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Original article

Influence of the wing-of-the-nostrils correction procedure on the change of the acid-base balance parameters and oxygen concentration in the arterial blood in French bulldogs

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Abstract

Brachycephalic syndrome develops as a result of a specific build of splanchnocranium. In dogs of brachycephalic breeds, an impairment of correct gas exchange occurs. 5 French bulldogs at the age of 11-14 months, which suffered from continuous mixed-type dispnoea and lowered effort tolerance, were examined. Apart from the above-mentioned symptoms, the occurrence of strong external nostril stenosis was noted in the clinical examination. The symptoms observed together with the nostril stenosis indicated a possibility of an occurrence of the brachycephalic syndrome. 1 ml of full blood was drawn from the femoral artery. Acid-base balance parameters were determined in the arterial blood: pH, pCO_2, HCO_3^-, and pO_2. The wing-of-the-nostrils correction procedure were carried out in general anaesthesia. In premedication, the patients received medetomidine and after 15 minutes, fentanyl together with atropine. The induction of propofol was carried out. After four weeks from the procedure, blood was collected and the acid-base balance and pO_2 parameters were again determined. The obtained values of the acid-base balance and pO_2 parameters showed a noticeable influence of the wing-of-the-nostrils correction procedure on the values of the parameters determined. The results of the blood gasometry obtained prior to the procedure clearly indicate the occurrence of respiratory acidosis. The correction of wings of the nostrils significantly influenced saturation of the arterial blood with oxygen and the symptoms of dispnoea observed by the owners and episodes of apnoea and the loss of consciousness entirely subsided.

Key words: brachycephalic syndrome, dogs, acid-base balance.

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Introduction

Brachycephalic syndrome develops as a result of a specific build of splanchnocranium and it often occurs in French bulldogs and other brachycephalic breeds (boxers, bulldogs, pekingeses, shi-tzu, and Boston terriers) likewise. In dogs of these breeds, an impairment of correct gas exchange occurs, i.e. a volume of the inhaled and exhaled air is significantly lower compared to the dogs of other breeds due to anatomic obstacles in the upper airways such as nostril stenosis, central dislocation of the external nostrils cartilaginous structure, nasal canal stenosis, lengthened soft palate, everted laryngeal pouches, laryngeal collapse and tracheal hypoplasia, which occurs in English bulldogs (Amis and Kurpershoek 1986). In a brachycephalic individual, a single defect out of the above-mentioned ones may occur or any combination of them (even all of them forming the so-called complete brachycephalic syndrome) (Hendrics 1992). The lengthened soft palate occurs the most often, even in up to 90% of individuals, and the external nostril stenosis – in 80% of dogs. Symptoms of the brachycephalic syndrome develop with age and, in the beginning, they occur only during exercise, later – also at rest and during sleep. Inspiratory dyspnoea dominates and is accompanied by wheezing, snoring, whistling rales, lowered effort tolerance, and, in more difficult cases, cyanosis and collapse (Wykes 1991). Dogs with such type of cranium are predisposed to death as a result of heat stroke (Bruchim et al. 2006) and episodes of sleep apnoea (Amis and Kurpershoek 1986). Treatment of the brachycephalic syndrome is mainly based on a surgical correction of the defect (Poncet et al. 2005, Poncet et al. 2006).

Materials and Methods

5 French bulldogs at the age of 11-14 months, which suffered from continuous mixed-type dispnoea and lowered effort tolerance, were brought to the Department of Internal Diseases with the Clinic for Horses, Dogs and Cats. Their owners also reported episodes of apnoea, which occurred most often at night, short-lived consciousness disturbances as well as wheezing, snoring, and whistling rales. Apart from the above-mentioned symptoms, the occurrence of strong external nostril stenosis was noted in the clinical examination. The cardiologic examination performed in the Clinic excluded a cardiac origin of the disturbances. The symptoms observed together with the nostril stenosis indicated a possibility of an occurrence of the brachycephalic syndrome. In order to carry out further diagnosis, complete blood cell count together with blood smear were performed as well as the biochemical examination of blood serum, in which the following was determined: AST (aspartate aminotransferaze) and ALT (alanine aminotransferaze) activity, concentration of urea, creatinine, total protein, albumins, bilirubin, and ionogram: Na^+, K^+, Cl^-, Mg^{2+}, Ca^{2+} and $P_{inorganic}$. 1 ml of full blood was drawn from the femoral artery to a heparinized syringe equipped with a needle with an internal diameter of 0.7 mm. Acid-base balance parameters were determined in the arterial blood: pH, partial pressure of CO_2 (pCO_2), concentration of bicarbonates (HCO_3^-), and partial pressure of oxygen (pO_2). The blood was passed on to the analytical laboratory immediately after being drawn. Then, the endoscopic examination and the wing-of-the-nostrils correction procedure was carried out in general anaesthesia. As premedication, the patients received intramuscularly medetomidine in a dose of 30 µg/kg of body mass. After 15 minutes, fentanyl was administered intravenously in a dose of 2 µg/kg of body mass together with atropine in a dose of 40 µg/kg of body mass due to moderate bradycardia. The induction of propofol in a dose of 4 mg/kg of body mass was carried out. The intubation conditions were reached after 1 minute. Prior to the insertion of an endotracheal tube, the endoscopic examination of the pharynx and larynx region was performed, which did not show hypertrophy of the soft palate in these cases. Next, the patients were laid in the sternum position, intubated, and the wing-of-the-nostrils correction procedure was carried out. The presence of the endotracheal tube ensured patency of the upper airways as well as enabled implementation of the oxygen therapy. The saturation during the procedure fluctuated within 96-98%. Propofol and fentanyl were applied for the conduction according to their effect. During the procedure, the vertical wedge-flap with the base turned towards its free edge was removed. The width of the removed tissue depended on an extent of the anterior nostril stenosis, and the depth of incision reached the wing fold. For haemostasia, tampons saturated with epinephrine were used during the operation. Then, surgical anastomosis of the wound was performed with the use of monofilament absorbable suture with a thickness of 3-0. 10 minutes prior to the end of the surgical procedure announced by the operator, administration of propofol was stopped, and 5 minutes before the end – administration of fentanyl. The procedure lasted for approximately 40 minutes on average, and the time for the patient's awakening – about 20 minutes. As a result of such a procedure, quick regaining of consciousness occurred and no morphinizing symptoms were observed, which enabled early extubation of the operated patient. Due to the cosmetic effect and potential great damage of the tissues during the correction, the use of an electric knife was abandoned and the incision was made by means of a scalpel. After the surgical procedure, protective collars were put on the patients for 10 days in

order to protect the wound. After four weeks from the procedure, blood was collected and the acid-base balance and pO_2 parameters were again determined, and the blood cell count and the biochemical examination of blood serum were performed as well. For carrying out of the research, the consent of II Local Ethics Committee for Research on Animals in Wrocław was obtained.

Results

The obtained values of the morphologic and biochemical examination were within the limits of reference values both before and after the wing-of-the-nostrils correction procedure, whereas the comparison of the acid-base balance and pO_2 parameters showed a noticeable influence of the wing-of-the-nostrils correction procedure on the values of the parameters determined. The obtained average values have been shown in Tables 1, 2, and 3. The results of the blood gasometry obtained prior to the procedure clearly indicate the occurrence of respiratory acidosis, i.e. such a kind of the acid-base balance disorder in which an original increase of pCO_2, carbonic acid anhydride, takes place.

Table 1. Values of the biochemical examination of blood before and after the wing-of-the-nostrils correction procedure.

	Before procedure	4 weeks after procedure
ALT (U/L)	39.0 ± 2.51	38.0 ± 1.82
AST (U/L)	33.0 ± 1.72	31.0 ± 1.41
Urea (mmol/L)	5.0 ± 0.32	5.40 ± 0.18
Protein (g/L)	53.0 ± 2.02	50.0 ± 2.45
Albumins (g/L)	29.0 ± 1.16	30.0 ± 1.24

Table 2. Concentration of ions in the blood serum before and after the wing-of-the-nostrils correction procedure.

	Before procedure	4 weeks after procedure
Ca (mmol/L)	2.74 ± 0.1	2.83 ± 0.08
Mg (mmol/L)	0.79 ± 0.02	0.63 ± 0.02
Pi (mmol/L)	1.70 ± 0.09	1.80 ± 0.04
Na (mmol/L)	116.50 ± 4.41	123.50 ± 3.18
K (mmol/L)	4.13 ± 0.21	4.54 ± 0.31
Cl (mmol/L)	98.50 ± 1.1	104.50 ± 2.1

Discussion

In the case of respiratory acidosis, the organism, aiming at the pH normalization, stimulates kidneys to regenerate HCO_3^- and to expell of H^+ (Constable 2000, Di Bartola 2006). This interpretation is in accordance with the classic description of the acid-base balance on the basis of the Henderson-Hasselbach equation, where the blood pH is the result of the metabolic component expressed by bicarbonate (HCO_3^-) concentration and the respiratory component or the pressure of carbon dioxide (pCO_2) (Di Bartola 2006).

$$pH = 6.11 + \log \frac{[HCO_3^-]}{pCO_2 \text{ x } 0.226}$$

In the cases discussed, the chronic respiratory acidosis can be noticed, in which an increase of pCO_2 by each 1 mmHg is accompanied by a compensatory increase of HCO_3^- concentration by 0.35 mEq/L, or more (De Morais and DiBartola 1991). In people with the chronic respiratory acidosis, an increase of pCO_2 by each 1 mmHg is accompanied by an increase of HCO_3^- concentration by 0.51 mEq/L (Martinu et al. 2003), which, as it results from the research conducted by Alfaro et al. (1996), is sufficient for normalization of the blood pH in the course of the disorder. On the basis of the obtained results, it was calculated that, in the cases presented, increase of pCO_2 by 1 mmHg was accompanied by a compensatory increase of HCO_3^- by 0.61 mEq/L, on average. A lower concentration of Cl^- ions before the wing-of-the-nostrils correction pro-

Table 3. Values of the acid-base balance and pO_2 parameters before and after the wing-of-the-nostrils correction procedure.

	Reference values*	Before procedure	4 weeks after procedure
pH	7.35-7.46	7.41	7.42
pCO_2 mmHg (kPa)	30.8-42.8 (4-5.56)	52.0 (6.76)	49.0 (6.37)
HCO_3^- mmol/L	18.8-25.6	32.20	27.60
pO_2 mmHg (kPa)	80.9-103.3 (10.51-13.42)	73.0 (9.49)	82.0 (10.66)

* Di Bartola S.P. Fluid, electrolyte and acid base disorders in small animal practice. Saunders Elsevier 2006 St Louis.

cedure also proves the occurrence of the chronic respiratory acidosis. Kidney compensation of the respiratory acidosis is associated with an increase in the HCO_3^- synthesis in the ammoniagenesis process, and NH_4^+ created is expelled together with Cl^- ions (Wall 2001), therefore there was a lower Cl^- concentration before the procedure in the cases discussed. The chronic respiratory acidosis is also accompanied by an increase of the value of SID (Galla and Luke 1988) (strong ion difference) or the difference of concentrations of strong cations and anions in the blood serum. According to the law of electroneutrality of systemic fluids, a sum of cations concentration and anions concentration in the blood serum must be the same. However, in the case of comparison of concentrations of strong cations and strong anions, there will be seemingly less negative ions. The effective difference of strong ions was calculated on the basis of the following formula applied for dogs (Siegling-Vlitakis et al. 2007):

SIDe(SID effective) = HCO_3^- + [albumin x (0.123 x pH-0.631)] + [$P_{inorganic}$ x (0.309 x pH – 0.469)]. SID before and after the procedure amounted to 43.41 and 39.2 mEq/L, respectively, thus, according to Galla and Luke's observations (1988), it was higher in the course of the chronic respiratory acidosis.

The analysis of the acid-base balance of the arterial blood performed after the procedure showed that pCO_2 and HCO_3^- concentrations slightly exceeding the reference values and pH within the standard, indicates maintenance of the compensated respiratory acidosis in spite of the nostrils correction. The correction of wings of the nostrils significantly influenced saturation of the arterial blood with oxygen, which achieved reference values and the symptoms of dispnoea observed by the owners and episodes of apnoea and the loss of consciousness entirely subsided. After the procedure, there were wheezing and whistling rales observed in 2 dogs, yet their intensity was much lower. The persistence of the respiratory acidosis was also observed in spite of the performed procedure. This is likely to result from changes in the chondro-osseous build of the nasal cavity. The therapy of respiratory acidosis consists mainly in restoration of the correct gas exchange. A possibility of further compensation of the disorder by means of Tromethamine (THAM), a drug sometimes applied in people, requires further research.

On the basis of the observations done, it can be stated that examination of the blood gasometry and the partial pressure of oxygen in the brachycephalic dogs is an important part of diagnosis of their health state and therapy success.

References

Alfaro V, Torras R, Ibanez J, Palacios L (**1996**) A physical-chemical analysis of the acid-base response to chronic obstructive pulmonary disease. Can J Physiol Pharmacol 74: 1229-1235.

Amis TC, Kurpershoek C (**1986**) Pattern of breathing in brachycephalic dogs. Am J Vet Res 47: 2200-2204.

Bruchim Y, Klement E, Saragusty J, Finkeilstein E, Kass P, Aroch I (**2006**) Heat stroke in dogs: A retrospective study of 54 cases (1999-2004) and analysis of risk factors for death. J Vet Intern Med 20: 38-46.

Constable PD (**2000**) Clinical assessment of acid-base status: comparison of the Henderson-Hasselbalch and strong ion approaches. Vet Clin Pathol 29: 115-128.

De Morais HAS, Di Batola SP (**1991**) Ventilatory and metabolic compensation in dogs with acid base disturbation. J Vet Emerg Crit Care 1: 39-49.

Di Bartola SP (**2006**) Introduction to acid – base disorders. In: Di Bartola SP (ed) Fluid, electrolyte and acid base disorders in small animal practice. Saunders Elsevier, St Louis, pp 229-251.

Galla JH, Luke RG (**1988**) Chloride transport and disorders of acid-base balance. Annu Rev Physiol 50: 141-158.

Hendricks JC (**1992**) Brachycephalic airway syndrome. Vet Clin North Am Small Anim Pract 22: 1145-1153.

Martinu T, Menzies D, Dial S (**2003**) Re-evluation of acid-base prediction rules in patients with chronic respiratory acidosis. Can Respir J 10: 311-315.

Poncet CM, Dupre GP, Freiche VG, Bouvy BM (**2006**) Long-term results of upper respiratory syndrome surgery and gastrointestinal tract medical treatment in 51 brachycephalic dogs. J Small Anim Pract 47: 137-142.

Poncet CM, Dupre GP, Freiche VG, Estrada MM, Poubanne YA, Bouvy BM (**2005**) Prevalence of gastrointestinal tract lesions in 73 brachycephalic dogs with upper respiratory syndrome. J Small Anim Pract 46: 273-279.

Siegling-Vlitakis C, Kohn B, Kellermeier C, Schmitz R, Hartmann H (**2007**) Qualification of the Stewart variables for the assessment of the acid-base status in healthy dogs and dogs with different diseases. Berl Munch Tierarztl Wochenschr 120: 148-155.

Wall RE (**2001**) Respiratory acid-base disorders Vet Clin North Am Small Pract 31: 1355-1367.

Wykes PM (**1991**) Brachycephalic airway obstructive syndrome Probl Vet Med 3: 188-197.