Theriogenology 86 (2016) 1333–1340

Contents lists available at ScienceDirect

Theriogenology

journal homepage: www.theriojournal.com

Hematocrit changes in healthy periparturient bitches that underwent elective cesarean section

K.G.M. De Cramer [a,*], K.E. Joubert [b], J.O. Nöthling [c]

[a] Rant en Dal Animal Hospital, Mogale City, Gauteng, South Africa
[b] Department of Paraclinical Sciences, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, Gauteng, South Africa
[c] Department of Production Animals, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, Gauteng, South Africa

ARTICLE INFO

Article history:
Received 21 January 2016
Received in revised form 20 April 2016
Accepted 22 April 2016

Keywords:
Cesarean section
Hematocrit
Dog
Blood loss
Anemia
Blood transfusion trigger

ABSTRACT

Hematocrits were measured before each of 406 cesarean sections performed on 324 bitches at term and again after crystalloid fluid therapy administered at 35 mL/kg over 1½–2 hours starting from induction. The mean hematocrit was 44.2% (95% confidence interval [CI] 43.8%–44.6%) before cesarean section and 37.8% (95% CI 37.3%–38.2%) after cesarean section and fluid therapy, with a mean decrease of 6.4% points (95% CI 6.1%–6.7%) over all 406 cesarean sections. These results provide the clinician with clear guidelines of the normal expected ranges of hematocrits in bitches before and after cesarean section. Results of this study show that bitches have hematocrits at term that are at the lower end of the normal reference ranges for nonpregnant dogs and that there is no true anemia of pregnancy. It is therefore suggested that if late term bitches present with anemia, other causes besides pregnancy should be considered.

1. Introduction

Poor-oxygen delivery may negatively affect bitches undergoing a cesarean section (CS) and their fetuses [1]. Various physiological changes during pregnancy affect oxygen delivery. Oxygen delivery depends on oxygen carrying capacity (hemoglobin), cardiovascular function, and respiratory function [1]. As early as 1977, Concannon et al. [2] referred to a physiological normocytic, normochromic anemia in pregnant bitches. They reported that the increase in body weight of the bitches they observed during pregnancy was accompanied by a decrease in hematocrit and proposed that this may have been due to a large increase in plasma volume.

The hematocrit of normal healthy nonpregnant dogs may lie between 42% and 62% (average 52%) [3] or between 37% and 55% (average 50%) [4]. Four studies have reported a lowering of hematocrit during gestation in bitches: In 1974, Hayashi [5] reported a steady decrease in the hematocrit of 15 bitches that became statistically significant on Day 50 of pregnancy, when it also reached a nadir of 33.7% (standard error of the mean [SEM] 1.8%) from when onward it increased to 38.7% (SEM 1.8%) on Day 60. Hayashi [5] also reported the mean postpartum hematocrit as 37%. In 1977, Concannon et al. [2] reported that the hematocrit in 12 pregnant bitches was consistently lower than that of 12 nonpregnant bitches from Day 20 after the onset of estrus onward and continued to decline to reach a nadir of 30.6% (standard deviation [SD] 0.8) by Day 60–62. In 1993, Kaneko et al. [6] reported that the hematocrit of 23 Beagles decreased from between 40% and 52% before pregnancy to between 28% and 42% at term and that the litter size had an influence on hematocrit [6]. Finally, in 2013, Dimço et al. [7] reported a mean hematocrit of 45.4% (SD 3.6%) in 16 nonpregnant bitches and a mean of 41% (SD 4.9%) in 16 bitches of similar body weight and age in the last trimester

* Corresponding author. Tel.: +27 0116603110; fax: +27 865635114.
E-mail address: kdcramer@mweb.co.za (K.G.M. De Cramer).

0093-691X/$ – see front matter © 2016 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.theriogenology.2016.04.075

of pregnancy. Owing to varying results, litter sizes and the small sample sizes of these studies, no definitive conclusions about hematocrits during pregnancy can be made.

The hematocrit of bitches that had been pregnant increased slowly after parturition but were still slightly lower by 145 days after the onset of estrus than those of bitches that had had nonpregnant estrous cycles [2]. There is no absolute decrease in erythrocyte mass, and the hematocrit returns to normal within 8–12 weeks after parturition as the plasma volume returns to normal [1].

Fluid therapy is recommended as a standard for CS in bitches [8–14]. Fluids are given to correct any fluid and electrolyte deficits, acid-base balances, the hypotensive effects of anesthesia, and maintain cardiac output and uterine blood flow [8]. Fluid rates of 10–30 mL/kg/h with additional boluses have been suggested to maintain perfusion [8,10,14]. Fluid therapy has the potential to cause additional change to the hematocrit.

Cesarean sections are associated with additional blood loss from surgery. There is no literature describing the hematocrits of bitches in late pregnancy before and after CSs. This is a stumbling block in the periparturient risk assessment of bitches that delivered by CS. After CS, bitches and their puppies are generally not kept in veterinary hospitals for long because of the risk of disease exposure and better nursing environments at home. Assessing risk before discharge after CS in bitches is particularly important because this may take place as soon as 2–3 hours after surgery. This study comprises a retrospective analysis of data on hematocrits before and after CSs in healthy bitches undergoing elective CS to assess what changes can be expected.

2. Materials and methods

The protocol was approved by the Animal Ethics Committee of the Faculty of Veterinary Science, University of Pretoria, (Onderstepoort, South Africa; protocol number V048–14). All experimental animals were housed and fed commercial dry pellets twice daily and with ad-lib water. This study included 406 CSs in 324 healthy, privately owned bitches presented to a private veterinary clinic for management of parturition during March 2012–October 2015. Only healthy bitches destined for elective CS were included in the present study. No ovariohysterectomies were done and the placenta was removed with each puppy. A blood smear evaluation was performed before surgery. A clinical examination was performed before and after surgery which included assessment of: skin for turgor, mucous membranes for color, moistness and capillary refill time, respiratory and heart rates, rectal temperature, and habitus. The decision to perform a CS was based on the first appearance of dilatation of the cervix on vaginoscopy performed every 6 hours. The bitches were weighed immediately before surgery and anesthetized using the standard anesthetic protocol in the practice which included low-dose alpha2-adrenergic agonist premedication (Medetomidine 7 μg/kg iv; Zoetis Animal Health, Sandton, South Africa), propofol (1–2 mg/kg iv; Fresenius Kabi, Midrand, South Africa) as induction agent and sevofluorane (1%–2%; Safeline Pharmaceuticals, Northcliff, South Africa) in oxygen for maintenance of anesthesia. The CS was performed in standard fashion as described by Gilson [15]. The blood required for hematocrit assessment (approximately 1 mL) was collected by jugular venipuncture using a syringe and 23-G needle directly before anesthetizing the bitch for surgery and again 1½–2 hours after induction for surgery and after the bitch had already received the set fluid volume (Ringer lactate, Fresenius Kabi, South Africa). No blood was collected from indwelling catheters used for fluid and drug administration as this would lead to potential errors in measuring the hematocrit. The blood was immediately transferred to a heparinized (sodium heparin 80 iu/mL) microhematocrit capillary tube (Marienfield laboratory glassware, Germany; 74.5–75.5 mm in length and 1.1- to 1.2-mm internal diameter) and centrifuged at 12000 revolutions per min for 10 minutes producing a relative centrifugal force of 14800 g and the hematocrit expressed as a percentage. This calculation was performed by measuring the red blood cell column in mm and dividing this value by the total length in mm of the blood column (plasma and packed cell column) and multiplying by 100 to obtain a percentage. If the serum appeared with reddish discoloration after centrifugation, it was assumed that hemolysis had taken place during the blood collection or centrifugation processes and blood collection was then repeated.

The total volume of fluids administered was 35-mL/kg body weight to each bitch. The fluid was administered over 1½–2 hours including surgery time, starting at time of induction, using simple fluid administration sets with the fluid rate ranging from 17.5 to 26.25 mL/kg/h. To standardize the effect of hemodilution on hematocrit in all the bitches, it was ensured that the bitch got the set fluid volume and approximate fluid rates. This was achieved by calculating the required amount of fluids the bitch should receive and removing it from the fluid bag. For instance, if the dog weighed 20 kg, the required amount is 700 mL and thus 300 mL would be removed from the 1-liter fluid bag in a sterile fashion. Because infusion pumps were not used, care was taken to ensure that the calculated fluid volume did not infuse in a time shorter than 1½ hours and not longer than 2 hours after the induction for anesthesia. The hematocrit after CS was not collected until the required fluid volume had been infused. For each bitch, the following data were recorded: date of CS, name of owner, name of bitch, breed, hematocrit before CS (Htbefore), hematocrit after CS (Htafter), body weight before CS, total number of puppies delivered (litter size)—irrespective of whether they were stillborn or delivered alive.

2.1. Data analysis

Linear regression was used to determine the effects of breed and litter size on Htbefore, and of Htbefore on Htafter. Each breed having 11 or more CSs in the data set was included in the regression models. These breeds were English Bulldogs (n = 119 CSs, labeled ‘Bulld’), Boerboels (n = 203 CSs, labeled ‘Boerb’), Bull Terriers (n = 21 CSs, labeled ‘Bull t’), German Shepherds (n = 11 CSs, labeled ‘G s d’), and Labradors (n = 11 CSs, labeled ‘Labr’). For analyses that include breed as independent variable, the English Bulldog was used as the baseline category and each other