TITLE: MONITORING DEPTH OF ANESTHESIA BY MEASURING LOWER ESOPHAGEAL CONTRACTILITY - A CLINICAL EVALUATION

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Introduction: Assessing depth of anesthesia is difficult when multiple agents are used; thus, anesthesiologists rely on cardiovascular stress responses as indicators for therapeutic interventions. Since such stress responses may be associated with significant morbidity, the development of monitors which afford an earlier warning is desirable. Stress has been shown to increase the tertiary contractile activity in the caudal smooth muscle portion of the human esophagus.[1,2]. Evans, et al, have shown that changes in spontaneous lower esophageal contractility (SLEC) correlates well with minimal alveolar concentration (MAC) under inhalational anesthetics alone[3]. We wished to examine the utility of SLEC as a measure of depth under "balanced" general anesthesia in comparison to heart rate (HR), systolic blood pressure (SBP), and electroencephalogram (EEG).

Methods: After receiving institutional approval we obtained informed consent from 16 patients (12 intra-abdominal procedures, 2 mastectomies, 1 excision of shoulder melanoma and 1 inguinal herniorrhaphy). All cases consisted of routine general anesthesia using a combination of inhalational (ethrane, isoflurane, N_2O) and narcotic (fentanyl or sufentanil) agents, either with or without a benzodiazepine premedication. Commonly used drugs with known effects on esophageal contractility, such as tubocurarine, hydralazine, nitrates and anticholinergic agents, were to be avoided. Spontaneous (tertiary) contractions in the smooth muscle portion of the esophagus were recorded with the Lectron 301® esophageal contractility monitor using a static balloon pressure transducer. An esophageal contraction was defined by an increase in intraluminal pressure of $\geq$ 5mmHg over transmitted intrathoracic ventilation pressures. The Neurometrics' Lifescan® monitor was used for online aperiodic analysis of a five-lead EEG. An average of the Lifescan® cumulative edge frequencies (EF) for each hemisphere was recorded for each sampling epoch. HR and SBP were monitored via electrocardiography (ECG) and automated sphygmomanometer. We identified 27 episodes of lightening of anesthesia, marked by either therapeutic intervention by the anesthesiologist or clinical assessment of awakening. Each one was evaluated for recognizable changes in HR (increase $\geq$ 120% of baseline or $\geq$ 120% of baseline or $\geq$ 140 mmHg), EEG (EF $\geq$ 10 Hz), and SLEC ($\geq$ 1 minute^{-1}).

Results: We evaluated 27 episodes in 9 patients. In one case included in the evaluation, one of the monitors had been removed prior to the end of the case. Seven cases could not be evaluated for the following reasons: malfunctioning of the EEG-data storage device (3 cases), malfunctioning of the Lectron 301® (2 cases), inadvertent erasing of HR and SBP data memory by a bystander (1 case), and use of hydralazine during during the operation (1 case). Eight episodes were awakening at the end of the case. In one episode the patient moved during the case. Eighteen episodes were marked by application of additional anesthetic drug. Recognizable changes of at least one of the monitored parameters were seen with SBP in 18, SLEC in 18, EEG in 14, and HR in 9 episodes. Changes in HR and/or SBP marked 21 episodes. The combination of HR, SBP and EEG detected 25 episodes, and changes in either HR, SBP, EEG or SLEC preceded or occurred concomitantly with all 27 episodes. Advance warning (> 1 minute) was afforded by HR in 5 episodes with a median warning time of 6 minutes. Values for the other variables are: SBP: 15 episodes/median warning time-7 minutes; EEG: 14 episodes/6 minutes; SLEC: 14 episodes/6.5 minutes. The first indicator to show a recognizable change was SLEC in 11 episodes, EEG in 9 episodes, SBP in 6 episodes and HR in 3 episodes. A high SLEC rate was seen twenty times in the absence of changes in HR, SBP, EEG or clinical status of the patient. Twelve of these false positive warnings occurred in two patients likely due to variable transmission of intrathoracic ventilation pressures.

Discussion: Measuring esophageal contractility may be a valuable adjunct to the traditional methods of gauging anesthetic depth. Although conclusions are limited by our small sample size, the SLEC monitor by itself does not appear superior to either the combined cardiovascular parameters or EEG. Another factor which may influence the utility of SLEC monitoring is the effect of various routinely used drugs on esophageal contractility. However, its low cost and the already existing combination with the esophageal stethoscope and future combination with thermometers, ECG and doppler probes for cardiac output make the esophagus a promising site for monitoring.

References:

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