

**TITLE:** IS LOWER ESOPHAGEAL CONTRACTILITY A RELIABLE INDICATOR OF THE ADEQUACY OF OPIOID ANESTHESIA?

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**Introduction:** Assessing the adequacy of anesthesia in the paralyzed patient is usually based on sympathetic and hemodynamic responses to stimulation. Such responses are not always reliable.<sup>1</sup> Somatic responses are not available in the paralyzed patient. The amplitude of provoked lower esophageal contractions (PLEC) and the rate of spontaneous lower esophageal contractions (SLEC) correlate with inhaled anesthetic MAC and are unaffected by skeletal muscle relaxants.<sup>1</sup> A device measuring PLEC and SLEC was developed as a potential monitor of the adequacy of anesthesia. The purpose of this study was to determine the reliability of such a device in detecting inadequate fentanyl (F) anesthesia.

**Methods:** Approval was obtained from the Human Investigations Committee. A total of 20 hemodynamically stable ASA physical class IV patients without esophageal disease scheduled for coronary artery surgery were studied. Premedication included midazolam (M) 0.5 mg/kg im and ranitidine 2 mg/kg po. Anesthesia was induced with F 50 ug/kg and maintained by a F infusion 0.2 ug·kg<sup>-1</sup>·min<sup>-1</sup>. Following tracheal intubation facilitated by succinylcholine 1 mg/kg, a disposable esophageal monitoring probe with a proximal air-filled distending balloon and a distal fluid-filled sensing balloon to measure PLEC and SLEC was inserted, and the data were displayed and recorded by the Lectron 302 (American Antec). Standard monitoring for cardiac surgery was utilized and a normal train-of-four twitch response was maintained. Clinical signs of inadequate anesthesia consisted of 1) movement, 2) tearing or sweating, 3) an increase in mean arterial pressure (MAP) > 15 mmHg over each patient's "normal" MAP defined as the most prevalent MAP measured on several occasions preoperatively, 4) an increase in HR by more than 15 beats per min over the "normal" HR. The presence or absence of these clinical signs were compared to SLEC and PLEC at times of 1) insertion of a nasal temperature probe, 2) skin penetration by towel clips, 3) skin incision, 4) sternotomy, 5) dissection of the internal mammary artery (multiple episodes of electrocauterization on sternal periosteum). The study was completed at the initiation of cardiopulmonary bypass. Inadequate anesthesia as demonstrated clinically was corrected by additional doses of F, M, or the addition of enflurane as required. SLEC and PLEC data were transformed into an esophageal contractility index (ECI) by the equation: ECI=70(SLEC) + PLEC. Data were analyzed by the t-test and p<0.05 was regarded as significant.

**Results:** The 20 patients received a total of 208 stimulations. The mean ±SD F concentration in plasma of all 20 patients during the study period was 29±15 ng/ml. These concentrations were expected to allow somatic responses to surgical stimuli in approximately 50% of the patients. Fig 1 presents the ECI of clinical responses (R) and non-responses (NR) to stimuli expressed as a cumulative percent of

total R and of total NR. The cross-over point was ECI=70. The ECI during the periods of no stimulation was 41±29 and it was 78±47 during the periods of intense stimulation (p<0.01). The 208 stimulations provoked 23 somatic responses. Of these, 18 were associated with an ECI >70 (agreement=78%) and 5 were associated with an ECI <70 (false negatives=22%). In addition, ECI >70 was not accompanied by any clinical sign of inadequate anesthesia in 51 of the 208 stimulations (false positives=25%). In all cases, additional anesthetic suppressed the increased lower esophageal contractility (LEC) activity. None of the 20 patients had any recall of the operative period when questioned on discharge from the intensive care unit.

**Discussion:** Inadequate anesthesia is indicated by clinical signs including sympathetic, hemodynamic and somatic. Somatic signs are lost in the paralyzed patient. We sought to determine if increased LEC activity could substitute for somatic responses as an indicator of inadequate anesthesia. ECI was significantly greater during periods of intense stimulation and an ECI=70 represented the point above which intense stimuli provoked most of the clinical responses and below which they did not (Fig 1). The 22% incidence of false negatives suggests that the LEC would not be a reliable substitute for somatic signs of inadequate anesthesia in the paralyzed patient anesthetized primarily with fentanyl.

**Conclusion:** In contrast to inhalational anesthesia, LEC is less reliable for detection of inadequate anesthesia when an opioid is used as the primary agent.

**References:** 1. Ausems ME, Hug CC Jr, de Lange S: Variable rate infusion of alfentanil as a supplement to nitrous oxide anesthesia for general surgery. *Anesth Analg* 62:982-986, 1983. 2. Evans JM, Bithell JF, Vlachonikolis IG: Relationship between lower esophageal contractility, clinical signs and halothane concentration during general anaesthesia and surgery in man. *Br J Anaesth* 59:1346-1355, 1987.

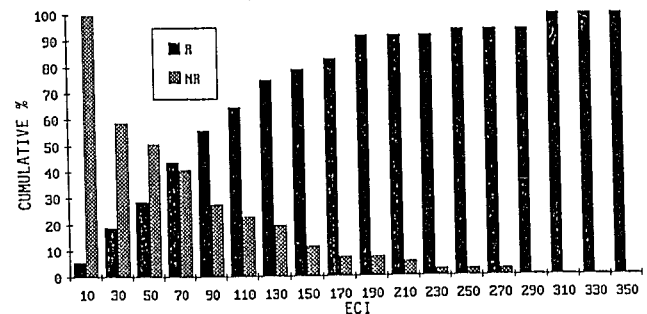


Fig 1: ECI of clinical responses (R) and absence of responses (NR) to surgical stimulations expressed as a cumulative % of total R and of total NR.