Lactated Ringer’s solution or 0.9% sodium chloride as fluid therapy in pigeons (*Columbia livia*) submitted to humerus osteosynthesis

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ABSTRACT.- Carregaro A.B., Gehrcke M.I., Marques J.S., Silva A.N.E. & Gomes K.T. 2015. Lactated Ringer’s solution or 0.9% sodium chloride as fluid therapy in pigeons (*Columbia livia*) submitted to humerus osteosynthesis. *Pesquisa Veterinária Brasileira 35*(1):95-98. Departamento de Medicina Veterinária, Universidade de São Paulo, Av. Duque de Caxias Norte 225, Pirassununga, SP 13635-900, Brazil. E-mail: carregaro@usp.br

The study aimed to compare the effects of intraosseous infusion of lactated Ringer’s and 0.9% sodium chloride solutions on the electrolytes and acid-base balance in pigeons submitted to humerus osteosynthesis. Eighteen pigeons were undergoing to isoflurane anesthesia by an avalvular circuit system. They were randomly assigned into two groups (n=9) receiving lactated Ringer’s solution (LR) or 0.9% sodium chloride (SC), in a continuous infusion rate of 20mL/kg/h, by using an intraosseous catheter into the tibiotarsus during 60-minute anesthetic procedure. Heart rate (HR), and respiratory rate (RR) were measured every 10 min. Venous blood samples were collected at 0, 30 and 60 minutes to analyze blood pH, PvCO₂, HCO₃⁻, Na⁺ and K⁺. Blood gases and electrolytes showed respiratory acidosis in both groups during induction, under physical restraint. This acidosis was evidenced by a decrease of pH since 0 min, associated with a compensatory response, observed by increasing of HCO₃⁻ concentration, at 30 and 60 min. It was not observed any changes on Na⁺ and K⁺ serum concentrations. According to the results, there is no reason for choosing one of the two solutions, and it could be concluded that both fluid therapy solutions do not promote any impact on acid-base balance and electrolyte concentrations in pigeons submitted to humerus osteosynthesis.

ambos os fluidos, não foram observadas alterações que justifiquem a predileção por alguma destas soluções. Diante destes resultados conclui-se que a escolha entre uma das soluções avaliadas não promoveu impacto sob o equilíbrio ácido-base e hidroeletrolítico de pombos submetidos a osteossíntese de úmero.

**TERMOS DE INDEXAÇÃO:** Pombos, *Columbia livia*, osteossíntese, fluidoterapia, via intraóssea, bicarbonato, equilíbrio ácido-base.

**INTRODUCTION**

Fluid therapy during surgery is essential to minimize blood loss and dehydration from surgical and anesthetic procedures. Fluid therapy has great importance in bird surgery, due to its low blood volume (Gunkel & Lafortune 2005) and high cellular metabolism (Abou-Madi & Kollias 1992, Steinoht 1999, Gunkel & Lafortune 2005).

Fluid therapy may be administered through different routes: oral, subcutaneous, intraperitoneal or intracelomotic, intravenous or intraosseous (Fowler 2007). Intra-venous and intraosseous routes of administration are the most efficient and most frequently used for blood volume replacement in birds during surgery or in critical situations (Powers 2006, Fowler 2007). Intraosseous infusion is more efficient than intravenous infusion because of the easy access and the higher stability. Intraosseous infusion is specially suggested in small birds or when the peripheral venous access may be difficult due to vasoconstriction in hypovolemic birds (Valverde et al. 1993, Heatley et al. 2001, Dubé et al. 2011).

Nevertheless, fractures, fluid losses from bone marrow to extramedular space, osteomyelitis and local pain have been described as some complications that are mainly associated to this route of administration (Dubé et al. 2011). Complications during intraosseous fluid therapy may be associated to the lack of practice of catheter insertion, time of the catheter inside the bone, or injection of hypertonic or alkaline solutions into the medullar bone space (Lennox 2008, Dubé et al. 2011). There are few data about the prevalence of osteomyelitis in birds associated of fluid therapy administration by this route. However, some studies in humans showed only a 0.6% prevalence of osteomyelitis patients submitted to intraosseous infusion (Massey 1950, Rosetti et al. 1985).

The choice of the fluid therapy depends on the clinical and biochemical conditions of the patient. Those might be especially described by serum total protein and its fractions, hematocrit and electrolytes (Na⁺, K⁺ and Cl⁻), associated with the degree of the dehydration and blood loss during the surgery (Montesinos & Ardiaca 2013). Bird’s blood serum usually has higher concentrations of Na⁺ and low concentrations of K⁺ than mammals (Gunkel & Lafortune 2005). Administration of isotonic solutions formulated to use in mammals may affect the dynamic of body fluids, physiologic processes and heart contractility in birds. Therefore, it is important to establish which is the best fluid and the adequate volume to be administered in those patients.

This study aims to evaluate the impact of fluid therapy with lactate Ringer’s solution or 0.9% saline solution, by intraosseous route, in pigeons (*Columba livia*) submitted to osteosynthesis of the humerus.

![Fig.1. (A) Isoflurane anesthetic induction of pigeon by face mask. (B) Tracheal intubation with a 2.0 no cuffed tube. (C) Insertion of a 20G catheter into the tibiotarsus bone. (D) Fluid therapy administration.](image-url)
MATERIALS AND METHODS

This study was approved by the Institutional Animal Use and Care Committee (number 38/2008) of Federal University of Santa Maria. Eighteen adults pigeons (Columbia livia), weighting 302.5±28.8g were used. Those birds were submitted to osteosynthesis of humerus with bone graft (parallel study).

The birds were manually restrained and submitted to inhalant anesthesia induction, by isoflurane (Isolfrana®, Cristália Prod. Farm. Ltda. Itapira, SP. Brazil) in 100% oxygen by use of a face mask (Figure 1a). After anesthetic induction, the birds were intubated with 2.0 uncuffed endotracheal tube (Figure 1b) (0 min) and maintained an expired fraction of isoflurane concentration (FE’Iso) of 3.0 ± 0.4% with a Bain circuit (Oxigel® São Paulo. SP. Brazil). The birds were placed on lateral recumbency on a thermal pad (Orottvet®. São Paulo. SP. Brazil) to maintain body core temperature (39-41°C). A 20 G catheter was introduced into the proximal region of the tibiotarsus to fluid therapy administration (Fig 1c and 1d).

The birds were randomly assigned in two groups (n=9), receiving either lactated Ringer’s solution (LR) (Ringer lactato. Fresenius Kabi Brasil Ltda, Aquiraz, Ceará, Brazil) or 0.9% sodium chloride (SC), and submitted to isoflurane anesthesia and maintained an expired fraction of isoflurane concentration (FE’Iso) of 3.0 ± 0.4% with a Bain circuit (Oxigel® São Paulo. SP. Brazil). Both solutions were administered at a rate of 20ml/kg/h rate using a syringe infusion pump (Golda de infusão B. Braun CC. modelo 8714827. Laboratórios B. Braun S.A., São Gonçalo, Rio de Janeiro, Brazil).

Surgical procedure was standardized in 40 minutes. Patient monitoring was performed during 60 minutes. Heart rate (HR) and respiratory rate (RR) were measured every 10 minutes. Ve nous blood samples were collected at 0, 30 and 60 minutes to analyze blood pH, CO2 pressure of venous blood (PvCO2), bicarbonate concentration (HCO3−), Na+ and K+ concentrations (I− Stat® 1, Abbott Point of Care Inc., Illinois, USA). All animals were given 1mg/kg of meloxicam (Maxicam® 0.2% injectable solution. Ourofino, Ribeirão Preto. São Paulo. Brasil) and 5mg/kg of morphine (Diamor® Cristália Prod. Quím. Farm. Ltda, Itapira, São Paulo, Brazil), into the pectoral muscles, at the end of isoflurane anesthesia, to provide postoperative analgesia.

Statistical analysis (Graph Pad Prism 5.0 Graph Pad Prism, Graph Pad Software Inc, San Diego. California, USA) was performed by analysis of variance (ANOVA) followed by the Bonferroni’s test for groups comparison along the times. Student’s t test was used to compare both groups, in each time. Differences were considered significant as p<0.05.

RESULTS

No significant changes were observed in the HR or RR in both groups. During the procedure, the HR was between 168±30bpm to 237±37bpm for the LR group and 202±29bpm to 225±34bpm for the SC group. The RR ranged from 22±10rpm to 28±8rpm and from 22±8rpm to 31±11rpm for the LR and SC groups respectively.

In relation to the blood gas and electrolytes analysis, both groups showed an increase in HCO₃⁻ values. This increase may be due to a rise in PvCO₂, even though no statistical difference was observed when compared values with 0min (Table 1). Regarding to the impact of the fluid therapy on the electrolytes concentrations, no difference was observed on Na⁺ or K⁺ blood concentrations. (Table 1).

Table 1. Mean and standard deviation of venous carbon dioxide pressure (PvCO₂), pH, bicarbonate (HCO₃⁻), potassium (K⁺) and sodium (Na⁺) concentrations in pigeons received lactated Ringer’s solution (LR) or 0.9% sodium chloride (SC), and submitted to isoflurane anesthesia and humerus osteosynthesis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group</th>
<th>0 min</th>
<th>30 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>LR</td>
<td>7.266 ± 0.054</td>
<td>7.245 ± 0.081</td>
<td>7.256 ± 0.075</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>7.268 ± 0.097</td>
<td>7.240 ± 0.059</td>
<td>7.222 ± 0.088</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>LR</td>
<td>25.7 ± 3.0</td>
<td>28 ± 2.4*</td>
<td>29.5 ± 2.2*</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>24.6 ± 2.0</td>
<td>27 ± 1.7*</td>
<td>28.0 ± 2.1*</td>
</tr>
<tr>
<td>K⁺</td>
<td>LR</td>
<td>3.4 ± 0.7</td>
<td>3.4 ± 0.6</td>
<td>3.6 ± 0.7</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>3.3 ± 0.5</td>
<td>3.5 ± 0.6</td>
<td>3.8 ± 0.7</td>
</tr>
<tr>
<td>Na⁺</td>
<td>LR</td>
<td>150.7 ± 4.6</td>
<td>151.2 ± 4.0</td>
<td>150.6 ± 4.3</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>152.7 ± 3.5</td>
<td>152.6 ± 3.9</td>
<td>152.2 ± 5.3</td>
</tr>
</tbody>
</table>

* Significant difference within a group in comparison with 0 min.

DISCUSSION

Acidemia (decrease of blood pH) was observed in both groups, since 0 min, when compared to reference values (Powell 2000). However, this pattern was not changed in both groups over time.

An increase in HCO₃⁻ concentrations was observed in both groups at 30 and 60 min. All moments showed values higher than those described for Zandvliet et al. (2001), who consider a normal pH of 37.92±4.23mmHg in healthy psittacines. Even though that data refer to a different species, it might suggests respiratory acidosis, once both species (psittacines and pigeons) have similar respiratory physiology, and pH at 0 min, in both groups, was lower than the considered normal for pigeons (Powell 2000). Thus, blood acid-base and electrolyte analysis suggests that the birds suffered respiratory acidosis during the anesthetic procedure. The values of HCO₃⁻ and PvCO₂ were higher during the procedure. HCO₃⁻ increased significantly at 30 min and 60 min in both groups compared to 0 min, showing a compensatory response to respiratory acidosis. The compensatory response of acid-base imbalance in this study was very similar to that described in parrots (Amazonas sp.) affected by respiratory dysfunction (Zandvliet et al. 2001) and in crested caracaras (Caracara plancus) submitted to isoflurane and sevoflurane anesthesia (Vitaliano et al. 2006).

The results suggest that anesthetic induction by face mask along physical restraint may cause a moderate respiratory acidosis. Respiratory acidosis could be associated to the stress due to the physical restraint and some episodes of apnea occurring during anesthetic induction. Guimaraes et al. (2000) and Vitaliano et al. (2006) also described similar pattern in other birds, and both studies correlate respiratory acidosis to respiratory suppression during perioperative period. It is important to point out that the RR remained quite stable during the anesthetic procedure. Furthermore, PvCO₂ values remained higher since the start of the procedure.

Values of pH observed in this study were significantly lower than those presented by Powell (2000), who described a blood pH as 7.503 for awake pigeons. The comparison between the results of this study (blood pH between

7.222 and 7.268) and those presented by Powell (2000) supports the hypothesis of respiratory acidosis caused by both physical restraint and the anesthetic procedure.

The blood gas and electrolytes analysis were obtained by a device that quantifies the \( O_2 \) and \( CO_2 \) concentrations, and pH by a direct measurement, and the \( HCO_3^- \) concentration by indirect measurement. That equipment bases on the human physiology to get those indirect values. This might promote a certain inaccuracy on the results, despite this technique is well used for dogs (Montesinos & Ardia-ca 2013). Studies in other species had been conducted in order to improve the technique (Kilgallon et al. 2008, McCain et al. 2010, Vannucchi et al. 2012, Lewbart et al. 2014). However, as discussed earlier, the parameters observed here, and combined with a compensatory response of both groups suggest a less significant effect of these variants to the shown data.

The results of \( Na^+ \) and \( K^+ \) concentrations, along with other parameters, such as \( PVCO_2 \), \( pH \), \( HCO_3^- \) and \( pH \) by a direct measurement, and the \( HCO_3^- \) concentration by indirect measurement. That equipment bases on the human physiology to get those indirect values. This might promote a certain inaccuracy on the results, despite this technique is well used for dogs (Montesinos & Ardia-ca 2013). Studies in other species had been conducted in order to improve the technique (Kilgallon et al. 2008, McCain et al. 2010, Vannucchi et al. 2012, Lewbart et al. 2014). However, as discussed earlier, the parameters observed here, and combined with a compensatory response of both groups suggest a less significant effect of these variants to the shown data.

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CONCLUSION

According to the results of the present study, 0.9% saline solution or lactated Ringer’s solution at a 20mL/kg/h rate infusion, by intraosseous route, do not cause significant changes on acid-base balance and electrolyte concentrations in pigeons.

REFERENCES


