

Preoperative “R Wave Amplitude Variation” on Electrocardiogram Predicts Severe Hypovolemia

Abstract

Preoperative fasting is essential to prevent aspiration and associated complications. However, quite often patients end up fasting for 12 h or more due to changes in the operating room schedules, delays, and postponements. Preoperative fasting may lead to a fluid deficit, which may contribute to perioperative discomfort and morbidity. We report a case of 44-year-old female posted for total mastectomy with axillary clearance for carcinoma breast, with prolonged fasting where preoperative R wave amplitude variation along with associated changes in the plethysmograph was noticed on the monitor. 500 milliliters of lactated ringer solution was administered before induction of anesthesia, by the time R wave amplitude variation decreased. Variations in plethysmography became normal after 1 L of fluid administration after induction of anesthesia. Gross R wave amplitude variation is not a very common finding and may predict severe hypovolemia in preoperative area in prolonged fasting patients.

Keywords: Anesthesia, electrocardiography, general, hypovolemia, plethysmography

Introduction

Electrocardiographic (ECG) monitoring is the standard of care in the operating room and the intensive care setting. However, it is now well established that a more detailed analysis of ECG waveform and its interaction with respiration may provide additional information of the overall volume status of the patient. Preoperative fasting is essential to prevent aspiration and associated complications. However, quite often, patients end up fasting for 12 h or more due to changes in the operating room schedules, delays, and postponements. Furthermore, preoperative fasting may lead to a fluid deficit, which may contribute to perioperative discomfort and morbidity.^[1-3] R wave amplitude variation on preoperative ECG in a patient with prolong fasting may predict hypovolemia. Here, we report a patient where this effect was seen very prominently on the ECG monitor just before induction of anesthesia.

Case Report

A 44-year-old female diagnosed with carcinoma of the left breast was posted for modified radical mastectomy with axillary

clearance. On preanesthetic evaluation, no positive history or findings were elicited and baseline investigations were within normal limits. ECG was normal without any electrical alternates, and her two-dimensional echocardiogram showed normal left ventricular function with an ejection fraction of 60%. Her effort tolerance was >4 METs. Preoperative instructions were given for fasting for 8 h for oily solid food and to have clear liquids up to 2 h before surgery.

However, she had fasted for 16½ h when she was received in the operating room. General anesthetic was planned. ECG, noninvasive blood pressure (NIBP), and pulse oximetry (SpO₂) monitors were attached and a 22 G cannula was secured. At this time, variation in the R wave amplitude was noticed in Lead II on ECG. It correlated with variations in the plethysmograph [Figure 1a]. The patient's heart rate was 98 beats/min and blood pressure was 112/86 mm of Hg. Since the patient was asymptomatic and hemodynamically stable, it was decided to proceed with the surgical procedure. Lactated ringer solution was started before induction of anesthesia and after 500 ml of fluid administration, variation of R wave

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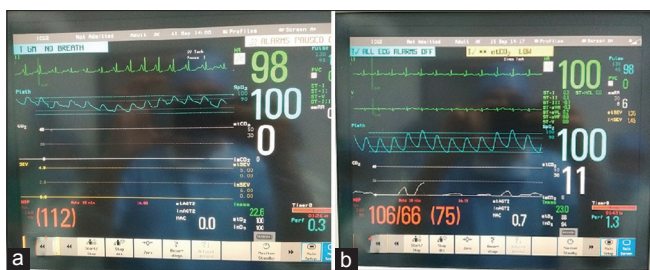


Figure 1: (a) Image showing “R wave amplitude variation” on preinduction electrocardiographic variations in plethysmography and perf of 0.3, (b) image showing decreased “R wave amplitude variation” but persisted variations in plethysmography and perf of 1.3

amplitude started reducing but plethysmography variation persisted [Figure 1b]. Perfusion numeric (perf) on monitor was 0.3 [Figure 1a] before giving fluids, which improved to 1.3 [Figure 1b] after giving fluid. General anesthesia was induced with sevoflurane along with 50 mg propofol, 100 mcg fentanyl, and 25 mg atracurium. Variation in R wave amplitude further decreased and eventually became normal after 1 L of lactated ringer solution was administered. Variations in plethysmography also became normal after 1 L of fluid administration. The patient was hemodynamically stable throughout surgery. The intraoperative blood loss was 200 ml. The procedure was uneventful and the patient was shifted to the postanesthesia care unit (PACU) for postoperative care where ECG, NIBP, and SpO₂ were monitored continuously. R wave amplitude variation and plethysmography variations were not observed, and the patient was started on clear liquids once wide awake. The patient was discharged from PACU after 2 h and shifted to postoperative ward. The patient was discharged from hospital on the next day.

Discussion

Brody,^[2] in 1956, described the effect of the intracardiac blood mass on ECG. It was characterized by the variation in the R wave amplitude in Lead II of ECG waveform. This is because there is a “shortcircuiting” effect by the intracavitary blood mass. While the conductivities of the myocardium and lungs are almost the same, the conductivity of the intracavitary blood mass is approximately 10 times that of the surrounding tissue. This leads to shortcircuiting effect of potentials generated within the myocardium by intracavitary blood mass. In other words, R wave in Lead II increases with increased cardiac preload due to the high electric conductivity of blood. Hence, respiratory variations in the left ventricular preload and stroke volume result in variation in R wave amplitude. This phenomenon is called the Brody effect.

Hypovolemia and dehydration are known complications of prolonged fasting. If not addressed, it results in adverse hemodynamic consequences following anesthesia induction and is associated with increased rates of postoperative

acute renal failure,^[4] myocardial ischemia, and cardiac arrest. Pulse pressure variation, stroke volume variation, central venous pressure, and pleth variability index have been used to identify fluid responsiveness and hypovolemia to optimize the fluid status of patients. Studies have now demonstrated that in mechanically ventilated patients, respiratory variations in R wave amplitude can be used to predict hypovolemia reliably.^[5-7] In one study, variation in R wave amplitude in Lead II of ECG has been demonstrated to detect central hypovolemia in spontaneously breathing awake patients.^[8]

In the present case, R wave amplitude variation decreased after giving 500 ml of fluid, but plethysmography variation persisted that indicated that our patient had severe hypovolemia. Plethysmography variation decreased after 1-l fluid administration. Induction of anesthesia, without fluid resuscitation, in this case, could have resulted in severe hypotension.

ECG is used as a standard monitor in anesthesia, and detection of the R wave amplitude variation in the preoperative period can be utilized as a very simple, noninvasive tool to detect severe hypovolemia and assist in optimizing the fluid status in dehydrated patients preoperatively, thereby averting associated complications.

Conclusion

Anesthesiologist should be aware of the R wave amplitude variation in preoperative area and should correct hypovolemia if the patient is fasting for a long time, to avoid hemodynamic instability after induction of anesthesia.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

References

1. Holte K, Kehlet H. Compensatory fluid administration for preoperative dehydration – Does it improve outcome? *Acta Anaesthesiol Scand* 2002;46:1089-93.
2. Brody DA. A theoretical analysis of intracavitary blood mass influence on the heart-lead relationship. *Circ Res* 1956;4:731-8.
3. Pinsky MR, Gorcsan J 3rd, Gasior TA, Mandarino WA, Deneault LG, Hattler BG, *et al.* Changes in electrocardiographic morphology reflect

- instantaneous changes in left ventricular volume and output in cardiac surgery patients. *Am J Cardiol* 1995;76:667-74.
4. Moghadamyeghaneh Z, Phelan MJ, Carmichael JC, Mills SD, Pigazzi A, Nguyen NT, *et al.* Preoperative dehydration increases risk of postoperative acute renal failure in colon and rectal surgery. *J Gastrointest Surg* 2014;18:2178-85.
 5. Cannesson M, Keller G, Desebbe O, Lehot JJ. Relations between respiratory changes in R-wave amplitude and arterial pulse pressure in mechanically ventilated patients. *J Clin Monit Comput* 2010;24:203-7.
 6. Soltner C, Dantec R, Lebreton F, Huntzinger J, Beydon L. Changes in R-Wave amplitude in DII lead is less sensitive than pulse pressure variation to detect changes in stroke volume after fluid challenge in ICU patients postoperatively to cardiac surgery. *J Clin Monit Comput* 2010;24:133-9.
 7. Giraud R, Siegenthaler N, Morel DR, Romand JA, Brochard L, Bendjelid K. Respiratory change in ECG-wave amplitude is a reliable parameter to estimate intravascular volume status. *J ClinMonitComput* 2013;27:107-11.
 8. McManus JG, Convertino VA, Cooke WH, Ludwig DA, Holcomb JB. R-wave amplitude in lead II of an electrocardiograph correlates with central hypovolemia in human beings. *Acad Emerg Med* 2006;13:1003-10.