

Comparing Heart Rate Variability Intensity Using the ANI Monitor: Opioid-Free Anesthesia vs. Opioid Induction

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Abstract:

Introduction:

General anesthesia aims to induce a controlled state of unconsciousness, amnesia, and immobility while maintaining physiological balance. Optimizing hypnosis levels and administering appropriate analgesics are crucial for minimizing complications and ensuring adequate pain management during surgery. This study focuses on the Analgesia Nociception Index (ANI) as a measure of heart rate variability (HRV) to compare two general anesthesia techniques: opioid-free anesthesia and opioid induction.

Methods:

A retrospective comparative analytic study was conducted on patients undergoing laparoscopic procedures under general anesthesia at Hospital Ángeles Metropolitano in Mexico City from January 2020 to December 2022. Patient records meeting specific criteria were classified into two groups: opioid-free anesthesia (OFA) and opioid anesthesia (OA). ANI measurements were collected at different time periods, including 5 minutes before surgical stimuli (ANI-5), at the stimulus (ANI-0), and 5 minutes after the stimulus (ANI+5).

Results:

The study included 32 patients, comprising 10 men (31.3%) and 22 women (68.8%) with a mean age of 52 ± 18 years. There were no significant differences in age or surgical duration between the OFA and OA groups. The ANI measurements did not show significant differences between groups at any time point, indicating similar HRV intensity.

Discussion:

Although no significant differences were found between the opioid-free anesthesia and opioid induction groups, a general linear model of repeated measures was employed to assess the effect of opioids on HRV over time. However, the effect size did not reach statistical significance.

Conclusion:

This study comparing the intensity of heart rate variability using the ANI monitor in opioid-free anesthesia and opioid induction did not reveal significant differences between the two techniques. Further research with larger sample sizes may be necessary to elucidate the potential effects of opioids on HRV during general anesthesia.

Keywords: general anesthesia, heart rate variability, Analgesia Nociception Index, opioid-free anesthesia, opioid induction.

1. INTRODUCTION

General anesthesia is defined as a reversible controlled state induced by drugs, this process is characterized by unconsciousness, amnesia, immobility, loss of sensitivity to nociceptive stimuli while in a physiological balance. Optimizing hypnosis levels helps to avoid

excessive or insufficient doses, while at the same time reducing its possible complications, likewise the administration of analgesics must be assessed, being individualized according to the intensity of the surgical stimulus [1].

Nociception is referred as the conduction and processing of the noxious stimulus in the nervous system during the unconscious state in anesthesia. Multiple monitors have been developed for the measurement of the nociceptive stimulus [1]; in this work we will focus on the Analgesia Nociception Index (ANI).

The ANI monitor measures the parasympathetic activity of the autonomic nervous system based on heart rate variability (RR interval)[2]. The ANI performs analysis on the RR interval, representing static and dynamic values on the monitor as a base value and a real-time value. Values between 70 and 100 demonstrate an increase in parasympathetic stimulation and suggest a decrease in analgesic status, an interval of 50 to 70 demonstrates adequate analgesia and an interval of less than 50 demonstrates an increase in sympathetic stimulation, therefore it is necessary to adjust the analgesic dose [3,4].

The aim of this study is to compare the intensity of the heart rate variability measured by the ANI monitor on two general anesthesia techniques: opioid-free anesthesia and with opioid induction.

2. METHODS

This is a retrospective comparative analytic study carried out with patients undergoing general anesthesia for laparoscopic procedures from January 2020 to December 2022 assisted in Hospital Ángeles Metropolitano in Mexico City.

Patients records were considered into the study when meeting the following criteria: Age

Table1. Socio demographic characteristics of the study groups

		Group	
		OFA	OA
	n	16	16
Gender	Male	6 (37.5%)	4 (25%)
	Female	10 (62.5%)	12 (75%)
Age	years	51.38 ±19.07	52.69 ±16.7
Gender data is shown as frequencies and proportions, age data is shown as mean ±SD			

Regarding the kind of surgery performed, they were variable, and the most frequent diagnoses were hernias, grade II obesity with metabolic syndrome and intestinal occlusions; the average duration of the surgeries was 65.38 ±25.15 minutes for OFA group and 60.56 ±38.21

range 18 to 60 years old, As a class I and II patients, undergoing laparoscopic surgery under general anesthesia with either opioid-free anesthesia or opioid anesthesia. Records of patients with diagnose of cardiac arrhythmias, beta-blockers therapy, with pacemaker implantation or usage of opioids other than fentanyl were excluded from the study.

Patient records were classified according to the type of anesthetic procedure: Opioid-free anesthesia (OFA) or Opioid Anesthesia (OA). Information collected from the ANI monitor for different time periods: 5 mins prior surgical stimuli (ANI-5), at stimuli (ANI-0) and 5 mins after stimuli (ANI+5). Also, for each period, average measurements of the last 60 seconds were taken (mANI-5, mANI-0, mANI+5).

3. RESULTS

32 cases of patients undergoing surgery under general anesthesia in an age range of 18 to 60 years in the period from January 2020 to December 2022 were included. The sample consisted of 10 men (31.3%) and 22 women (68.8%), mean age was 52 ±18 years

Cases were assigned to a study group according to the use or not of opioids, each group was made up of 16 patients. In the OA group, the proportion was 4 men (25%) and 12 women (75.0%); the OFA group was made up of 6 men (37.5%) and 10 women (62.5%). The mean age was 52.69 ±16.7 years in the group with OA group and in the OFA group it was 51.38 ±19.07 years, however, these ages did not represent a significant difference between groups (Student's t-test, p=.837) (Table 1).

minutes for the OA group, there was no significant differences between groups (Student's t-test, p=0.677).

The OFA group showed an ANI-5 and mANI-5 of 46.44 ±28.47 and 45.88 ±27.53

respectively; on the other hand, the OA group had an ANI-5 and mANI-5 of 50.38 ± 26.54 and 53.00 ± 25.94 . A Student's t test was performed to assess whether there were significant

differences between groups in the time prior to the surgical stimulus, finding that there were no significant differences (Student's t-test, $p=0.689$, $p=0.457$) (Figure 1).

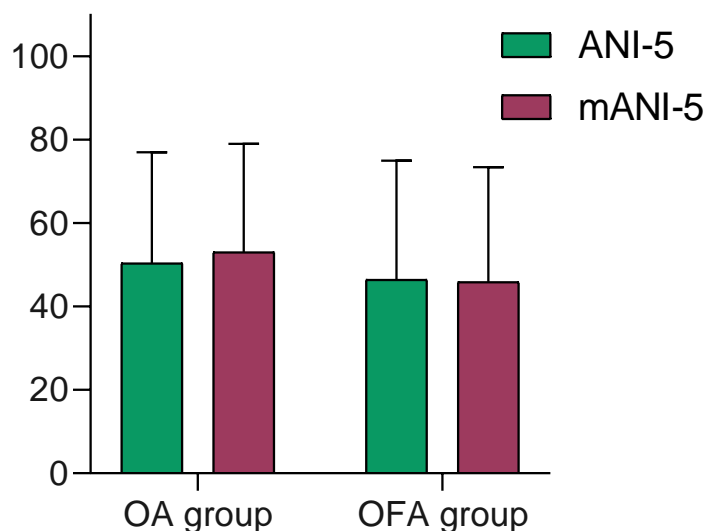


Figure1. ANI score 5 minutes prior to surgical stimulation

Regarding the ANI-score at the time of the stimulus; the OFA group showed an ANI of 51.88 ± 26.06 and a mANI-0 of 54.13 ± 23.28 ; for the OA group, the ANI was 44.44 ± 21.65 and the mANI-0 was 47.13 ± 19.80 . The

Student's t-test between groups did not show significant differences in the ANI measured at the time of the surgical stimulus (Student's t test, $p=0.387$, 0.367).

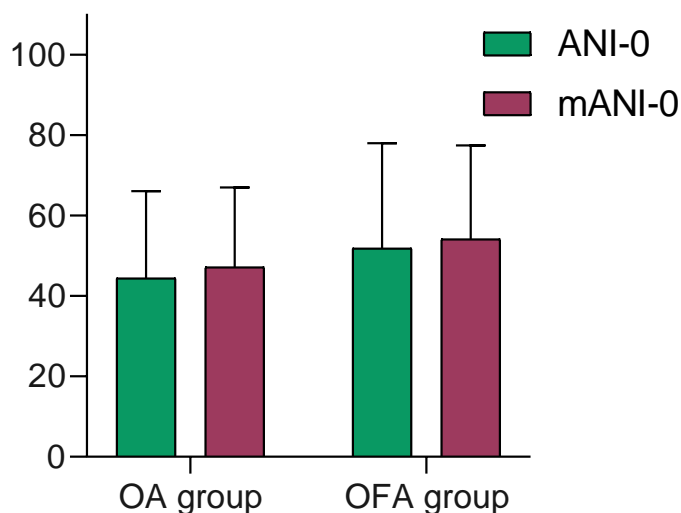


Figure2. ANI score at the surgical stimulation

For the ANI measurement 5 minutes after the surgical stimuli, the OFA group had a score of 50.56 ± 18.13 and for the mANI+5 it was 50.50

± 19.94 . For the OA group, the ANI score was 46.06 ± 20.10 and 43.56 ± 17.87 for the mANI+5. There were also no significant

differences between groups (Student's T test, $p=0.511$, $p=0.308$).

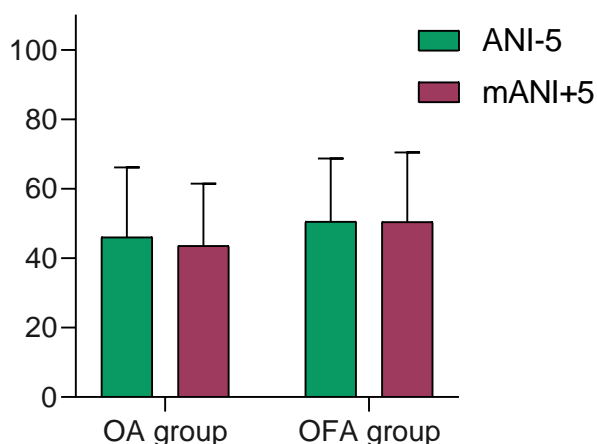


Figure3. ANI score 5 minutes after surgical stimuli

Even though no significant differences were found, a general linear model of repeated measures was run to evaluate the change between times and, in turn, the difference between groups, this with the objective of determining if the use of opioids is related to the scores through different times; however, the effect size was not statistically significant (Greenhouse-Geisser, $p=0.474$).

4. DISCUSSION

The present study aimed to compare the intensity of heart rate variability (HRV) measured by the Analgesia Nociception Index (ANI) monitor in two general anesthesia techniques: opioid-free anesthesia (OFA) and opioid induction (OA). The results did not demonstrate significant differences in HRV intensity between the two groups at any measured time point.

The measurement of HRV has gained attention in anesthesia monitoring as it provides valuable insights into the autonomic nervous system's activity during surgery. HRV reflects the dynamic balance between sympathetic and parasympathetic influences on the heart, which can be affected by various factors, including anesthetic agents and surgical stimuli [5,6]. The ANI monitor specifically focuses on the parasympathetic activity of the autonomic nervous system by analyzing the RR interval [7].

The findings of this study are consistent with previous research that suggests HRV may not

be significantly influenced by opioid administration during anesthesia. A study by Jeleazcov et al. (2018) compared HRV indices between patients receiving remifentanyl-based anesthesia, propofol and fentanyl measured by the bispectral index. They found no significant differences in HRV parameters between the two groups, indicating that opioids may not have a substantial impact on HRV during anesthesia [8].

However, it is important to note that the lack of significant differences in HRV intensity between the OFA and OA groups does not imply that opioids have no effect on the autonomic nervous system. Opioids are known to modulate pain perception and can affect sympathetic outflow, although the precise mechanisms are still not fully understood [9]. It is possible that the HRV changes induced by opioids during anesthesia might be subtle and not captured by the ANI monitor.

The absence of significant differences in HRV intensity between the two anesthesia techniques suggests that both opioid-free anesthesia and opioid induction can maintain a similar autonomic balance during surgery. This finding has implications for clinical practice, as it implies that either technique may be utilized without a significant impact on HRV.

Despite the study's contribution to the understanding of HRV during anesthesia, it is essential to acknowledge its limitations. Firstly, the sample size was relatively small, which might have limited the statistical power to

detect subtle differences in HRV between the groups. Additionally, the study focused on laparoscopic procedures, and the findings may not be generalizable to other types of surgeries or patient populations.

Future studies with larger sample sizes and diverse surgical procedures are warranted to further explore the influence of opioids on HRV during anesthesia. Moreover, combining HRV analysis with other parameters, such as blood pressure variability or sympathetic activity markers, could provide a more comprehensive understanding of the autonomic responses to anesthesia.

5. CONCLUSION

This study comparing the intensity of heart rate variability using the ANI monitor in opioid-free anesthesia and opioid induction did not reveal significant differences in HRV between the two techniques. While opioids are known to modulate pain perception and autonomic activity, their impact on HRV during anesthesia may be subtle and not captured by the ANI monitor. Further research is needed to elucidate the complex interactions between opioids, autonomic control, and HRV during anesthesia.

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