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Cardiorespiratory and haematological parameters of healthy french bulldogs

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Abstract
Brachycephalic dogs have a normal lower jaw and a receded upper jaw, and these dogs are predisposed to nostril stenosis, elongated palate, tracheal hypoplasia and hyperthermia due to heat stress. Given these characteristics, these dogs are more predisposed to respiratory and cardiovascular disorders. The popularity of brachycephalic dogs that have a greater tendency for cardiorespiratory disorders, such as French bulldogs, has increased recently; however, studies on the cardiorespiratory and haematological parameters in this breed are lacking. Thus, the present study sought to evaluate the cardiorespiratory and haematological parameters of healthy French bulldogs to standardize normal values for this breed. Thirty-six French bulldogs were used without predilection for age or sex, and the following parameters were evaluated: temperature (T), heart rate (HR), respiratory rate (RR), erythrogram, leukogram, total plasma protein, plasmatic fibrinogen, blood platelet count, urea, creatinine, alkaline phosphatase (AP) and alanine aminotransferase (ALT). The mean and standard deviation were as follows: T°C (38.3±0.4), HR (111.1±27.0) beats per minute, RR (54.8±32.5) breaths per minute, erythrocyte count (7.3±1.2x10^6), haemoglobin (16.9±2.8 g/dL), haematocrit (48.9±7.7%), MCV (67.6±2.4 fL), MCH (23.3±0.7 pg), MCHC (34.6±0.8%), RDW-CV (9.3±0.9; 9.2-12.0%), total leukocytes (11009.7±2907.3/mm^3), band neutrophils (250.0±260.4/mm^3), segmented neutrophils (7094.4±2307.3/mm^3), eosinophils (589.7±561.3/mm^3), lymphocytes (2020.8±1457.5/mm^3), monocytes (987.6±528.4/mm^3), total plasma protein (6.9±0.5 g/dL), plasmatic fibrinogen (274.1±96.5 mg/dL), blood platelet count (366.4±88.5/mm^3), urea (35.2±12.6 mg/dL), creatinine (0.8±0.2/mg/dL), AP (49.1±25.8U/L), ALT (36.2±12.3U/L). The haematological parameters and heart rate were within the normal values for the species, but the respiratory rate values (54.8±32.5 breaths per minute) were greater than the normal average of 10 to 30 breaths per minute. We conclude that the haematological parameters and heart rate of healthy French bulldogs are within the normal limit for dogs; however, the respiratory rate is above reference values, reinforcing the notion that dogs of this breed, although healthy, exhibit an increased risk of respiratory disorders.
Keywords: biochemical; brachycephalic; heart rate; respiratory rate; haemogram.

Parâmetros cardiorrespiratórios e hematológicos de cães sadios da raça buldogue francês

Resumo
Cães braquicefálicos apresentam maxilar inferior normal, maxilar superior recuado, além disso, são predispostos à estenose de narina, palato alongado, hipoplasia traqueal e hipertermia por estresse por calor. Devido à essas características são mais predispostos à distúrbios respiratórios e cardiovasculares. A popularidade de cães braquicefálicos aumentou muito recentemente, como por exemplo, o Buldogue Francês, que possui uma maior tendência para transtornos cardiorrespiratórios, porém, não há estudos dos parâmetros cardiorrespiratórios e hematológicos nessa raça. Desta maneira, o presente estudo tem como objetivo avaliar os parâmetros cardiorrespiratórios e hematológicos de cães sadios da raça Buldogue Francês para padronização dos valores normais e servir de subsídios para a rotina clínica, cirúrgica, laboratorial e de futuros estudos nessa raça. Foram utilizados 36 cães da raça Buldogue Francês, sem predileção de idade, raça ou sexo e avaliados os seguintes parâmetros: temperatura (T), frequência cardíaca (FC), frequência respiratória (FR), eritrograma, leucograma, proteínas plasmáticas totais (PPT), fibrinogênio plasmático, contagem de plaquetas, ureia, creatinina, fosfatase alcalina (ALP) e alanino amino

transferase (ALT). A média e desvio padrão foram: T°C (38,3±0,4), FC (111,1±27,0) batimentos/min, FR (54,8±32,5) movimentos/min, contagem de eritrócitos (7,3±1,2x106), Hb(16,9±2,8g/dL), VG(48,9±7,7%), VCM (67,6±2,4fL), HCM (23,3±0,7pg), CHCM (34,6±0,8%), RDW-CV (9,3±0,9; 9,2-12,0%), leucócitos totais (11009,7±2907,3/mm3), bastonetes (250,0±260,4/mm3), neutrófilos (7094,4±2307,3/mm3), eosinófilos (589,7±561,3/mm3), linfócitos (2020,8±1457,5/mm3), monócitos (987,6±528,4/mm3), PPT (6,9±0,5g/dL), fibrinogênio plasmático (274,1±96,5mg/dL), contagem de plaquetas (366,4±88,5/mm3), ureia (35,2±12,6mg/dL), creatinina (0,8±0,2/mg/dL), ALP (49,1±25,8U/L) e ALT (36,2±12,3U/L). Os parâmetros hematológicos e de frequência cardíaca ficaram dentro da normalidade, porém os valores da frequência respiratória (54,8±32,5) movimentos/min ficaram acima da média normal que é de 10 a 30 movimentos/min. Conclui-se que cães saudáveis da raça Buldogue Francês possuem parâmetros hematológicos e de frequência cardíaca dentro da normalidade para cães, porém, a frequência respiratória acima dos valores de referência, reforçando que cães dessa raça, mesmo saudáveis, possuem aumento do risco de transtornos respiratórios.

Palavras-chave: bioquímico; braquicefálico; frequência cardíaca; frequência respiratória; hemograma.

Introduction

Domestic dogs potentially exhibit the most morphological diversity among terrestrial mammal species known by men. Breed dogs are artificially selected for extreme aesthetics dictated by patterns of formal breeds. Brachycephaly (shortening of the facial skeleton) is a discrete mutation that has been selected in many popular dog breeds, such as the French bulldog (PACKER *et al.*, 2015). Over recent years, the popularity of brachycephalic breeds has been increasing considerably. According to the AKC (2020), the 5 most registered breeds in 2019 in the USA were as follows: 1st place, Labrador retriever; 2nd place, German shepherd; 3rd place, Golden retriever; 4th place, French bulldog; and 5th place, English bulldog. According to data from the Brazilian Institute of Geography and Statistics (IBGE), Brazilians have over 54 million dogs at home. In 2019, the Brazilian Confederation of Cynophilia (CBKC): acronym in Brazilian Portuguese) made public the 6 most registered breeds in Brazil: 1st place, Shih tzu (185.538); 2nd place, French bulldog (113.039); 3rd place, Yorkshire terrier (71.702); 4th place, Pomeranian; 5th place, Maltese; and 6th place, Pug (IBGE, 2019).

Given the high and selective breeding of brachycephalics, elongation of the soft palate, tracheal hypoplasia and a reduction in the nasal ostium occurs, so these anomalies might result in severe respiratory difficulties and cardiovascular and haematological disorders (ALLEN; MACKIN, 2001; OECHTERING, 2010). The trachea of French bulldogs is typically hypoplastic (KOCH *et al.*, 2003; TILLEY; SMITH JR., 2008). Other brachycephalic breeds also present narrower tracheae than those observed in mesocephalic and dolichocephalic dogs. However, this phenomenon is thought to be a consequence of abnormal embryogenesis instead of a sequela of more cranial stenosis (KOCH *et al.*, 2003; OECHTERING, 2010; TILLEY; SMITH, 2008).

Haematological and biochemical reference intervals play a fundamental role for assessing the health condition, physiologic alterations, disease diagnosis and treatment decision-making in animals; at the same time they provide a very useful tool for animal welfare evaluations. A key aspect of blood reference intervals is that they are influenced by multiple factors, such as genetics, breeds, husbandry practices, and environmental conditions (FRIEDRICH *et al.*, 2012).

The clinical alterations generated by anatomical abnormalities of the upper respiratory tract of brachycephalic dogs cause an increase in resistance to air flow, subsequent pulmonary hypertension and often an increase in heart rate (GALIÈ *et al.*, 2009; LUMB; SLINGER, 2015). Defective nostril development is noted in these breeds. In addition, the nasopharynx elongates, and the cranium develops abnormally with a reduced length (TROSTEL; FRANKEL, 2010). Due to these anatomical alterations, there is a narrowing of the lumen of the upper respiratory tract (ETTINGER, 2010; LODATO; HEDLUND, 2012; EMMERSON, 2014). These alterations may lead to inspiratory dyspnoea, resulting in secondary respiratory distress and the emergence of respiratory noise (BRDECKA *et al.*, 2007; LODATO; HEDLUND, 2012).

Studies on cardiorespiratory and haematological alterations in French bulldogs, currently one of the most popular breeds, are limited. Thus, the present study sought to evaluate the cardiorespiratory (heart rate and respiratory rate) and haematological (haemogram, kidney and liver function) parameters of healthy French bulldogs for standardization of normal values and to serve as a reference for routine clinical, surgical and laboratory parameters and for future studies on the breed.

Materials and Methods

Animals

Thirty-six healthy French bulldogs were used, including 20 males and 16 females. The following mean parameters of dogs included in the study were noted: weight (12.2±2.6; 6.3 – 16.9) kg, age (3.1±1.6; 1 – 7) years, and T (38.3±0.4; 37.1 – 39.0) °C. Dogs that came for care at the UNOESTE's Veterinary Hospital from Presidente Prudente, SP, Brazil. The study was approved by the Animal Use Ethical Commission (CEUA: acronym in Brazilian Portuguese) under protocol number 4818.

Clinical Exams

The dogs were evaluated by the completion of a clinic chart with anamnesis and routine clinical exams, including temperature (T) (°C) measured with a digital thermometer, heart rate (HR) (bpm) measured with a stethoscope, and respiratory rate (RR) (bpm) measured with a stethoscope.

Laboratorial Exams

Haemogram

The determination of the red blood cell distribution width (RDW-CV) and its fractions as well as erythrocyte, haematocrit (Ht), haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), total leukocyte and blood platelet count values were obtained using the haematological analyser model POCH-100iV DIFF (Sysmex from Brazil Industry and Commerce Ltd., Curitiba/PR-Brazil) (BACALL, 2009; RIOND *et al.*, 2011). To obtain the total and differential count of leukocytes, a blood smear stained with fast staining (Diff-Quick) was performed according to Jain (1993). The refractometry technique was used to determine the total plasma protein, and plasmatic fibrinogen was measured by heat-induced precipitation (KERR, 2003; KANEKO *et al.*, 2008).

Biochemical Exams

For the evaluation of urea, creatinine, alanine aminotransferase (ALT) and alkaline phosphatase (AP) levels, four mL of whole blood was collected and stored in tubes without anticoagulant. The tubes were centrifuged at 2500 rpm to obtain serum. The exams were performed in an automated device (COBAS C111 – Roche Diagnostics Brazil Ltd., São Paulo, SP) using biochemical kits (KERR, 2003).

Results and Discussion

The cardiorespiratory parameter results (mean ± standard deviation; minimum and maximum) included HR (111.1±27.0; 30.0 - 192.0) beats per minute and RR (54.8±32.5; 30.0 - 192.0) breaths per minute.

The following haematological and biochemical parameter results (mean ± standard deviation; minimum and maximum) were obtained: erythrocytes count (7.3±1.2; 3.5 - 9.5) x 10^6/ mm^3, haemoglobin (16.9±2.8; 8.2 - 22.0) g/dL, haematocrit (48.9±7.7; 25.0 - 63.1) %, MCV (67.6±2.4; 61.8 - 72.1) fL, MCH (23.3±0.7; 21.6 - 24.6) pg, MCHC (34.6±0.8; 32.8 - 36.2) %, RDW-CV (9.3±0.9; 9.2 - 12.0) %, total plasma protein (6.9±0.5; 5.8 - 7.8) g/dL, plasmatic fibrinogen (274.1±96.5; 200.0 - 400.0) mg/dL, blood platelets (366.4±88.5; 123.0 - 661.0) x 10^3 mm^3, leukocytes (11009.7±2907.3; 6000.0 - 17200.0)/mm^3, band neutrophils (250.0±260.4; 32.0 - 85.8)/mm^3, segmented neutrophils (7094.4±2307.3; 440.0 - 11376.0)/mm^3, eosinophils (589.7±561.3; 97.0 - 2800.0)/mm^3, lymphocytes (2020.8±1457,5; 468.0 - 4584,0)/mm^3, monocytes (929.8±528.4; 156.0 - 1584.0)/mm^3, urea (34.9±12.6; 17.7 - 63.0) mg/dL, creatinine (0.8±0.2; 0.6 - 1.5) mg/dL, AP (49.1±25.8; 22.2 - 113.8) U/L and ALT (36.2±12.3; 14.0 - 64.8) U/L. All haematological and biochemical parameters were within the average values considered normal for the species (FELDMAN *et al.*, 2000; FLAIBAN; BALARIN, 2004; HODGES; CHRISTOPHER, 2011).

The average heart rate values measured in healthy French bulldogs (111.1±27.0; 30.0-192.0 beats per minute) were within the normal values for the species. Large adult dogs typically exhibit a resting heart rate of 60 to 100 beats per minute, whereas small adult dogs typically have a normal heart rate from 100 to 140 beats per

minute with the possibility of reaching 180 beats per minute (CAMACHO; MUCHA, 2008).

However, the measured mean respiratory rate values (54.8±32.5; 30.0 - 192.0 breaths per minute) were greater than the normal average of 10 to 30 breaths per minute (FERREIRA, 2008). In normal dogs, the upper airways represent 50 to 70% of the total air resistance, whereas the percentage is greater in brachycephalic dogs due to anatomical alterations (TILLEY; SMITH, 2008). As a result of the high and selective breeding of brachycephalics, elongation of the soft palate, tracheal hypoplasia and reduction of the nasal ostium occur, and these abnormalities result in severe respiratory difficulties, leading to systemic alterations in brachycephalics (ALLEN; MACKIN, 2001; OECHTERING, 2010).

The greater than normal respiratory rate values associated with brachycephalic anatomical alterations may cause brachycephalic syndrome in these dogs. In addition, these dogs frequently exhibit hyperthermia and severe dyspnoea given that the respiratory system of dogs is responsible for temperature regulation. Coughing, retching, dysphagia and syncope may also be observed (TILLEY; SMITH, 2008). In the treatment of emergencies associated with this syndrome, the animal must be sedated and receive oxygen therapy, anti-thermal medication and cooling (KOCH *et al.*, 2003; FASANELLA *et al.*, 2010; FONFARA *et al.*, 2011; OECHTERING, 2010; TILLEY; SMITH, 2008). One of the preventive measures to avoid this syndrome involves surgery to correct nostril stenosis and palate elongation (KOCH *et al.*, 2003).

This is the first study on cardiorespiratory, haematological and biochemical values in healthy French bulldogs, demonstrating that the only abnormal parameter in this breed was respiratory rates greater than normal values observed for the species, which makes this breed susceptible to brachycephalic syndrome.

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