

Impact of Rhinoplasty and Staphylectomy on Venous Blood Gas Parameters in French Bulldogs with Brachycephalic Obstructive Airway Syndrome (BOAS)

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Case Report

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Abstract

Objective: To assess the impact of rhinoplasty and staphylectomy on gas exchange in French Bulldogs using venous blood gas analysis performed before and after surgery.

Methods: French Bulldogs diagnosed with brachycephalic obstructive airway syndrome (BOAS) were evaluated. Venous blood gas parameters were measured before surgery and six months after rhinoplasty and staphylectomy.

Results: Venous blood gas analysis revealed alterations in respiratory and acid–base parameters before surgery, consistent with compensated respiratory acidosis. Following rhinoplasty and staphylectomy, PCO_2 and HCO_3^- values showed a trend toward normalization, indicating partial improvement in ventilatory function. However, PO_2 and oxygen saturation showed lower mean postoperative values. Changes in serum electrolyte concentrations were also observed, including increased potassium and calcium concentrations and decreased sodium concentrations.

Clinical Significance: This study highlights the importance of blood gas monitoring in brachycephalic dogs before and after surgical correction of brachycephalic obstructive airway syndrome (BOAS). The findings demonstrate respiratory and acid–base alterations compatible with compensated respiratory acidosis, although no statistically significant differences were detected between preoperative and postoperative evaluations. A notable contribution of this study is the comparative analysis of serum electrolyte concentrations before and after surgery, an aspect that has not been investigated in previous studies.

Introduction

Brachycephaly refers to a shortened skull conformation and is characteristic of several canine breeds, including the French Bulldog [15;22;18;5;32]. In these dogs, skeletal abnormalities, characterized by mediolateral widening of the skull and rostrocaudal shortening of the muzzle, are accompanied by soft tissue structures that do not decrease proportionally with the reduction in facial skeletal length. As a result, the upper airways within the nasal cavities and pharynx become compressed, leading to brachycephalic obstructive airway syndrome (BOAS) [6].

The primary upper airway abnormalities associated with BOAS in dogs include stenotic nares, elongation of the soft palate, macroglossia, tracheal hypoplasia, aberrant nasal turbinates, narrowing of the nasopharyngeal and oropharyngeal spaces, and reduction of the retropharyngeal space [16]. These alterations promote turbulent airflow, increased airway resistance, and excessive inspiratory effort, generating elevated negative pressure within the respiratory tract and predisposing affected dogs to secondary airway changes [23;4;2;21;32].

Secondary abnormalities include edema and inflammation of the oropharynx and nasopharynx, thickening of the soft palate, epiglottic cysts, eversion of the laryngeal sacculles, tonsillar hyperplasia,

sialoceles formation, laryngeal granulomas, laryngeal collapse or paralysis, and collapse of the trachea and mainstem bronchi [7;5;21].

Dogs with BOAS commonly exhibit respiratory noises, particularly snoring, stridor, and stertor, as well as sleep disturbances, dyspnea, mucosal cyanosis, exercise intolerance, and prolonged recovery following physical activity [7;23;5;21;32]. The diagnosis of BOAS is established based on anamnesis, physical examination, and diagnostic imaging studies [16].

Blood gas analysis is an important tool for both the diagnosis of respiratory dysfunction and the monitoring of treatment response in brachycephalic dogs with BOAS [27;19;32]. Due to airway obstruction, affected dogs frequently develop respiratory acidosis. This occurs when carbon dioxide elimination by the lungs is inadequate relative to its production by the body. On blood gas analysis, this alteration may be identified by increased partial pressure of carbon dioxide (PaCO_2) and increased hydrogen ion concentration, reflected by changes in blood pH [3;19;32]. In addition, these patients may exhibit decreased partial pressure of oxygen (PaO_2) and reduced hemoglobin oxygen saturation (SO_2) as a consequence of impaired gas exchange [14;1;8].

Surgical intervention is the treatment of choice for correcting the obstructive abnormalities associated with BOAS and improving patient quality of life [5] (Dupré & Heidenrich, 2016). Among the primary abnormalities, stenotic nares are commonly corrected by alarplasty (rhinoplasty), a surgical technique involving wedge resection of the nasal alae followed by primary closure [16]. Elongation of the soft palate is most commonly treated by staphylectomy (palatoplasty), which consists of resection of the excess caudal palatal tissue [6].

Therefore, the aim of this study was to evaluate changes in venous blood gas parameters in French Bulldogs with stenotic nares and elongated soft palate before and after rhinoplasty and staphylectomy.

Materials and Methods

Following approval by the Animal Ethics Committee of the Federal University of Pelotas (CEUA Protocol No. 23110.017632/2022-84) and informed owner consent, 14 French Bulldogs were enrolled in the study and evaluated between 2023 and 2024, regardless of sex, age, or reproductive status. Clinical evaluations and surgical procedures were performed at the Veterinary Teaching Hospital of the Federal University of Pelotas (HCV-UFPeI).

To ensure procedural standardization, all clinical examinations were conducted by the same clinician, all anesthetic procedures by the same anesthesiologist, and all surgeries by the same surgeon.

For the initial clinical evaluation, a standardized anamnesis questionnaire, developed based on clinical signs described in the literature, was used in conjunction with a general and specific physical examination. In addition, venous blood samples were collected during the first consultation for blood gas analysis. The cephalic vein was punctured, and 1 mL of blood was collected using a 3-mL syringe

and a 24-gauge needle. The sample was then transferred to a heparinized syringe, transported to the Clinical Pathology Laboratory of HCV-UFPEL, and processed within 10 minutes of collection.

The same sampling protocol was repeated during the follow-up evaluation performed six months after rhinoplasty and staphylectomy. However, in some patients, the interval between sample collection and processing exceeded 10 minutes during the follow-up period because blood collection was performed at the owners' homes to minimize stress associated with transportation and hospital visits.

For patients with clinical suspicion of BOAS, complementary diagnostic tests were performed as part of a comprehensive pre-anesthetic evaluation. These examinations included a complete blood count, serum biochemistry profile (albumin, ALT, AST, ALP, urea, and creatinine), ambulatory electrocardiography, 24-hour Holter monitoring, cervical and thoracic radiography, and Doppler echocardiography in dogs older than six years of age.

Following confirmation of stenotic nares and elongated soft palate, and verification of adequate health status for anesthesia and surgery, the dogs were referred for rhinoplasty and staphylectomy.

Prior to surgery, food was withheld for 8–12 hours. Premedication consisted of methadone (10 mg/mL; 0.2 mg/kg, intramuscularly). Fifteen minutes later, intravenous access was established, and anesthesia was induced with propofol (10 mg/mL; 3 mg/kg), ketamine (100 mg/mL; 1 mg/kg), and midazolam (5 mg/mL; 0.3 mg/kg), administered intravenously.

The dogs were then positioned in sternal recumbency for orotracheal intubation, and anesthesia was maintained with isoflurane (1.2–1.8%). An infraorbital nerve block was performed using lidocaine (10 mg/mL; 0.1 mL/kg) to provide locoregional analgesia.

Surgical correction began with staphylectomy, performed according to the technique described by Fossum (2014) [12]. The patient was positioned in sternal recumbency with the mouth held open using a metal mouth gag. The surgical field was prepared and draped, and the drapes were secured with Backhaus towel clamps. The caudal edge of the soft palate was grasped with Allis tissue forceps, and stay sutures using 2-0 nylon were placed at the intended resection margin. Excess soft palate tissue was excised from right to left using Metzenbaum scissors, followed by appropriate hemostasis. Closure was performed using a simple continuous suture pattern along the palatal margin with 4-0 absorbable suture material (Vicryl).

Subsequently, the patient was repositioned with the mouth closed, and rhinoplasty was performed according to the technique described by Fossum (2014) [12]. The surgical field was again prepared and draped, and the drapes were secured with Backhaus towel clamps. A vertically oriented wedge resection was performed in each stenotic nostril using a No. 11 scalpel blade. Hemostasis and closure were achieved with two to four simple interrupted sutures using 3-0 absorbable suture material (Vicryl).

Postoperatively, prednisolone was prescribed at a dose of 0.5 mg/kg orally twice daily (BID) for 5 days, and dipyrone (500 mg/mL) at 25 mg/kg orally three times daily (TID) for 3 days. Both medications were

generic formulations obtained from human pharmacies. In addition, owners were instructed to provide a soft diet for 10 days, maintain the use of an Elizabethan collar for 14 days, and clean the nasal sutures twice daily with gauze and 0.9% saline solution for 14 days.

Six months after surgery, the patients returned for clinical re-evaluation of BOAS-related outcomes and collection of a venous blood sample for blood gas analysis to assess the response to treatment.

Data were analyzed descriptively and statistically using GraphPad Prism® software. Fisher’s exact test was used for nominal categorical variables.

Results

Between March 2023 and December 2024, 66 French Bulldogs were evaluated. Of these, 20 underwent surgical treatment; however, only 14 returned for the six-month follow-up evaluation. According to owner reports, the six dogs that did not return were unavailable for re-evaluation due to time constraints or because their owners considered follow-up unnecessary in the absence of clinical concerns.

Among the 14 dogs that completed the follow-up evaluation, 9 were female (64.3%) and 5 were male (35.7%). At the initial consultation, ages ranged from 10 months to 6 years, and most dogs were adults (85.7%). Nine dogs were neutered (64.3%), whereas five remained intact (35.7%).

Assessment of nostril stenosis by direct inspection, according to the classification described by Liu et al. (2016), showed that before surgery, most dogs (85.7%) presented with severe stenosis. Following rhinoplasty, 92.9% of the dogs exhibited either no stenosis or only mild stenosis.

Among the venous blood gas parameters evaluated (Table 1), mean PCO₂ and HCO₃⁻ concentrations were above the reference range before corrective surgery (44.1 mmHg and 26.55 mmol/L, respectively) and decreased to values within the reference interval after surgery (40.3 mmHg and 24.59 mmol/L, respectively). In contrast, mean PO₂ and SO₂ values were below the referenced range before surgery (41.65 mmHg and 72.42%, respectively) and showed lower values postoperatively (39.04 mmHg and 66.84%, respectively).

Mean base excess (BE) was mildly elevated before surgery and showed a slight increase postoperatively. The mean anion gap was within the reference interval before surgery but was lower at follow-up falling below the reference range. Mean hematocrit was slightly above the reference range before surgery and increased after the procedures, whereas hemoglobin concentration and pH remained within the reference interval at both evaluation time points.

No statistically significant differences were observed between preoperative and postoperative measurements for any of the venous blood gas parameters evaluated (Table 1).

Table 1. Venous blood gas and acid–base parameters in French Bulldogs before and six months after rhinoplasty and staphylectomy.

Variable	Before (Mean $\pm$ SD [Min–Max])	After (Mean $\pm$ SD [Min–Max])	Reference Range	p- value
pH	7.392 $\pm$ 0.026 (7.355–7.433)	7.392 $\pm$ 0.035 (7.327–7.441)	7.351–7.443	>0.05
PCO ₂ (mmHg)	44.1 $\pm$ 7.552 (36.5–55.7)	40.3 $\pm$ 11.522 (11.8–56.5)	33.6–41.2	>0.05
PO ₂ (mmHg)	41.65 $\pm$ 9.851 (25.3–56.4)	39.04 $\pm$ 14.639 (27.0–70.8)	47.9–56.3	>0.05
SO ₂ (%)	72.42 $\pm$ 12.533 (43.4–86.4)	66.84 $\pm$ 20.894 (20.8–95.0)	97–100	>0.05
BE (mmol/L)	1.4 $\pm$ 3.837 (-3.5–7.9)	1.9 $\pm$ 4.723 (-13.4–5.8)	-7–+1	>0.05
Anion gap (mmol/L)	15.1 $\pm$ 6.249 (5.1–22.1)	12.5 $\pm$ 5.970 (7.7–31.9)	15–25	>0.05
HCO ₃ ⁻ (mmol/L)	26.55 $\pm$ 4.564 (21.0–33.5)	24.59 $\pm$ 6.307 (6.9–31.4)	21–25	>0.05
Hematocrit (%)	45.35 $\pm$ 4.414 (38.0–54.4)	47.57 $\pm$ 4.735 (39.0–54.0)	37–45	>0.05
Hemoglobin (g/dL)	16.37 $\pm$ 1.955 (12.8–19.7)	15.87 $\pm$ 1.558 (12.9–17.9)	12–18	>0.05

Among the electrolytes evaluated (Table 2), mean ionized calcium (iCa) concentration was below the reference range before surgery (1.11 mmol/L; reference range: 1.20–1.40 mmol/L) and the value returned within the reference interval at the postoperative evaluation (1.26 mmol/L). The remaining electrolytes were within the reference range at both time points.

Mean potassium (K) and chloride (Cl) concentrations increased at the postoperative evaluation (K: 4.07 mmol/L; Cl: 111.78 mmol/L) compared with preoperative values (K: 3.74 mmol/L; Cl: 110.06 mmol/L). In contrast, mean sodium (Na) concentration decreased postoperatively (144.76 mmol/L) compared with the preoperatively (148.06 mmol/L).

Statistically significant differences were observed for potassium ($p = 0.02$) and sodium ($p = 0.02$), whereas no significant differences were detected for ionized calcium or chloride concentrations (Table 2). These findings suggest that surgical correction may have influenced potassium and sodium concentrations in the studied dogs.

Table 2. Electrolyte concentrations in French Bulldogs before and six months after rhinoplasty and staphylectomy

Variable	Before (Mean $\pm$ SD [Min–Max])	After (Mean $\pm$ SD [Min–Max])	Reference Range	p-value
K (mmol/L)	3.74 $\pm$ 0.495 (2.84–4.33)	4.07 $\pm$ 0.160 (3.67–4.24)	3.5–5.8	0.02
iCa (mmol/L)	1.11 $\pm$ 0.278 (0.48–1.38)	1.26 $\pm$ 0.043 (1.19–1.34)	1.20–1.40	>0.05
Cl (mmol/L)	110.06 $\pm$ 4.165 (102.4–116.6)	111.78 $\pm$ 1.785 (107.8–114.4)	100–120	>0.05
Na (mmol/L)	148.06 $\pm$ 4.119 (142.3–155.6)	144.76 $\pm$ 1.769 (141.2–146.9)	140–155	0.02

Discussion

Arterial blood sampling in conscious patients with BOAS involves inherent risks due to respiratory compromise associated with upper airway obstruction. When arterial sampling is not feasible, venous blood analysis may provide valuable information on pH, HCO_3^- , and PCO_2 , contributing to patient monitoring [13;1;8].

Brachycephalic obstructive airway syndrome (BOAS) is not typically associated with hematological or biochemical abnormalities; however, it may result in hypoxemia and respiratory acidosis due to impaired ventilation. Therefore, blood gas assessment is clinically important in brachycephalic dogs, as it allows evaluation of disease severity and postoperative physiological response by assessing acid–base status before and after surgical correction [11;28;10].

No significant differences were observed in the evaluated venous blood gas parameters between the preoperative and postoperative assessments in French Bulldogs with BOAS. These findings suggest that rhinoplasty and staphylectomy did not result in measurable changes in venous blood gas parameters within the evaluated period.

Similarly, Erjavec and Nemec (2021) [8] reported no significant effect of surgical treatment on venous blood gas parameters, which is consistent with the results of the present study.

Mean pH values remained within the reference range for the species both before and after the surgical procedures. In the study by Erjavec and Nemec (2021) [8], pH values were reported below the lower reference limit, indicating acidemia both before and after treatment. In contrast, Mendes Júnior et al. (2019) [19], evaluating arterial blood gas parameters before and after rhinoplasty, reported an increase in pH following surgical intervention.

In cases of upper airway obstruction, respiratory acidosis may occur due to inadequate elimination of carbon dioxide relative to its production. This leads to increased partial pressure of carbon dioxide (PCO_2) and hydrogen ion (H^+) concentration, resulting in decreased pH, with compensatory increases in bicarbonate (HCO_3^-) concentration [3]. Consequently, reductions in PCO_2 and HCO_3^- accompanied by

maintenance of pH within the reference range may indicate improved respiratory function following surgical correction [3;19;32].

A decrease in mean PCO_2 was observed following the surgical procedures (40.3 mmHg) compared with the preoperative period (44.1 mmHg), with postoperative values falling within the reference interval. Similarly, mean HCO_3^- concentration decreased from 26.55 mmol/L preoperatively to 24.59 mmol/L postoperatively, reaching values within the reference range. These findings suggest a possible improvement in carbon dioxide elimination and acid–base status following surgical correction. However, no statistically significant differences were observed in pH, PCO_2 , HCO_3^- , PO_2 , or SO_2 between preoperative and postoperative evaluations.

Previous studies have also reported reductions in PCO_2 following rhinoplasty procedures [19]. In contrast, Erjavec & Nemec (2021) [8] observed persistent hypercapnia both before and after treatment, highlighting variability in blood gas responses among brachycephalic dogs undergoing surgical correction.

Mean PO_2 and SO_2 values decreased following the surgical procedures (PO_2 : 39.04 mmHg; SO_2 : 66.84%) compared with preoperative values (PO_2 : 41.65 mmHg; SO_2 : 72.42%). In the study by [19], a slight increase in PO_2 and SO_2 was reported in arterial blood gas analysis after rhinoplasty.

However, venous blood gas analysis has limited accuracy for evaluating oxygenation parameters such as PO_2 and SO_2 , as it does not reliably reflect arterial oxygen status [13;1;8].

The mean anion gap decreased after treatment (12.5 mmol/L) compared with preoperative values (15.1 mmol/L) and was below the species reference interval at follow-up. No previous studies have evaluated changes in this parameter before and after surgical treatment in dogs with BOAS.

The anion gap is a calculated variable derived from the difference between measured cations (sodium and potassium) and measured anions (chloride and bicarbonate). It is primarily used to estimate the presence of unmeasured anions and cations, including proteins, phosphate, sulfate, organic acids, calcium, and magnesium, and is used as an important tool in the evaluation of acid–base disorders [29].

Mean base excess (BE) increased after surgery (1.9 mmol/L) compared with preoperative values (1.4 mmol/L). The reduction in HCO_3^- may reflect a trend toward normalization of compensatory responses associated with chronic respiratory impairment, although no statistically significant differences were detected.

In other studies, both bicarbonate and BE remained within the reference range before and after treatment, with no marked variations reported [19;8]. Bicarbonate concentration is influenced by renal compensatory mechanisms involved in acid–base regulation, particularly through modulation of hydrogen ion excretion and bicarbonate reabsorption [29].

In the present study, mean hematocrit increased from 45.35% before surgery to 47.57% after rhinoplasty and staphylectomy, whereas mean hemoglobin concentration decreased slightly from 16.37 g/dL to 15.87 g/dL. Similarly, [19] reported a reduction in hemoglobin concentration following surgical correction. Dogs with BOAS have been reported to develop hematological adaptations secondary to chronic hypoxemia, including increased erythropoietin stimulation and higher red blood cell mass compared with non-affected dogs [31].

No studies comparing electrolyte profiles in dogs with BOAS before and after surgical treatment were identified in the literature. In the present study, mean ionized calcium concentration was below the reference interval before surgery (1.11 mmol/L) and returned to values within the reference range at the postoperative evaluation (1.26 mmol/L).

In addition, potassium concentration increased significantly after surgery ($p = 0.02$), whereas sodium concentration decreased significantly ($p = 0.02$). Chloride concentration remained within the reference interval and showed little variation between evaluations.

Acid–base disturbances may influence electrolyte distribution through the exchange of hydrogen and potassium ion between intracellular and extracellular compartments. During alterations in acid–base balance, these compensatory mechanisms contribute to the maintenance of electrical neutrality and may affect circulating electrolyte concentrations and cellular homeostasis [29]. Although the observed changes in potassium and sodium concentrations were statistically significant, the values remained within the reference range and their clinical relevance requires further investigation.

The relatively small sample size may have limited statistical power to detect differences between time points.

Conclusion

Rhinoplasty and staphylectomy in French Bulldogs with brachycephalic obstructive airway syndrome (BOAS) were associated with a reduction in venous PCO_2 and HCO_3^- values, with postoperative measurements falling within the reference intervals for these parameters. In addition, ionized calcium concentrations were below the reference interval before surgery and were within the reference range at follow-up.

Although no statistically significant differences were observed for most blood gas variables, the postoperative trends observed in some respiratory and electrolyte parameters suggest physiological changes following surgical correction. Because multiple anatomical abnormalities contribute to BOAS severity, further studies with larger sample sizes are needed to better determine the effects of rhinoplasty and staphylectomy on blood gas and electrolyte parameters.

Factors such as metabolic status, stress, and body temperature should also be considered when interpreting blood gas analysis results.

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