Assessment of the relationship between analgesia nociception index (ANI) and some depth of anesthesia indexs (BIS, PRST) and visual analogue pain score (VAS) after open abdominal surgery

Hoang Thi Thanh Tam, Nguyen Huu Tu

Ha Noi Medical University

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Corresponding author:
Hoang Thi Thanh Tam,
Ha Noi Medical University
No.1 Ton That Tung Str., Ward Dong Da, Ha Noi City
Mobile: 0395 910 195
Email: thanhtam011995@gmail.com

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Abstract

Introduction: The analgesia/nociception index (ANI), a 0 –100 non-invasive index calculated from heart rate variability, reflects the analgesia/nociception balance during general anaesthesia. The aim of this study was to evaluate the relationship between ANI with Bispectral index (BIS), PRST score and VAS in adult patients undergoing general anaesthesia.

Patients and Methods: A total of 60 patients of American Society Anesthesiologist(ASA) physical status I and II undergoing open abdominal surgery. All patients were monitored and anesthetized according to the protocol. Measurement and recording ANI, BIS, PRST, VAS at the time of study.

Results: There was a relationship between ANI with PRST, BIS intraoperatively and VAS at recovery period after open abdominal surgery. There was a moderate correlation between ANI and PRST with r = 0.433 (r^2 = 0.187, ANI = -3,26*PRST + 56,68) and a low correlation between ANI and BIS with r = 0.362 (r^2 = 0.131, ANI = 0.339*BIS + 33.636). And, there was significant negative correlation between the ANI and the VAS score with r = - 0.517 (r^2= 0.268, ANI = -4,065*VAS+76.49) postoperatively.

Conclusion: The use of ANI monitoring with clinical assessment allows anesthesiologists precise analgesia/nociception balance and a right dosage of analgesics, especially in patients with higher operative risk.

Introduction

Open abdominal surgery is one of the causes lead to pain for patient. The recognition and assessment of the patient's pain level intra- and postoperation is actual important. This helps us to give anesthesia and pain relief properly and avoid overdose or underuse of the drug. Evaluation pain of anesthetized patient is often difficult, it based on clinical criteria (such as pulse, blood pressure, etc.) but they are easily confused and nonspecific.

The changes that occurs in the autonomous nervous system following a nociceptive stimulation will activate the sympathetic nervous system, increasing the stress hormones production(catecholamines and cytokines), increasing heart rate and arterial blood pressure to finally inducing a general cellular stress. Since 2010, analgesia nociception index (ANI), a 0–100 non-invasive index calculated from HRV, has also been recently proposed to replicate the analgesia/nociception balance during general anaesthesia. It is a non-invasive device that takes an ECG analogue output from the patient monitor and displays an average measurement of ANI over the previous 120 s. The ANI calculation is relied on the integrative influence of the respiratory cycle on the RR interval derived from ECG. It permits a qualitative and quantitative measurement of HRV, primarily facilitated by parasympathetic and sympathetic outflow from the central nervous system to the sinoatrial node. A painful stimulus induces a decline in parasympathetic tone leading to a decrease in ANI scores. ANI scores vary between 100, which shows a state of maximum parasympathetic tone and a low nociceptive level, and 0, which represents the minimum parasympathetic tone and a high nociceptive level. A value ≥ 50 indicates adequate analgesia. Several studies have shown that ANI could be used to predict immediate postoperative pain, guide intraoperative opioid administration, and predict the need for analgesia during the early postoperative period.[1–4]

On the other hand, the measurement of ANI appears to be a simple and non-invasive method to assess immediate postoperative analgesia. Currently, there have been a number of studies showing the benefits of using ANI monitor. Continuous Analgesia/Nociception balance evaluation during general anesthesia could be of precious help for the optimization of analgesic drugs delivery, limiting the risk of toxicity due to the use of opioid drugs, limiting the risk of post operative hyperalgesia, and, probably, reducing time of recovery after surgical procedure.[5] In Vietnam, there have not been many studies using ANI monitor in clinical practice, so this study was conducted with objectives: Evaluation of the relationship between ANI and BIS, PRST score in balanced anesthesia for open abdominal surgery. Evaluation of the correlation between ANI and VAS in the recovery period after balanced anesthesia for open abdominal surgery.

Patients and methods

Patients

Patients who underwent open abdominal surgery at anethesiologist derpartment of Hanoi Medical University Hospital from January 2021 to September 2021.

Inclusion criteria:

Patients aged 18-70

ASA I, II

There are indications for open abdominal surgery

The patient consent to participate in this study

Exclusion criteria:

Patients with circulatory diseases: NYHA III, IV, heart failure, cardiacarrhythmias:Atrial fibrillation, atrioventricular block, patients with pacemakers, neuromuscular diseases...

Patients are taking drugs affecting the autonomic nervous system including beta blockers, parasympathomimetic drugs.

Methods:

Study design: A cross - sectional study

Sample Size: Apply to estimate a proportion. So the sample was 60.

Study procedure:

Preparation: The patient was explained to participate in the study and prepared for surgery. The patient was anesthetized with propofol, fentanyl, rocuronium, sevoflurane.

Intraoperative: epidural analgesia was maintained with ropivacaine 0.1% 5ml/h. Monitoring and recording the indexes: ANI, BIS, PRST at the time: H1-H14, ANI and VAS after surgery.

(H1: before induction, H2: after induction H3 before intubation, H4: after intubation 1 minute; H5: after intubation 3 minute; H6: before incision; H7: after incision 1 minute; H8: after incision 3 minute; H9: after incision 30 minute, H10: after incision 60 minute; H11: before closing skin; H12: after closing skin 1 minute; H13: after closing skin 3 minute; H14: after closing skin completely)

Postoperative: Assessment in the recovery room when the patient is awake and extubated and recording VAS, ANI indexs after intubation at 15, 30, 45, 60 minutes.

Statistical analysis

Software SPSS version 20.0 for operating system was used to process data in this study. Standard normal distribution was evaluated by the Kolmogorov - Smirnov test. The correlation between indexes was tested by Pearson, Spearman, Kendall test with non - standard distribution quantitative variables and Chi squared test with qualitative variables. The result was considered statistically significant with p value < 0.05.

Results

Sixty patients were included in the study.

In our study, the mean age was 56.10±14,027. Mean height, weight and BMI within normal limits of Vietnamese people. (Table 1)

Tables 1. General characteristics of the study patients

General characters	Mean ± SD	Min-Max
Age(years)	56.10±14.027	21-70
Height(cm)	161.21±7.887	145-172
Weight (kg)	54.87±7.909	35-79
BMI(kg/m^2)	21.080±2.4170	16.5-28.4
Gender (%)	Male	55.74
	Female	44.26

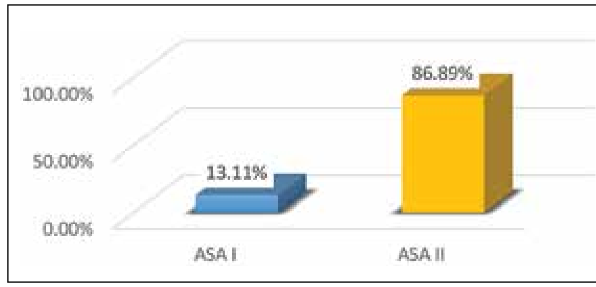

Figure 1. ASA classification

Most patients(86.89%) had ASA II status while ASA I status accounted for 13.11%.(Figure 1)

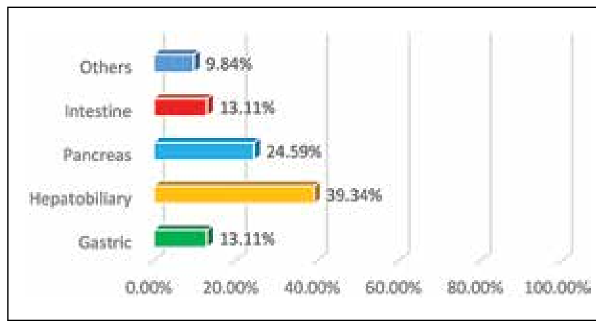

Figure 2. Surgical organs

The type of surgery with the highest proportion is hepatobiliary surgery, followed by pancreas, intestine and gastric surgery, the lowest is other organs such as uterus, ovaries.

Table 2. Classification of surgical organs and operation time

Surgical organs	Operation time ($\bar{X}$ ± SD)	Min-Max	Anesthesia time ($\bar{X}$ ± SD)	Min-Max
Gastric	163.75±49.262	90-210	195.00±49.857	120-240
Hepatobiliary	144.58±44.524	60-250	173.75±46.139	80-280
Pancreas	170.67±57.130	60-230	202.00±58.5	90-270
Intestine	143.75±39.256	90-220	173.75±39.256	120-250
Others	128.33±7.528	120-140	158.33±13.292	140-180

The pancreatic surgery had longest operation time (170.67±57.13), followed by gastric, hepatobiliary, intestinal and others surgery. (Table 2)

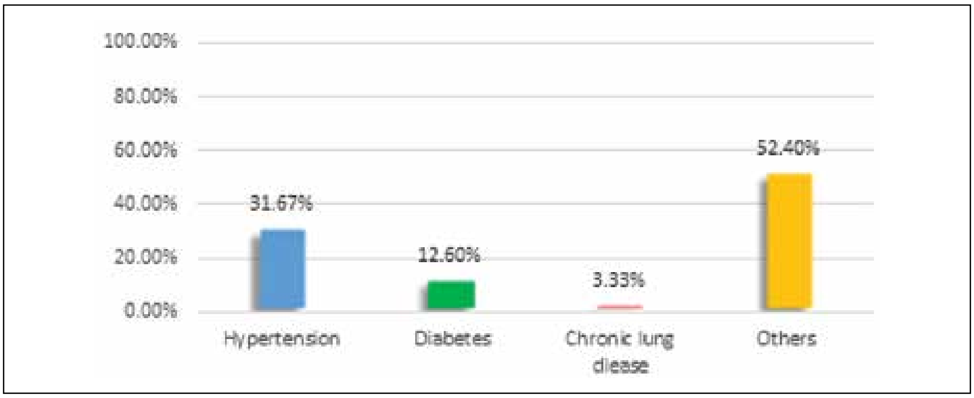

Figure 3. Chronic comorbidities

Most patients in our study did not have comorbidities. However, 31.67% had hypertension, 12.60% had diabetes and chronic lung diease accounted for 3.33%. (Figure 3)

The Figure 4 shows that mean arterial pressure (MAP) decreased slightly at H2 and H3 then stabilize. MAP is stable during general anesthesia from H4 to H14. (Figure 4)

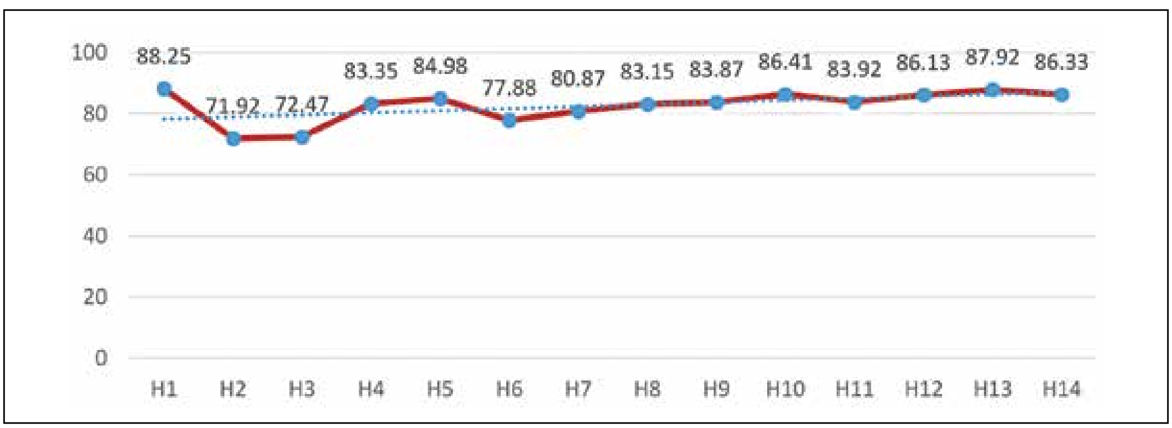

Figure 4

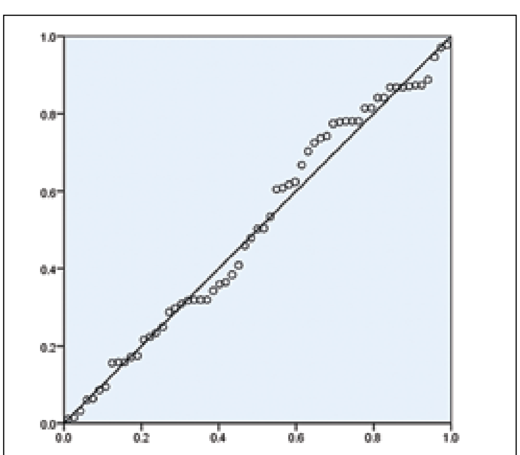

Figure 5. Correlations between ANI and BIS

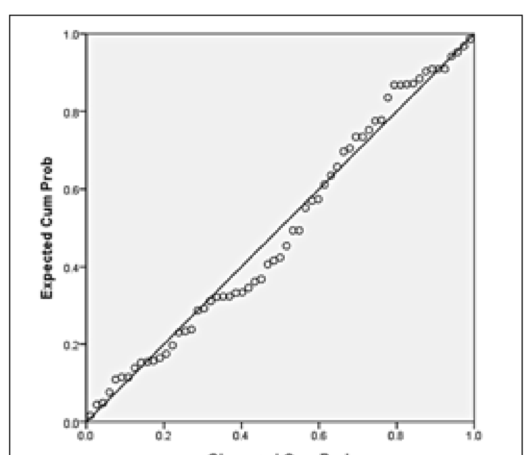

Figure 6. Correlations between ANI and PRST

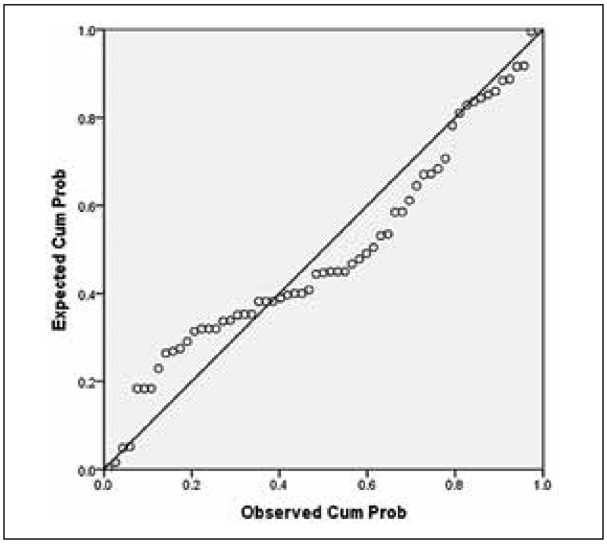

Figure 7. Correlations between ANI and VAS

The results show that there was a weak correlation between ANI and BIS with r = 0.362, constant b = 33,636 and a = 0.339 (r^2 = 0.131,ANI = 0.339*BIS + 33.636) (Figure 5)

Figure 6 demonstrated a moderate correlation between ANI and PRST with r = 0.433, with constant b = 56,68 and a = -3.26. The estimated regression equation was ANI = -3,26*PRST + 56,68

A statistically significant negative linear relationship was observed between ANI and VAS with r = - 0.517 (r^2= 0.268, ANI=-4,065*VAS+76.49) at arrival in PACU. (Figure 7)

Discussion

In their daily work anesthesiologists assess the pain levels based on clinical signs, which deputise a response of the autonomic nervous system of the organism to shallow anesthesia including tachycardia, hypertension, sweating, tearing, and dilation of the pupil. Evans and Davies in 1984 introduced a scoring system for clinical assessment of depth of anesthesia (PRST score including blood pressure, heart rate, swearing and tearing).[6] After that, PRST score was also used to assess intraoperative pain.[7] Increasing the parameter values of PRST score can cause hypovolemia, inadequate analgesia, hypoxia or hypercapnia. Signs of a shallow anesthesia often occur, but the correlation with nociception is low. In recent day, BIS is the new index to evaluate the depth of anesthesia. BIS values was 40-60 maintain intraoperative.[8–10] So ANI was demonstrated to be more sensitive than heart rate and systolic blood pressure to reflect nociceptive stimuli in both total intravenous anesthesia and inhalation anesthesia.[11,12]

In our study, There was a relationship between ANI index with PRST, BIS intraoperatively and VAS at recovery period after open abdominal surgery.

There was a moderate correlation between ANI and PRST with r= 0.433. This result was appropriate to research of Ngo Minh Diep 2018.[13]

Furthermore,this study shows a low correlation between ANI and BIS with r = 0.362 (r^2 = 0.131). This shows that anesthesia and pain levels have a low correlation, when the patient is adequate anesthesia, it does not mean that the patient is no pain.

Several studies have evaluated the ability of ANI to measure nociception or pain. Le Guen et al. reported that the ANI had an inverse linear relationship with visual analogue scores during labor [14]. Ledowski et al. however, found that the ANI did not reflect different levels of postoperative pain in adults undergoing sevoflurane-based anesthesia. These authors explained that the presence of anesthetic drugs and associated sedation of the patient were likely to influence ANI score and proposed that ANI might be more valuable in anesthetized patient [15]. Boselli et al. reported that ANI measured immediately before extubation among adults undergoing general anesthesia using an inhalational agent and remifentanil was significantly associated with pain intensity on arrival in the PACU and the ANI was able to discriminate between patients with a NRS ≤ 3 and NRS > 3 with a high sensitivity (88%) and specificity (83%).[5] In 2018, Ngo Minh Diep reported that ANI has strong negative correlation with VAS (r=-0,773).

In our study, we found that the patient has a low VAS score corresponds ANI, with VAS ≤ 2 corresponding ANI score >50, it means the patients have mild pain or no pain, unnecessary for additional analgesics. Meanwhile, in cases with VAS score ≥ 4, the ANI score < 50 corresponds to moderate to severe pain, requiring additional analgesics.

In this study, we found significant negative correlation between ANI and VAS score with r = - 0.517 (r^2= 0.268), it was similar to the study of Ngo Minh Diep.

Conclussion

Evaluation of intraoperative pain is one of the main tasks of anesthesiologists. In their daily work anesthesiologists assess pain by clinical parameters. Assessing the pain levels using ANI monitoring is a noninvasive method. ANI monitoring is not a substitute for clinical assessment. With ANI monitoring it is necessary to observe clinical parameters, and the ultimate decision about the measures, which should be taken, make on the basis of ANI and clinical parameters in the equivalent time. The use of ANI monitoring with clinical assessment allows anesthesiologists precise analgesia/nociception balance and a right dosage of analgesics, especially in patients with higher operative risk.

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