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## Original research article

# Comparison of acid–base and electrolyte imbalances between normal saline and 1.4% sodium bicarbonate intravenous fluids therapy during cervical and lumbar laminectomy

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## ARTICLE INFO

## Article history:

Received 22 February 2016

Received in revised form

15 March 2016

Accepted 30 March 2016

Available online xxx

## Keywords:

Crystalloid solutions

Fluid therapy

Laminectomy

Sodium Bicarbonate

Water-electrolyte balance

## ABSTRACT

**Introduction:** Large amounts of normal saline infused in surgeries can cause hyperchloremic metabolic acidosis.

**Aim:** This study was designed to evaluate electrolyte and acid–base imbalances in the common fluid therapy method (normal saline) and the use of 1.4% sodium bicarbonate with normal saline fluid therapy during surgical laminectomy.

**Material and methods:** In this double-blind randomized clinical trial patients from 35 to 70 years in age, having American Society of Anesthesiologists physical status class I–II, candidation for cervical and lumbar laminectomy in Baqiyatallah Hospital (Tehran, Iran) in 2015 were enrolled. Patients were randomized into either two groups receiving 1.4% sodium bicarbonate and normal saline intravenous solutions for deficit fluid therapy during the surgery. Hemodynamics, arterial blood gases, and electrolytes levels were measured before and after surgery. Data were compared between the groups by SPSS.

**Results and discussion:** Forty patients with a mean age of  $49.9 \pm 12.7$  years were evaluated. There were no significant differences in demographic data, mean surgery duration, blood loss, urine output, and infused fluid volumes between the two groups ( $P > 0.05$ ). The mean  $PCO_2$  and  $HCO_3$  values significantly increased in the bicarbonate group, whereas they decreased significantly in the normal saline group. The mean serum lactate increased significantly in the bicarbonate group while the mean serum  $Cl^-$  increased significantly in the normal saline group ( $P < 0.05$ ).

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<http://dx.doi.org/10.1016/j.poamed.2016.03.005>

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**Conclusions:** The results of this study showed the superiority of 1.4% sodium bicarbonate fluid in controlling acid–base and electrolyte imbalances during this kind of surgery, but it should be verified by further studies.

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## 1. Introduction

Fluid therapy is an essential part of surgeries<sup>1</sup> and nearly all patients with general anesthesia should receive some intravenous (IV) fluids.<sup>2</sup> Evidence shows that fluid therapy during surgeries has a dramatic effect on surgery results in the long-run.<sup>1</sup> In general, two groups of serums, crystalloid and colloid, are more commonly used for fluid therapy during surgeries.<sup>3</sup>

Achieving an appropriate effective circulating volume and assuring oxygen delivery to tissues are the goals of fluid therapy which are provided by a high volume of crystalloid, usually ringer and normal saline. Required fluids in patients include maintenance and deficit fluids like bleeding and third space.<sup>1</sup>

Acid–base balance is of great importance as the life of patients depends on it.<sup>4</sup> In patients undergoing general anesthesia, acid–base disorders followed by cardiovascular, muscular, and respiratory dysfunctions as well as central nervous system disorders are highly prevalent.<sup>1</sup> Electrolyte disorders damage cells by changing intra- and extra-cellular fluids balance. They occur repeatedly, especially in surgeries of long duration.<sup>5</sup>

During long surgeries, patients receive a high amount of normal saline which may result in hyperchloremic metabolic acidosis with perfusion alteration and end organ dysfunction.<sup>4,6</sup> Sodium-bicarbonate 7.5%, a hypertonic solution, is usually used for treatment which is associated with intracellular acidosis as a complication.<sup>7,8</sup>

This prospective study was done to evaluate electrolyte and acid–base imbalances in the common fluid therapy method (normal saline) and the use of 1.4% sodium bicarbonate with normal saline in cervical and lumbar laminectomy surgeries in order to decrease the incidence of metabolic acidosis and achieving an improvement in fluid therapy.

## 2. Material and methods

### 2.1. Study subjects

This double-blind clinical trial was carried out of patients of age ranging 35–70 years old referring to Baqiyatallah Hospital (Tehran, Iran) in 2015 with American Society of Anesthesiologists (ASA) physical status class I–II that were considered candidates for elective cervical and lumbar spinal laminectomy by the same neurosurgeon. Patients with chronic kidney disease (CKD), hepatic failure, electrolytes imbalance, changes in blood pressure more than 30% of basal amount, need for blood transfusion before and during operation, intestinal preparation before operation, and need for lower PaCO<sub>2</sub> less than 35 mmHg were excluded from the study. The included and excluded patients are described in Fig. 1. No patient was excluded during the study.

### 2.2. Study design

Patients were visited the night before operation and randomized into two groups by a computer-generated randomization list. After entrance to the operation room, demographic data and patients' numbers were written on each checklist. A blood sample was taken from IV line before IV fluid was infused and an arterial blood sample was taken for arterial blood gases' analysis. Premedication was done using midazolam (1–2 mg) and fentanyl (75–150 µg). The patients were oxygenated by 100% O<sub>2</sub> gas; then 5 mg/kg sodium thiopental for anesthesia and 0.5 mg/kg atracurium were administered for facilitating intubation. Laryngoscopy was done and the patients' tracheas were intubated using 8-mm and 7.5-mm high-volume/low-pressure SUPA endotracheal tubes (SUPA, Tehran, Iran) for male and female patients. After fixation, endotracheal tube was connected to a mechanical ventilator (Drager, Lubeck, Germany) with tidal volume of 10 cc/kg and respiratory rate of 12 per minute setting. For anesthesia maintenance, 60 µg kg<sup>-1</sup> min<sup>-1</sup> propofol was prescribed and analgesia was done using 5–10 mg IV morphine. A Foley catheter was inserted for all patients and urine output was measured. Fluids needed were calculated in checklists. Maintenance fluid therapy was done using normal saline and deficit fluid therapy was carried out using 1.4% sodium bicarbonate in the first group, whereas maintenance and deficit fluid therapies were done using normal saline in the second group. The 1.4% sodium bicarbonate was produced using 150 mL sodium bicarbonate 7.5% added to 850 mL infusible distilled water identical in shape and size to normal saline fluid by another anesthesiologist. Drug prescriber, who filled the checklists in all stages as well as the person who performed the analysis were unaware of the infused fluid in both groups. All patients were evaluated in terms of arterial blood gases, electrolytes, and hemodynamic factors before and after the operation (on arrival in the PACU). During the suturing time, propofol was discontinued; then 100% oxygen was prescribed. After finishing the surgery, with observation of respiration, reverse drugs, such as 0.04 mg/kg neostigmine and 0.02 mg/kg atropine, were infused.

### 2.3. Measurements

Arterial blood gases were analyzed using GEM Premier 3000 (Instrumentation Laboratory, Bedford, MA, USA) and all other laboratory findings were measured using Pars Azmoon lab kits (Pars Azmoon Co., Tehran, Iran) at the Central Laboratory of Baqiyatallah Hospital.

Systolic and diastolic blood pressures were continuously measured by an advanced practice nurse in anesthesia using an automatic monitoring system (Cardioset FX7, SaIRAN Medical Industry-Iran) during the operation.

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