Short-term Parameters of Heart Rate Variability During Balanced Anaesthesia with Administration of Two Different Inhalation Anaesthetics

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ABSTRACT

Introduction: Heart rate variability which denotes variations of the length of consecutive heart cycles has been suggested to reflect the modulation of heart rate by autonomic nervous system. Methods: Sixty four patients of ASA I and ASA II status scheduled for elective abdominal surgical procedures were randomly allocated to group 1 and group 2. Premedication and induction of anaesthesia were performed with same agents. After orotracheal intubation maintenance of balanced anaesthesia was based on administration of same induction agents, opioids and muscle relaxant while delivery of gaseous mixture with sevoflurane in the group 1 (n=32) and isoflurane in the group 2 (n=32). Haemodynamic parameters were monitored in perioperative and electrocardiogram was recorded by holter ECG recorder, while the analysis of the parameters were performed by corresponding softwares. Data were presented as mean values of logarithmic (natural logarithm) values of the power of the total spectrum of heart rate variability (TP), mean values of the logarithmic values of low frequency band (LF), mean values of the logarithmic values of high frequency range (HF), and mean values of SD1 and SD2 parameters. Results: Analysis of the values of hemodynamic parameters has shown changes of haemodynamic parameters during perioperative period without significant statistical differences between the groups. Analysis of the logarithmic values of parameters of heart rate variability of frequency domain has shown changes of the total spectrum power and LF and HF spectra with variations of the values of total power spectrum and individual components of the spectrum of heart rate variability during the balanced anaesthesia with administration of two different inhalation anaesthetics, without statistically significant differences between the groups. Conclusion: The results have shown that during balanced anaesthesia with two different inhalation anaesthetics there are variations of haemodynamic variables and parameters of heart rate variability without statistically significance that could show the difference between the groups and different agents administered.

Key words: heart rate variability, balanced anaesthesia, inhalation anaesthetics.

1. INTRODUCTION

Variability of the complex systems enable those systems to respond to different environmental and intrinsic inputs in a whole spectrum of reactions and effects. Heart rate variability reflects the possibility of the cardiovascular system to adapt to the whole spectrum of different more or less demanding tasks and situations. Heart rate variability is reduced in many pathological conditions and most altered after myocardial infarction and in the failing heart, besides the other pathological conditions (1, 2). It is an important predictor in risk stratification and early prediction of cardiac autonomic neuropathy (3, 4). The importance of the monitoring of heart rate variability during surgical procedures and anaesthesia have been recognized. Poincaré plot is a visual presentation of time series of signal and has been used for quantifying of the parameters of heart rate variability (5). Standard descriptors of the Poincaré plot have been introduced, SD1 and SD2. SD1 represents the standard deviation of the variability of the signal in short terms, while SD2 represents standard deviation of the long term RR interval (6).

Proposed physiological explanations of the significance of parameters are listed elsewhere (1, 7).

There have been many clinical trials performed aiming to assess if there could be found significant differences of the effects of different anaesthetic agents (8, 9, 10). Besides two main linear methods of analysis (time-domain and frequency-domain method) there are modifications of these methods of analysis, as we as methods of non-linear analysis (11).
indices and frequency-domain indices) there have been many new nonlinear methods of analysis evolving. Some linear measures appropriate for short-time recordings are shown in the Table 1.

Surgery and anaesthetics influence significant changes of homeostasis what is reflected in changes of haemodynamic variables (9, 10, 11).

2. PATIENTS AND METHODS

After obtaining approval of Ethics Committee and informed consent sixtyfour patients of ASA I and ASA II status, who were scheduled for elective abdominal surgery were randomized to two groups: group 1 (balanced anaesthesia with inhalatory anaesthetic sevoflurane) and group 2 (balanced anaesthesia with inhalatory anaesthetic isoflurane). Patients with cardiovascular disease, diabetes mellitus, arrhythmias, endocrine and neurologic conditions and therapy with medications that may affect heart rhythm were not included in the trial. Exclusion criteria were recordings with many artifacts. Monitoring of haemodynamic parameters and recording of the electrocardiogram were performed during perioperative period.

Fortyfive minutes before induction of anaesthesia patients were given midazolam (Dormicum, F. Hoffman-La Roche Ltd Basel, Switzerland) in the dose of 7.5 mg. In the preinduction period patients were given opioid fentanyl 2μg/kg-1 (Fentanyl –Janssen-Cilag, Belgium). Five minutes later induction was started by thiopentone (Thiopental, Roche Ltd Basel, Switzerland) in the dose of 7.5 mg. In the preinduction period patients were given benzodiazepine midazolam (Dormicum, F. Hoffman-La Roche Ltd Basel, Switzerland) in combination with fentanyl.

Power spectra were determined in nine 5-minutes segments, in preinduction period Tpre, after administration of opioid – T1, after induction – T2, after orotracheal intubation – T3, period, during balanced anaesthesia with two different inhalation anaesthetics sevoflurane or isoflurane – (T4-T7), and in postoperative period T post two hours after emergence – Tpost. Spectral analysis was performed using Hanning window.

Data were presented as mean values of logarithmic values of the total power spectrum values (TP), mean values of the logarithmic(natural logarithm) values of power spectrum of high frequencies (HF), mean values of the logarithmic values of power spectrum of high frequencies (HF). Descriptors of Poincare plots were presented for gender, Student t-test for age, Mann-Whitney test for BMI data, and one-way repeated analysis of variance (ANOVA) for parameters of hemodynamic and heart rate variability during balanced anaesthesia.

| Table 2. Demographic data. CH=Cholecystectomy ,H=Hernioplasty |
|---------------------------------------------------------------|
| Group 1 | Group 2 |
| N | 32 | 32 |
| Age | 47.75(SD 8.65) | 45.63(SD 9.06) |
| Gender | M 17 F 15 | M 20 F 12 |
| BMI | 27.37 (SD 2.18) | 27.23 (SD 2.92) |
| Surgery | CH 15 | CH 17 |
| | H 17 | H 15 |

| Table 3. Hemodynamic variables in periprocedural period. Results are presented as means and standard deviation in brackets |
|---------------------------------------------------------------|
| Group 1 | Group 2 |
| MAP(mmHg) | MAP(mmHg) | HR(f/min) |
| Tpre | 96,25 (9.17) | 98,16(8.12) | 76,13(7) | 78,59 (7) |
| T1 | 94,81(6.07) | 96,98(6.65) | 75 (7) | 76 (7) |
| T2 | 86,18(5.01) | 87,49(3.51) | 84 (6) | 80,87 (7) |
| T3 | 90,58(3.66) | 87,53(4.41) | 82,8 (6) | 78,46(6) |
| T4 | 86,84(2.64) | 86,02(3.85) | 77,5 (5) | 77,8(5) |
| T5 | 86,21(3.71) | 84,25(3.73) | 78,13(5) | 77,9(5) |
| T6 | 82,86(4.86) | 83,02(4.6) | 76,5 (6) | 78 (7) |
| T7 | 83,96(5.86) | 84,56(5.79) | 72,1(4) | 76(6) |
| T post | 97,23(4.96) | 97,33(4.57) | 77 (7) | 80(9) |

| Table 4. Logarithmic values (native logarithm) of the TPLEHF spectra and SD1 and SD2 value. Results are presented as means and standard deviation in brackets |
|---------------------------------------------------------------|
| Group 1 | Group 2 |
| LNTP(ms2) | LNLF(ms2) | LNHF(ms2) | SD1 | SD2 |
| Tpre | 8,060(0.56) | 8,010(0.2) | 7,150(0.34) | 7,100(0.3) | 6,540(0.56) | 6,550(0.52) | 20,60(6.3) | 18,79(4.7) | 50,05(11.7) | 43,63(12.6) |
| T1 | 7,980(0.18) | 7,850(0.56) | 6,150(0.51) | 6,200(4.8) | 4,770(0.59) | 4,650(0.46) | 19,46(5.2) | 18,88(4.8) | 49,38(11.2) | 43,63(12.6) |
| T2 | 7,440(0.42) | 7,240(0.47) | 5,360(0.47) | 5,710(0.41) | 4,320(0.52) | 4,230(0.39) | 8,74(2.4) | 9,57(2.5) | 37,27(11.6) | 31,26(8.6) |
| T3 | 7,380(0.44) | 6,930(4.64) | 5,320(0.53) | 5,630(0.53) | 4,420(0.54) | 4,490(0.44) | 9,27(2.1) | 9,96(2.3) | 35,03(9.2) | 33,61(10.1) |
| T4 | 6,790(0.74) | 6,520(7.5) | 5,300(0.72) | 5,580(0.41) | 4,430(0.86) | 4,260(0.87) | 9,43(1.9) | 10,28(2.4) | 34,49(8.2) | 36,87(9.4) |
| T5 | 6,930(0.45) | 6,520(5.8) | 5,410(0.91) | 5,180(1.08) | 4,140(1.07) | 3,980(1.03) | 9,63(2.0) | 9,82(1.8) | 35,95(11.4) | 35,76(9.0) |
| T6 | 7,020(0.9) | 6,41(1.01) | 5,34(1.25) | 4,85(1.21) | 4,39(0.67) | 3,99(0.72) | 10,70(1.9) | 10,57(2.1) | 38,76(11.8) | 35,38(3.8) |
| T7 | 6,040(0.54) | 6,27(0.04) | 3,910(0.30) | 4,240(0.44) | 3,910(0.3) | 4,240(0.44) | 9,64(1.9) | 10,67(2.7) | 37,84(10.5) | 32,68(7.2) |
| T post | 7,620(0.46) | 7,38(7.1) | 6,07(0.61) | 6,27(0.57) | 3,98(0.58) | 3,84(0.60) | 20,15(3.9) | 19,85(4.7) | 43,36(8.6) | 44,53(8.6) |

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variability parameters. P value <0.05 was considered as statistically significant.

3. RESULTS

Analysis was performed by statistical package IBM Statistics SPSS v22.0 (Chicago, Illinois, USA). Results of analysis of demographic data have not shown statistically significant differences between the groups (Table 2). Results of the analysis of hemodynamic parameters have shown variations of hemodynamic variables in both groups, with slight decrease of the values of mean arterial pressure in both groups after administration of induction agent thiopental and changes in heart rate, but there was no statistically significant differences (Table 3).

Analysis of the changes of the values of the power of total spectrum (TP), low frequency (LF) and high frequency (HF) spectra, demonstrated alterations of the power of all spectral parameters in both groups, which was most visible after induction, without statistically significant differences between the groups. Results of analysis of hemodynamic parameters are shown in the diagrams in Figure 1, results of the analysis of heart rate variability and Poincaré plot descriptors (SD1 and SD2) in Figure 2, while some of the diagrams of Poincaré plot from different periods of perioperative time are shown in Figure 3.

4. DISCUSSION

Monitoring of heart rate variability could show clinical usefulness during perioperative period. Stress reaction to surgical procedure and general anaesthesia have strong impact on the dynamic stability of the variability of physiological functions.

There have been numerous published papers on the topic of possible influence of different anaesthetic agents on the parameters of heart rate variability (8,9,10,11,12).

Huang HH. and coworkers who studied the effects of induction of anaesthesia by thiopentone have shown decrease of the power of total spectrum and individual components of the spectrum but no significant changes in the relationship between the spectral components, what suggested that there were no changes in the balance of autonomic nervous system (9).

Latson TW. and coworkers also examined the effects of three induction anaesthetic techniques on heart rate variability (10). They have shown that induction of anaesthesia both with thiopental and nitrous oxide and etomidate and nitrous oxide were associated with decrease of the powers of total spectrum, low frequency and high frequency spectra, with more evident decrease of low frequency spectrum (LF) with thiopental in regard to etomidate (10).

Tanaka S. and coworkers investigated effects of different inhalation anaesthetics and did not find sympathetic activation in patients who were administered sevoflurane unlike to those who received desflurane and isoflurane (11). In the trial performed by Kato M. and coworkers, who investigated the effects of inhalation anaesthesia with isoflurane with different inhalatory concentrations it was shown that all components of the heart rate variability were decreased in dose dependent manner, but with more effects on the high-frequency and mid-frequency components (12). Ebert TJ et al. described that sevoflurane could have such pharmacological profile that does not elicit profound heart rate changes (13, 14). According to the findings of the Wodey E. et al. variations of heart rate in children who were administered sevoflurane as inhalation anaesthesia during induction could be described as withdrawal of parasympathetic tone (15).

Results of our trial have shown variations of hemodynamic variables in both groups, with decrease of the values of mean arterial pressure in both groups after administration of induction agent, thiopental and consecu-
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While general anaesthesia was performed using balanced technique in which the induction agent was the same (thiopentone) while the inhalatory components were two different anaesthetic agents: sevoflurane and isoflurane, have shown variable changes of all spectral components of the total spectrum of heart rate variability in both groups. The most visible changes of HRV parameters were evident in perinduction period, without statistically significant differences between the groups.

CONFLICT OF INTEREST: NONE DECLARED

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5. CONCLUSION

Short-term heart rate variability parameters measured in frequency-domain, in peroperative period in patients who underwent elective abdominal surgical procedures of moderate stress...