Physical Transmission of Jet-ventilation Oscillations to Frontal Registration Positions for Process-calculated EEG-Parameters: A Clinical-experimental Pilot Study

G Schwarz, G Mausser, G Litscher, G Friedrich

Citation

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Abstract

During endoscopic laser resection of a squamous cell carcinoma of the vocal cord, in a 70-year-old patient (ASA 2) using tubeless high frequency jet-ventilation, we investigated whether jet-ventilation oscillations could be transmitted to frontal EEG-recording positions.
Under total intravenous anaesthesia with propofol and remifentanil and muscle relaxation with rocuronium, jet-ventilation using two different pulsating frequencies (600/min and 60/min) was performed.

Using piezzo-electric sensor technology, the Aspect A1000 (Aspect Medical Systems Inc., Natick, MA, USA) proved that synchronous pulse frequency oscillations from jet-ventilation could be transmitted to the frontal region. Further studies to investigate the influences of these effects on electrophysiological parameters for the evaluation of depth of anaesthesia are currently in progress.

INTRODUCTION

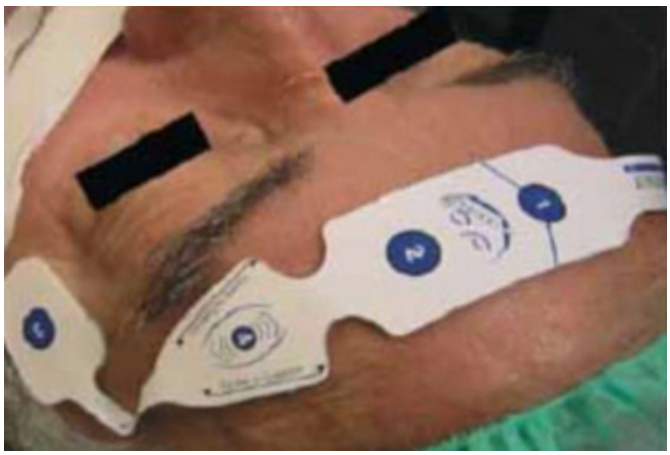
Endogenous (biological) and exogenous (technical) induced oscillations can contaminate the registration of biosignals at a topographical distance from the epicentre of generated oscillations.

The most well known endogenous interference signals which can influence EEG-monitoring are the electro-cardiogram (ECG), electro-myogram (EMG), electro-oculogram (EOG) and the electro-dermatogram (EDG) [1]. In addition, influences caused by breathing, sweating, vascular pulsations or blinking effects must be considered [2]. The types of medical-technical instruments which can influence EEG results range from simple infusion and perfusion devices [3] to highly complicated navigation systems for surgical intervention [4].

Goal of this study was to investigate whether high frequency jet-ventilation oscillations can be transmitted to frontal positions used for EEG-recordings (Figure 1).

Figure 1

Figure 1: Frontal EEG-registration which illustrates the recording of the bispectral index (BIS).



METHODS

After institutional review board approval and written consent we enrolled a 70-year-old patient (ASA 2, 84 kg body weight, 184 cm height) in our study. He was undergoing a microlaryngoscopic laser resection of a squamous cell carcinoma of the left vocal cord.

The study took place immediately before the surgical procedure under total intravenous anaesthesia (TIVA). For premedication we used midazolam 7.5 mg orally 1 hour prior to the operation.

Anaesthesia was induced intravenously with fentanyl 100 g and propofol 200 mg. Rocuronium 0.5 mg/kg was administered as muscle relaxants. For maintenance of anaesthesia we used continuously propofol 8.7 mg/kg/h and remifentanil 0.15 g/kg/min.

The jet-ventilation and the endoscopic surgical procedure with the micromanipulator guided CO_2-laser were performed via a modified Kleinsasser laryngoscope (Figure 2).

Figure 2

Figure 2: Jet–laryngoscope.

The tubeless high frequency jet-ventilation was performed by a commercial jet-respirator (Bronchotron , Percussionaire Air Corp, Sandpoint, ID, USA; Figure 3) with following adjustments: a) superimposed high frequency jet-ventilation with a conventional breathing rate of 14/min superimposed with pulsating frequencies of 600/min and b) high frequency jet-ventilation with a frequency of 60/min.

The setting of inspiration duration was defined with 50 %, driving pressure was < 2 mbar, FiO_2 0.4.

Figure 3

Figure 3: Jet–respirator (Bronchotron).

The transmission of jet-ventilation oscillations were registered multi-locularly from the pre-laryngeal, buccal and frontal regions.

The registration of signals was based on the piezzo-electric principle (Siemens 6870950E232ES11, Sweden). Signal representation was done with the Aspect A1000 monitor system (Aspect Medical Systems Inc., Natick, MA, USA).

RESULTS

The following figures 4-6 show the photographic documentation of the positioning of the piezzo-electric sensor (fastened with self-adhesive tape) and the corresponding jet-frequency oscillations on the screen of the Aspect A1000. Figure 7 shows the complete view of the study scheme.

Figure 4

Figure 4: Pre-laryngeal registration. Pulsating frequency: 60/min (upper panel) and 600/min (lower panel).

Figure 5

Figure 5: Buccal registration. Pulsating frequency: 600/min.

Figure 6

Figure 6: Frontal registration. Pulsating frequency: 60/min.

Figure 7

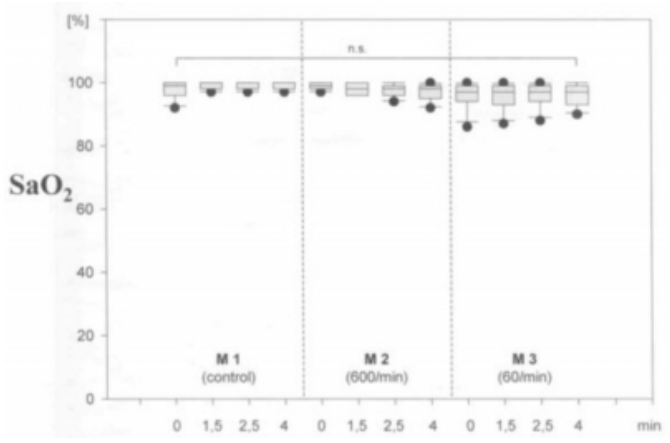
Figure 7: Device arrangement with jet-laryngoscope, jet-ventilator, BIS monitor A1000 and frontally positioned piezzo-electric sensor.

DISCUSSION

Tubeless superimposed high frequency jet-ventilation increases the diagnostic and therapeutic options in endoscopic surgery of the respiratory tract [5] by providing unimpaired surgical fields under simultaneous sufficient ventilation and unproblematic oxygenation conditions (Figure 8).

Figure 8

Figure 8: Peripheral oxygen saturation (SaO 2; box plot) during jet ventilation registered with pulse oximetry in 11 patients. Insignificant (n.s.) changes during the study under all conditions of ventilation: control - spontaneous breathing (M1), jet-ventilation with pulsating frequencies of 600/min (M2) and 60/min (M3). Unpublished data 2003 (Schwarz G, Mausser G, Litscher G, Friedrich G).



The jet-ventilation technique can also be used successfully in infants when all precautionary measures are considered (Figure 9).

Figure 9

Figure 9: Jet-ventilation in a premature infant (age: 31 days, body weight: 2,400g)

Surgical interventions during jet-ventilation are performed under TIVA [5]. In this type of anesthesiological management electro-physiological monitoring of the depth of anaesthesia is indicated because of the higher risk of awareness [6].

But, high frequency oscillations of non-cerebral genesis can influence intraoperative measurement results of EEG parameters such as the bispectral index (BIS) [7,8] and may therefore compromise the estimation of the depth of anaesthesia.

Our findings of the presented clinical-experimental study show that the transmission of high frequency jet-ventilation oscillations to frontal structures of the head is possible.

These observations could be important, since the hairless frontal structures of the head are points for cerebral biosignal registration in monitoring the depth of anaesthesia (Figs. 1 and 6).

To what extent the filter and software developments in the Aspect 2000 can avoid potential contamination with artefacts of jet-ventilation, is content of an already started, following study.

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Author Information

Gerhard Schwarz, MD
Department of Anesthesiology for Neurosurgical and Craniofacial Surgery and Intensive Care, Medical University of Graz

Gerlinde Mausser, MD
Department of Anesthesiology for Neurosurgical and Craniofacial Surgery and Intensive Care, Medical University of Graz

Gerhard Litscher, PhD
Department of Biomedical Engineering and Research in Anesthesia and Critical Care, Medical University of Graz

Gerhard Friedrich, MD
Department of Ear, Nose and Throat Surgery, Medical University of Graz