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Incidence of Postoperative Acid-Base Disturbances in Abdominal Surgery

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ABSTRACT

Introduction: Respiratory and blood pressure changes as well as fluid administration alter the acid-base balance during the perioperative period which may cause consciousness disturbance and additional hemodynamic disorders. The aim of this study was to identify frequent postoperative acid-base disturbances in order to control postoperative complications.

Materials and Methods: This prospective, observational study design was used on patients who underwent abdominal surgery during a six-month period. Gasometry was performed immediately after the patients' admittion to ICU and six and 12 hours postoperatively. SPSS v13 software was used, and $P<0.05$ was considered significant.

Results: 213 patients (123 male and 90 female) aged 14-85 years (51.7± 22.4) were evaluated. During admission, PH and $PaCO_2$ were (7.29±0.13) and (38.3±11.9), respectively; however, although PH increased gradually (P=0.001), $PaCO_2$ was reduced (P=0.03). Bicarbonate and base excess had opposite effects; bicarbonate initially decreased but increased after 12 hours (P=0.001), whereas base excess initially increased (-6.3±11.6) and then decreased gradually (P=0.003). The arterial oxygen pressure was reduced for 22.5% of the patients throughout the admission period, and this did not significantly change (P=0.57).

Conclusion: According to the results, in admission, 65.7% had metabolic acidosis, but metabolic alkalosis was the least. Gradually, metabolic acidosis was modified, but metabolic alkalosis increased. Intraoperative hypotension and fluid infusion may be the main factors of early metabolic acidosis and control of hypotension, or correction of acidosis may increase metabolic alkalosis.

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Introduction

Ventilation changes, amount and type of fluids, autonomic nervous system stimulation, and hemodynamic disorders make acid-base imbalance during anesthesia. Hypoventilation, light anesthesia, sympathetic stimulation, hyperthermia or glucose overdose increase arterial carbon dioxide and can make respiratory acidosis (1). On the other hand, hyperventilation, hypoxemia, hypothermia and muscles' paralysis reduce arterial carbon dioxide and result in respiratory alkalosis (2). Metabolic acidosis in healthy patients during operation is mostly due to high infusion of saline 0.9% (hyperchloremic acidosis) and hypotonic serum (dilutional acidosis). Also, hypotension, hypoxemia, renal failure, cirrhosis, diabetes and related diseases can cause metabolic acidosis (3). Perioperative metabolic alkalosis is usually of iatrogenic origin. It is mostly created by hyperventilation of patients with chronic obstructive pulmonary disease and chloride loss in urine (Hypochloremic alkalosis) (4), excessive intake of lactated ringer's solution or citrated blood (converting lactate and citrate to bicarbonate) or diuretics. Acid-base disturbances create various side effects. Acidosis leads to hyperkalemia, delayed emergence of anesthesia, dyspnea, respiratory muscles' fatigue, hypotension, bradycardia, and hypovolumia.

On the other hand, alkalosis results into hypokalemia, postoperative muscle relaxation, restlessness, low cerebral blood flow, low coronary perfusion pressure, and the increase of airway

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resistance (5, 6). In a study, mortality in patients with lactic acidosis was reported nearly twice than patients with non-lactic acidosis (7). In this study, incidence and the type of postoperative acid base disorders are evaluated after intensive care unit (ICU) admission and the early hours. In the future, we will analyze ethiology and correct perioperative acid-base changes.

Materials and Methods

This study was a prospective and non-intervention design conducted in abdominal surgery patients transferred to the ICU during six months. During this period, the patients with abdominal surgery who were transferred from the operating room to the ICU were assessed. At first, the patients were monitored. The patients with apnea, tidal volume<5ml/kg and respiratory rate < 8/per min, hypercarbia and (PH<7.25) were ventilated mechanically. Arterial Blood Gases (ABG) was performed three times (in admission time and 6 and 12 hours after admission). The patients were mechanically ventilated or oxygenated, and they were treated by chloride or bicarbonate infusion, when (PH<7.1), (HCO_3<12), (BE>-10) or the patient had a critical condition (was applied with the formula of Base Excess×weight×0.3). Half of the obtained amount was infused rapidly, and in cases of the lack of modification, the remaining bicarbonate was infused after half an hour (6). The serum was infused according to hemodynamic changes, concurrent diseases, acid and base disorders. The data was analyzed by SPSS V_{13} software. To compare the parameters, repeated measure analysis of variance was applied in three phases, and to investigate the dependence of acid-base dysfunctions with independent and demographic parameters, regression method was used. P-value<0.05 was considered significant.

Results

Demographic data showed the admitted patients aged 14-85 years (51.7±22.4), 123 men and 90 women. Of 213 patients in the ICU, 18 patients (8.5%) had normal ABG, and 195 patients (91.5%) were with acid-base dysfunctions. By analyzing acid-base dysfunction, the highest dysfunction among these patients was metabolic acidosis (65.7%), and the lowest dysfunction was metabolic alkalosis (1.4%). During the admission, metabolic and respiratory acidosis was reduced, and metabolic alkalosis prevalence was increased to 7.5%.

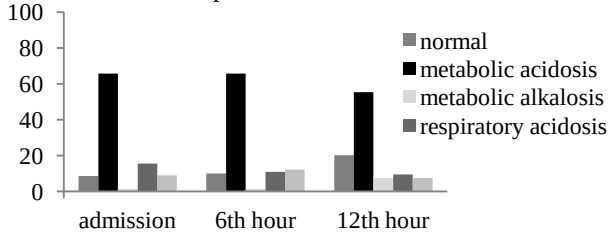

Figure1: The prevalence of acid-base disturbances (%) at zero, six, 12 hours after ICU admission.

The increase of PH, base excess and reduction of bicarbonate and carbon dioxide pressure after admission was statistically significant compared to the values recorded in the first minute (Table 1).

Table 1: PH, carbon dioxide, bicarbonate, base excess (BE), PaO_2 and SaO_2 values. Mean (SD)

	During admission	After 6 hr	After 12 hr	P- value
PH	7.29(0.13)	7.35(0.1)	7.36(0.1)	0.001
PaCO2	38.3(11.9)	35(8.8)	33.6(8.60)	0.03
HCO3	17.7(4.5)	18.9(5.1)	19.4(4.5)	0.001
BE	-6.3(11.6)	-3.1(12.3)	-2.9(12.3)	0.003
PaO_2	91.6(51.4)	86.2(41.50)	79.9(36.8)	0.57
SaO2	87(16.5)	86(18.9)	86.6(15.9)	0.29

Arterial oxygen pressure during ICU admission was 40.2-298 mm Hg (91.6±51.4), and about 22.5% of the patients experienced the reduction of arterial blood oxygen. After 12 hours, there was no considerable change in the amount of arterial blood oxygen, 17.4% showed mild hypoxemia yet (The mean arterial oxygen pressure was (86.2±41.5) mm Hg at the sixth hour and (79.9±36.8) mmHg at the 12th hour). The statistical analysis of the data showed that pressure and saturation of arterial oxygen changes was not statistically significant (0.57 and 0.29 subsequently).

Discussion

In the six-month study on the general surgical patients, it was shown that during ICU admission, only 18 patients (8.5%) had natural ABG, and the others had acid-base disturbance. By analyzing, the highest disturbance among the patients was metabolic acidosis (65.7%), and the lowest dysfunction was metabolic alkalosis. During admission, more than half of the patients had metabolic acidosis, but it was improved over time, and metabolic alkalosis was increased. There are various studies about postoperative acid-base changes with various results in terms of the type of surgeries. In a study conducted by Ichikura and Tamakuma (8), the same result was presented. They found that the main reason of acidosis prevalence during admission was hormone changes due to anaerobic glycolysis, stress, and lactic acidosis. Also, secondary aldosteronism and conversion of lactate or citrate to bicarbonate are some of the causes of metabolic alkalosis. High prevalence of acidosis was reported in other studies including the studies performed on patients who underwent thoracotomy surgery (9), cirrhotic patients whose liver was removed (10), and children underwent open heart surgery (11).

There are various important factors of acidosis.

Panditt et al showed in their studies that the type of surgery is one of the effective factors such that they concluded that thoracotomy results in higher $PaCO_2$ than abdominal surgery (9). Cuccheti et al (10) considered the perioperative hemorrhage and liver disturbances as effective factors on the severity of

acidosis. In children who underwent open heart surgery, the main cause of metabolic acidosis was the increase of chloride and reduction of Albumin (11).

The type of solution is one of the ethiologies of perioperative metabolic acidosis (12, 13). Despite the mentioned items, other studies referred to the high amount of alkalosis occurrence during admission, as the study conducted on 293 patients with abdomen surgery.

The cause of 50.5% prevalence of metabolic alkalosis among the patients was due to the infusion of Fresh Frozen Plasma (FFP) (14). In a study conducted by Boaz et al (15), metabolic alkalemia occurred more frequently than metabolic acidemia preoperatively and postoperatively, while acidemia occurred intraoperatively. As it was said, one of the most common causes of metabolic acidosis is the reduction of blood pressure and arterial oxygen and is based on the critical condition of the patients as the reason for their admission to the ICU. The main cause of metabolic acidosis is due to the reduction of perioperative or preoperative blood pressure.

Considering the high prevalence of hypoxemia, another cause of metabolic acidosis is the reduction of oxygen level during the transfer from recovery to the ICU. During the admission after 12 hours, metabolic acidosis and respiratory acidosis were reduced, and metabolic alkalosis was increased from 1.4% to 7.5%.

The reduction of pressure of carbon dioxide due to the increase of ventilation, pain, and anxiety were predicted in the reduction of acidosis. Also, the reduction of acidemia and low base excess were due to the modification by kidney or bicarbonate infusion. In complicated surgeries, alkalosis can occur by postoperative hypovolumia, the loss of gastric secretions, and hypokalemia.

Conclusion

In this study, postoperative metabolic acidosis was prevalent among critical patients (65.7%) and follows orderly for respiratory acidosis, respiratory alkalosis, and metabolic alkalosis.

One of the factors of resistance against vasoconstrictors and fluids is acidosis, and its rapid modification, is effective for the recovery of the patient.

Therefore, it should be said that correction of fluid administration, ventilation, and oxygenation would probably be minimized metabolic acidosis and its related complications.

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