical hemodynamic responses relative to SE and MF was examined at two perioperative stimuli: 1) tracheal intubation, 2) the initial abdominal skin incision to peritoneal dissection.

**Results.** INTUBATION: (Table 1.) None of the patients demonstrated clinical signs of inadequate anesthesia at the indicated SE and MF values. Systolic BP and pulse actually decreased from the alfentanil induction. SKIN INCISION TO PERITONEAL DISSECTION: (Table 2, fig 1 & 2) All 15 patients had an increase of systolic blood pressure > 15 mmHg from control during this period (Table 2, fig 1 & 2). The SE and MF increased significantly (repeated measures ANOVA with tukey contrast procedure) after skin incision but before the hemodynamic response was evident. A further significant increase in EEG frequency occurred during the hemodynamic response. An increase of AF-C<sub>p</sub> resulted in hemodynamic control and a decrease of SE and MF to values similar to the pre-incision period.

**Conclusions.** From awake to post intubation, it was possible to define SE and MF values that were

associated with no clinical response to intubation. For the skin incision and peritoneal dissection, EEG activation (increased SE and MF) occurred prior to and during the clinical response. This shift of EEG frequency was statistically significant but small in absolute value. There was a moderate degree of variability in pre-incision EEG frequencies and EEG response between patients group. This study suggests that within a patient an increase of the EEG frequency can be used to indicate pending or existing inadequate surgical anesthesia.

Table 1: EEG/Hemodynamic Responses to Intubation

Parameter	(Mean ± SD) Awake	Post Intubation
Spectral edge (Hz)	19.9 ± 3.7	8.8 ± 1.9
Median Frequency (Hz)	8.7 ± 1.4	3.2 ± 0.5
Systolic BP (mmHg)	136 ± 17	119 ± 17
Pulse (beats/min)	93 ± 16	79 ± 14
AF-C <sub>p</sub> (ng/ml)	0	507 ± 14.9

Table 2: EEG/Hemodyn. Responses to Skin Incision/Perito. Dissect. (Mean ± SD)

Parameter	Post Skin			
	Pre-Skin Incision	Pre-response	During Response	Post Response
SE (Hz)	11.4 ± 3.3	13.1 ± 2.6	14.8 ± 2.6	11.5 ± 2.7
MF (Hz)	3.2 ± 1.0	3.9 ± 1.1	5.2 ± 1.6	3.8 ± 1.5
Sys. BP(mmHg)	114 ± 14	122 ± 14	143 ± 13	126 ± 16
Pulse(/min)	76 ± 12	76 ± 10	84 ± 9	77 ± 7
AF-C <sub>p</sub> (ng/ml)	312 ± 12	291 ± 107	341 ± 110	441 ± 170

Figure 1: SE response prior to skin incision, after skin incision but prior to hemodynamic response, during the hemodynamic response and after the response was treated with an increase of the AF-C<sub>p</sub>.

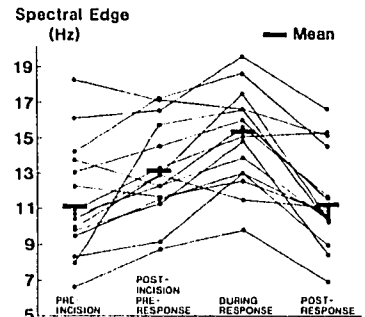
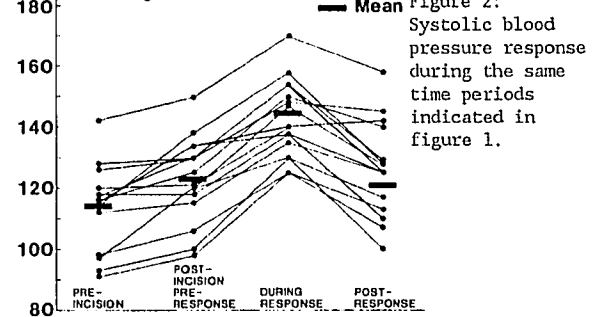


Figure 2: Systolic blood pressure response during the same time periods indicated in figure 1.



Ref. 1. Scott et al. Anesthesiology 62:234, 1985.  
2. Ausems et al. Anesthesiology 65: 362, 1986.