Title: EEG Effects of Thiopental After a Narcotic Induction

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Introduction: As the electroencephalogram (EEG) becomes more common in the O.R. for monitoring of depth of anesthesia, awareness, and cerebral ischemia, it is important to consider the effects of multiple anesthetics on the EEG. The effects of thiopental (STP) and high-potency narcotics are profound and have been examined before[1,2]. However little is known about how these drugs, when combined, affect the EEG, although that is how they are commonly used. For instance, STP has been shown to have a bimodal effect, where at low doses it activates the EEG, and at higher doses it causes marked depression of the EEG to burst suppression and electrical silence[3]. Do these effects still occur after a large dose of narcotic?

Methods: Fourteen unpremedicated patients (ages 22-65) for major surgery were brought to the OR. Informed consent and IRB approval was obtained. After a 3-5 minute baseline EEG, an equipotent bolus of either sufentanil (S) 125µg or fentanyl (F) 1250µg (selected randomly) was given IV. After 4-5 minutes, 1-3 mg/kg of STP was given as a bolus. In 4 patients, additional narcotic was administered prior to the STP bolus, to verify that maximal narcotic EEG effects had been obtained. Muscle relaxants were given to allow assisted mask ventilation. Bilateral frontal-occipital leads were recorded using a Beckman EEG machine and Vetter FM tape recorder. A power spectral analysis of the analog EEG signal was obtained offline using Fourier analysis with a DEC PDP 11/73. The 95% spectral edge (SE) was calculated from each 5.12 second epoch and smoothed as a moving average of 10 epochs. The onset of the STP EEG effect was easily determined from the SE vs Time curve (Fig 1). The magnitude of the SE change due to STP was determined as the maximum SE value within 2 minutes after the STP bolus.

Results: Six patients received F and 8 patients received S. There was no significant difference between the ages and weights of the two groups. The narcotic and STP boluses were well tolerated by all patients, with maintainance of stable hemodynamics and adequate ventilation. In every patient, the EEG showed a marked decrease in frequency and increase in amplitude (delta waves) after the narcotic bolus. In 12 of the 14 patients, an additional effect was observed in the raw EEG after the STP bolus. This effect was an increase in high frequency, low amplitude waves "on top" of delta waves (Fig 1). The SE increased markedly in these 12 patients within 30 seconds of the STP bolus (Figure 2, Table 1). There was no significant difference in the SE change due to STP between the F and S patients (Table 1).

Discussion: It is well known that the EEG changes after a large bolus of a potent narcotic. It is of interest however, that the effects of low dose STP are retained even when it is given after a narcotic. These effects are seen both in the raw EEG and after computer processing. In the 2 patients receiving more than 3 mg/kg of STP, the activation due to the STP was less obvious, possibly because activation of the EEG is seen at low doses of STP and with higher doses the STP effects are similar to narcotic effects (large amplitude, low freq.).

EEG changes due to barbiturates, narcotics and volatile agents have been well described. Many of these studies have examined only one agent at a time. This study demonstrates that when narcotics and STP are given together, the EEG effects of each are retained. Further work is needed to precisely quantitate these effects, to evaluate different doses, and to combine these agents with volatile agents and/or benzodiazapines.

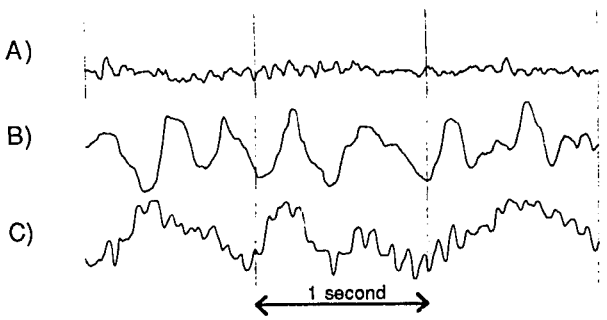


Fig. 1: EEG signal before and after boluses of sufentanil (S) and thiopental (STP). Tracing (A) was recorded during baseline period; tracing (B) at 3 minutes after S; and tracing (C) at 2 minutes after STP. Note slow waves after S, and fast waves "on top" of slow waves after STP.

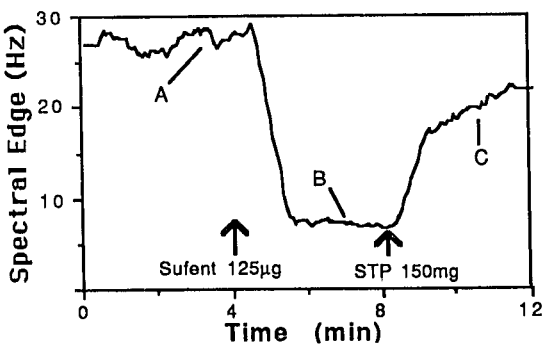


Fig. 2: Spectral Edge(SE) vs. Time. Arrows indicate the times at which S and STP were given. Points A,B, and C refer to times that the tracings in Fig. 1 were recorded. Figures 1 and 2 are from patient 14.

| Pt No. | Narc. | Dose | STP Dose | BaseSE | Narc SE | STP SE |
|---|---|---|---|---|---|---|
| 1 | F | 200 µg | 1.7mg/kg | 28.2 Hz | 7.1 Hz | 20.9Hz |
| 2 | S | 125 | 1.6 | 30.4 | 6.8 | 20.1 |
| 3 | F | 1250 | 1.4 | 28.1 | 9.6 | 18.2 |
| 4 | S | 175 | 1.0 | 32.4 | 5.4 | 20.7 |
| 5 | F | 1250 | 1.2 | 32.1 | 9.0 | 14.6 |
| 6 | S | 175 | 1.1 | 24.8 | 5.7 | 17.3 |
| 7 | F | 1250 | 1.7 | 31.8 | 8.7 | 23.5 |
| 8 | S | 225 | 1.5 | 26.4 | 10.6 | 17.6 |
| 9 | S | 125 | 3.3 | 25.2 | 10.0 | N/A |
| 10 | F | 1250 | 3.2 | 32.1 | 19.6 | N/A |
| 11 | S | 125 | 2.5 | 25.0 | 6.2 | 18.5 |
| 12 | F | 1250 | 2.2 | 26.0 | 9.4 | 24.4 |
| 13 | S | 125 | 2.8 | 20.2 | 9.8 | 24.8 |
| 14 | S | 125 | 2.6 | 27.9 | 7.3 | 19.4 |
| Fent | | | 1.9 (0.7) | 29.7(2.6) | 10.6(4.5) | 20.3(4.0) |
| Sufent | | | 2.0 (0.7) | 26.5(3.8) | 7.7(2.1) | 19.8(2.5) |

Table 1. SE values and Drug Doses for 14 Patients. BaseSE indicates baseline SE value. NarcSE indicates SE after narcotic bolus. STP SE indicates highest SE value within 2 minutes after SE bolus.Values at bottom are mean values (+/- S.D.).

References: 1. Kiersey D, et al: Br J Anaesth 23:141-152, 1951.
2.Sebel P, el at: Anesthesiology 55:203-211, 1981.
3.Winters W: Progress in Drug Research 26: 225-258, 1982.