# The relationship between intra-operative entropy of the EEG and non-depolarizing neuromuscular blockade: A descriptive study

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**Background**

Entropy is based on the extent of order in both the cortical EEG and facial EMG (FEMG) signals, measured from the patient's forehead. Order equals regularity of the EEG signal. In an awake patient, the EEG is very irregular and the entropy high. As the level of anesthesia deepens, the EEG becomes more orderly and the entropy reduces.[1] The deeper the level of anesthesia, the lower the frequency of the EEG signal and, higher the amplitude, thus a more orderly and predictable EEG signal, the lesser the disorder, the lower the entropy.

The Datex Ohmeda S/5™ Entropy module expresses State Entropy (SE) as a measure of the order of the cortical electrical activity (0-32Hz). Response Entropy (RE) combines a measurement for cortical electrical activity and FEMG activity (0-47Hz). The RE-SE difference represents FEMG activity.[2,3]

Neuromuscular blockade has no effect on SE, but RE decreases to nearly the same value as SE. RE and SE stays the same until neuromuscular blockade has worn off. If analgesia is adequate it is unlikely that RE and SE will differ from one another because there is no FEMG activity. If analgesia is inadequate painful stimuli can awaken the cortex. This is seen first as a rapid increase in RE. If the difference between RE and SE values >10 , it is likely that the patient will move. It is also likely that the SE will start to rise and the patient eventually wakes up.[5]

**Aim of the study**

The aim of this study is to determine the relationship between intra-operative entropy of the EEG and non-depolarizing neuromuscular blockade, more specifically the RE-SE difference and the percentage recovery of the train of four (%TOF) measurements.

**Method**

21 patients were selected and informed consent obtained. The group is made up of ASA I and II patients between 18 and 80 year of age; both sexes; undergoing elective or semi-elective procedures under general anesthesia.

Before induction the following monitors were applied: M-Entropy (S/5™ Entropy module, Datex Ohmeda Division, Instrumentarium Corporation, Helsinki, Finland) and M-NMT (S/5™ M-NMT module, Datex Ohmeda Division, Instrumentarium Corporation, Helsinki, Finland).

General anesthesia was induced with Propofol 2mg/kg and Alfentanyl 10µg/kg. Neuromuscular blockade was instituted with Rocuronium 0.6mg/kg. Anesthesia was maintained with Isoflurane 1.5%. At the end of the procedure the neuromuscular blockade was reversed with Neostigmine 50µg/kg and Glycopyrrolate 10µ/kg.

The following parameters were documented from the onset of surgical anesthesia (1.3 MAC): RE, SE, RE-SE difference, TOF, %TOF recovery and any gross motor movements. If the patient moved, the depth of anesthesia was increased with a bolus of Propofol 0.25mg/kg. No additional Rocuronium or Alfentanyl was administered. At the end of the procedure Morphine 0.1-0.3 mg/kg was administered for post-operative pain relief.

**Results**

21 patients participated in the study. 7 made a gross motor movement intra-operatively. This movement occurred at an Isoflurane concentration of 1.3 MAC. A RE-SE > 9 was shown in 22 measurements, of which 11 of these measurements were accompanied by a movement (avg. 50%). A RE-SE > 9 without any movement occurred in 11 cases (avg. 50%). Only 1 patient moved with a RE-SE < 9 (avg. 4.54%). The average RE-SE difference at which a movement was observed was 11.03%.

No patients moved without a twitch returning to the TOF. No patients moved when only 1 twitch returned to the TOF. 5 cases moved at a TOF of 2, 1 at a TOF of 3 and 5 at a TOF of 4. The average %TOF at which movement was observed was 53.8%.

An analysis of variance between the RE-SE and TOF data was done (P=.000834). The results of the Pearson test showed the following: TOF and RE-SE (-0.17434), RE-SE and %TOF (-0.14061) and RE-SE and the occurrence of movement (0.480049).

**Discussion**

The findings acknowledge the fact that FEMG is suppressed primarily by anesthesia and not paralysis.[4] There is a slight negative correlation between the recovery of TOF and the RE-SE difference as well as a slight negative correlation between %TOF recovery and RE-SE difference. There is a moderate positive correlation between RE-SE difference and the occurrence of movement in a patient under surgical anesthesia.[5]

**References**


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