

Anesthetic Management during Cesarean Section in English Bulldogs

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Abstract: The authors describe their experience with the management of the perioperative period, general anesthesia and the postoperative period in English bulldogs undergoing elective cesarean section and its effect on the neonates. The anesthetist for animals undergoing cesarean operation must be aware of any special needs, not only of the patient undergoing surgery, but also of the neonates. Anesthetic drugs administered to the pregnant patient will readily cross the placenta and affect them, with the exception of local anesthetics. Pregnant female patients are at increased anesthetic risk due to pregnancy-associated physiological alterations, such as altered pulmonary function. The anesthetist is often called to perform anesthesia on brachycephalic dogs for an elective cesarean section. Due to their conformation, these animals may have one or more anatomical abnormalities of the upper airways, which compromise the ability to ventilate adequately. The induction and recovery phases of anesthesia can be extremely dangerous in these patients, but the maintenance phase is generally fairly straightforward because the airways are controlled during maintenance. In addition, vagal tone is frequently high and this can contribute towards significant bradycardia and further airway narrowing. All these reasons make general anesthesia in brachycephalic dogs undergoing cesarean section rather complicated.

Key words: Anesthesia, cesarean section, English bulldog, brachycephalic syndrome.

1. Introduction

The English bulldog is a breed with various health issues, such as brachycephalic syndrome, heart disease and orthopedic, skin and reproductive problems. The reproductive management of English bulldog bitches involves various different skills that include artificial insemination, ultrasound monitoring, and the performing of a cesarean section at the end of the pregnancy. Brachycephalic airway syndrome refers to a particular set of upper airway abnormalities which affects brachycephalic dogs. The upper airway abnormalities occurring in this syndrome include stenotic nares, an elongated soft palate, a hypoplastic trachea and everted laryngeal sacculles [1]. Any of these upper airway abnormalities can cause increased

airway resistance to airflow and the work of breathing, respiratory distress, stridor, reduced exercise tolerance and, in more severe cases, cyanosis and collapse [2].

In addition, stress-induced and pain-induced tachypnea, with subsequent increased work of breathing, will cause a significant increase in negative pressure in the airways and this negative pressure can exacerbate airway obstruction [3]. Stress, excitement and pain can all cause increased sympathetic nervous system activity resulting in vasoconstriction and increased systemic vascular resistance [4].

In particular, advanced pregnancy greatly increases the workload on the heart, mainly when the patient is in dorsal recumbency during surgery and the pressure of the abdominal organs on the diaphragm causes hypoventilation, hypoxia, and hypercapnia further compromising respiratory function [5]. In addition, there are many consequences due to an increase of intra abdominal pressure. Cardiac output and stroke

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volume after a short initial rise due to the squeezing of the blood from the abdominal veins is then compromised through decreased venous return, elevated intra-thoracic pressure, and increased systemic vascular resistance, resulting in decreased cardiac preload, increased cardiac afterload, and depressed ventricular function [6]. The fetus is vulnerable to changes in the mother's cardiovascular system due to poor autoregulation of fetal blood flow and the uterine perfusion being pressure-dependent.

Therefore, it is of fundamental importance to take into account all the physiological changes which occur during pregnancy and which affect the anesthetic management of the patient: decrease in functional lung residual capacity and increase in minute ventilation, increase in cardiac output and blood volume, delayed gastric emptying with decreased esophageal sphincter tone. Anesthesia can cause further complications as anesthetic drugs and equipment can exacerbate or even cause airway difficulties and respiratory compromise [7]. Anesthetic drugs, dehydration and intraoperative fluid losses will result in maternal hypotension and pregnant animals appear to have blunted cardiovascular responses and are less able to tolerate hypovolemia [8].

During the evaluation and before anesthesia, the patient should be handled quietly and gently to avoid stress-induced tachypnea with subsequent increased work of breathing and possible further respiratory dysfunction. Tranquilization is often necessary to keep the patient calm, and analgesia is required for any patients in pain [3]. Although it is essential that the patient should receive adequate anesthetic agents to provide immobilization and analgesia for the surgery, it is advisable to use minimal doses as those agents depress respiration in puppies. In fact, it is not possible to selectively anesthetize the mother since anesthetic drugs readily cross the placenta and affect the neonates [9]. During surgery, pregnant animals have a reduced need for inhalant agents due to the

sedative effect of circulating progesterone and elevated β -endorphins levels [10].

The aim of this study was to identify the critical points in the management of the perioperative period, general anesthesia and the postoperative period in English bulldogs undergoing elective cesarean section considering both the characteristics of this breed and the physiological changes that occur during pregnancy. The authors describe their experience, suggesting basic steps to decrease maternal anxiety, avoid hypoxia and hypovolemia, provide analgesia, reduce anesthetic requirements and ensure smooth induction and recovery.

2. Materials and Methods

Eight English bulldog bitches underwent elective cesarean section at the Veterinary Teaching Hospital of the School of Veterinary Medical Sciences, University of Camerino. The dams were given a thorough examination with particular attention to cardiopulmonary function and hydration status. As part of the examination, an ultrasound examination was performed to establish viability of the fetuses and fetal anomalies, such as hydrops fetalis. A blood sample was drawn from the dam to perform hematocrit, total protein, glucose, calcium, and blood urea nitrogen evaluation. An x-ray of the abdomen was taken to assess the presence of gas and the amount of food inside the stomach. The bitches were then taken into the premedication room. The patients were administered 2 $\mu\text{g}/\text{kg}$ of dexmedetomidine (Dexdomitor 0.5 mg/mL, Orion Pharma Janssen Animal Health, Italy) and 0.2 mg/kg of butorphanol (Dolorex 0.1 mg/kg, Intervet, Italy) intramuscularly and were preoxygenated from 2 min to 5 min by face mask while the sedatives were taking effect. Delivery of 100% oxygen allows the functional residual capacity to fill with oxygen. During this time, an intravenous catheter was inserted. After adequate sedation, only two bitches were suitable for epidural anesthesia. This was performed with a single injection

of 1 mL/6 kg of lidocaine (Lidocaine 2%, Fort Dodge Animal Health, Italy) via the lumbosacral (L7-S1) intervertebral space using a 22-20 gauge spinal needle. The total volume of the epidural solutions was made up to 0.2 mL/kg BW with sterile saline. The animals were placed in sternal recumbency with their legs pulled forward. To confirm the correct placement of the needle, the loss of resistance test was performed using a syringe filled with fluid connected to the needle. The drugs were injected over a two-min period. The patients were induced to anesthesia slowly with 2-3 mg/kg of propofol (Rapinovet 10 mg/mL, Intervet, Italy) intravenously and intubated as soon as this took effect. Once intubated, the endotracheal tube cuff was carefully inflated. The abdomen was clipped, the initial surgical preparation of the skin was carried out and oxygen administered. The patients were transferred to the operating theatre, where the surgeon was ready with scalpel blade in hand. The anesthesia was maintained with isoflurane vaporized in oxygen delivered through a circle breathing system and spontaneous ventilation. The operating table was inclined in reverse Trendelenburg position to decrease the weight of the pregnant uterus on the diaphragm. A final abdominal scrub was performed and surgery was under way. Ringer's lactate solution (RL solution, Fresenius Kabi, Italy) was infused IV at 10 mL/kg per hour, or more depending on the blood pressure, using a peristaltic infusion pump (B Braun Compact). A multi-parameter monitor (BeneView T8, Mindray, China) was used to record the following physiological variables: respiratory rate, (RR), heart rate (HR), electrocardiogram (ECG), non-invasive systolic, diastolic and mean pressures (SAP, DAP, MAP), oxygen saturation of hemoglobin (SpO₂), esophageal temperature (T), end-tidal isoflurane (E'Iso) and carbon dioxide concentration (PE'Iso), inspired oxygen concentration. E'Iso was allowed to reach 1.5% and the vaporizer setting was decreased by 0.2% every 5 min until the depth of anesthesia was deemed sufficient (assessment of palpebral reflex, mandibular

tone, absence of response to surgical stimulus and changes in cardiovascular parameters). The puppies were delivered as rapidly as possible and turned over to assistants. The care of the newborn puppies consisted in clearing the pharynx of mucus and fluid, vigorous rubbing, oxygen delivery by face mask, gentle chest compressions, swinging neonates in head-down position and sublingual naloxone and/or atipamezole if the pups were slow to begin vocalizing. To remove the mucus and fluids from the nostrils, a nasal aspirator—commonly applied in human neonates—was utilized as described by Goericke-Pesh and Wehrend [11].

Once breathing appeared adequate, the neonates were placed in a thermic incubator. After surgery, the dams were observed closely. The endotracheal tube was left in place as long as possible until the patient began to chew and oxygen was delivered. Once the tube was removed, the animal's head and neck were extended. Ventilatory function was monitored for at least 1 h following recovery from anesthesia.

Statistical analysis was performed with one-way analyses of variance (ANOVA) for repeated measures to evaluate the differences between two litters that had received epidural lidocaine and those that had not. Data are reported as mean \pm standard deviation (SD) values. Differences were considered significant when $P < 0.05$.

3. Results

Blood test values were normal in all animals included in the study although a mild anemia was evident, probably due to an increase in the total blood volume resulting in the red blood cells not keeping pace with plasma expansion. No correlation was observed between the severity of the anemia and the number of puppies [12].

The depth of sedation was sufficient for the application of a venous catheter and to administer oxygen without causing further stress to the animals, with the exception of one, where the administration of

an additional dose of dexmedetomidine at 0.5 µg/kg IV proved necessary to deepen the level of sedation. The dams that received epidural lidocaine were calm enough to allow this procedure to be carried out.

After induction, the animals were rapidly intubated to prevent gastric reflux caused by gastric emptying delayed as a result of increased intra-abdominal pressure. Moon et al. reported that 5 out of 9 bitches whose death was associated with caesarean section had pneumonia, suggesting that aspiration is also an important risk factor in dogs [13]. There were no significant differences in total propofol dose (2.2 ± 0.4 mg/kg) in the animals included in the study. Oxygen delivery was prolonged after intubation and was suspended when the dams were transferred to surgery to avoid fetal hypoxia and acidemia due to the transient apnea that can occur following propofol administration.

The anesthesia was maintained with isoflurane in spontaneous ventilation. In one case, manual ventilation proved necessary. To decrease the degree of atelectasis, the pop-off valve on the anesthetic circuit was closed and the reservoir bag briefly squeezed at a pressure of 15-20 cm H₂O. During general anesthesia Ringer's lactate solution was infused IV at 10 mL/kg per hour, proving sufficient to support the cardiovascular system and to compensate for the substantial fluid losses associated with surgery. In only one case, a constant rate infusion of dobutamine (5 µg/kg/min) was required to increase hypotension (< 60 mm/Hg) that was refractory to simply increasing the rate of fluid administration and decreasing anesthetic delivery. The bitches that received epidural anesthesia required less anesthetic volatile agents (E Iso 1.4 ± 0.12) but the difference was not statistically significant compared to dogs that had not received it (E Iso 1.5 ± 0.10). There were no differences in the other parameters recorded.

No dogs required rescue analgesia in the perioperative period. Isoflurane was discontinued at the end of surgery and the dogs were transported to

the recovery room. Surgery was carried out without complications in all cases and all dogs were discharged from the hospital 3 h later. The mean (\pm SD) surgery time, from the skin incision to the last stitch, was 40 ± 7 min. In one case, both re-induction and re-intubation proved necessary due to dyspnea and cyanosis during the postoperative period. In no case did the dogs require rescue analgesia or show signs of urinary retention during the postoperative period. Apart from two litters, where the neonates died following severe edema, two puppies showed slight signs of reduced respiratory and cardiovascular function, but the situation was rapidly taken care of. In these cases, one drop of atipamezole—the specific antagonist of dexmedetomidine—was injected into the root of the tongue. No puppies required intubation. Forty-eight puppies were born overall.

4. Discussion

The veterinarian anesthetist is always faced with the dilemma of having to anesthetize the mother, who may already be compromised, without adversely affecting the fetus. All drugs have direct and indirect effects on the puppies, but the veterinarian must be familiar with the anesthetic technique and have a good knowledge of the specific problems concerning each breed.

Although the alpha₂ agonists should be avoided as a premedication agent in parturient patients, the use of a new and safer drug at very low doses, such as dexmedetomidine, did not result in adverse side-effects. In addition, the effects of alpha₂ agonists can be reversed by specific antagonists whose dosage should be based on the amount of agonist administered initially and the time that has elapsed since the agonist was administered. Dexmedetomidine is an alpha₂ adrenoreceptor agonist with reported synergistic sedation and analgesia with opioids [14, 15]. Dexmedetomidine is the dextro-rotatory isomer of medetomidine and may have some advantages over the racemate in terms of increased analgesic potency.

In addition, although administration of dexmedetomidine still causes bradycardia, this may be less severe than with racemic medetomidine [16]. A perceived advantage of dexmedetomidine sedation is the availability of an antagonist, atipamezole, which produces rapid recovery from sedation. In this study, the use of low doses of dexmedetomidine was not associated with preoperative and perioperative adverse effects, such as bradycardia, bradypnea or hypotension. It might, therefore, be useful as a premedication drug prior to cesarean section, providing excellent sedation without evident depression in puppies. In fact, only two puppies out of 48 were in need of sublingual drops of atipamezole.

All opioids cross the placenta and can cause neonatal respiratory depression, but their effects can be reversed by antagonist agents such as naloxone. Furthermore, the degree of opioid-mediated respiratory depression is generally minimal and easily controlled, especially if the patient is going on to anesthesia and will be intubated and maintained on 100% oxygen. Butorphanol is a synthetic kappa opioid agonist and mu opioid antagonist and has been used extensively in a wide variety of veterinary species [17]. The use of this drug alone promotes minimal changes in cardiopulmonary function and the respiratory depression caused by this opioid is less than that induced by morphine [18]. Butorphanol has been used for obstetric analgesia because it induces less respiratory depression and provides moderate levels of sedation [19]. It was included in our protocol without any adverse effects, providing excellent analgesia and probably allowing a reduction in the total dose of propofol required for induction.

Propofol, an alkyl phenol hypnotic, has been studied as an intravenous anesthetic in dogs and it was reported to be a short-acting, rapidly metabolized agent, characterized by a virtual lack of any cumulative effects and by rapid recovery [20]. The use of propofol to produce narcosis resulted in increased newborn survival rates and in good vitality following

surgery with minimal residual fetal depression [21]. In this study, slow administration (from 30 seconds to a minute) of propofol prevented the onset of apnea and induced minimal changes in heart rate. After induction, the animals were rapidly intubated and oxygen delivery was prolonged after intubation. The evaluation of oxygen saturation indicated the adequacy of ventilation.

The lumbosacral epidural anesthesia is noted for its simplicity, safety and effectiveness, and is one of the most frequently used regional anesthetic techniques described for surgical procedures which are caudal to the umbilicus [22]. Epidural anesthesia is frequently recommended for cesarean section because, unlike other anesthetic techniques, it does not depress the puppies. In this study, only two dams received epidural anesthesia because the premedication allowed adequate sedation, but if the dam will not cooperate for epidural anesthesia, this procedure should be avoided. A reduced volume of 2% lidocaine (1 mL/6 kg) was satisfactory for epidural anesthesia maybe due to the distension of the epidural veins, which decreased the size of the epidural space and increased the spread of the local anesthetic. Furthermore, chronic exposure to progesterone altered the permeability of the intercellular connective-tissue matrix facilitating diffusion through the nerve [23]. Epidural anesthesia, using a local anesthetic, increases the risk of hypotension following sympathetic nerve blockade. Hypotension induced by epidural anesthesia can be managed with crystalloid solutions and dobutamine in continuous rate infusion to prevent decreased uterine perfusion and fetal compromise. During surgery, in this study, the only dog that presented hypotension was one of those that had not received epidural anesthesia. It is likely that the hypotension occurred following uterus exteriorization from the abdomen. In this case, the uterus was of considerable size. The hypotension was treated with 5 µg/kg/min of dobutamine in constant rate infusion.

For the duration of the surgical procedure, the

patient should be maintained on the lowest possible concentration of inhalant anesthetic agents, bearing in mind that anesthetic gas requirements are believed to be reduced in the pregnant animal. E'Iso was maintained between 1.4 ± 0.12 and 1.5 ± 0.10 , without any significant differences between the dogs that received epidural anesthesia and those that had not. We believe that this could either be due to the fact that the number of animals that received additional epidural anesthetic lidocaine was too small to show any significant differences between the two groups or that the dose of epidural lidocaine might have been too small to provide supplemental analgesia.

No animal presented hypothermia probably due to the short duration of the surgery (40 ± 7 min).

In conclusion, elective procedures should be considered in Bulldogs which constitute 17% of all cesarean sections [13]. In an elective situation a complete physical examination and blood tests would be performed. Any period of hypoxemia in the mother is also a period of hypoxemia in the fetus and this can significantly decrease fetal viability at birth. Therefore, the dams should be preoxygenated by face mask during the preoperative period. General anesthesia should be induced quickly. Oxygenation and ventilation are more easily controlled and the airway is protected with endotracheal tube placement. The anesthetist should choose the anesthetic protocol that will have minimal effects on the puppies and the one with which they are most familiar. During anesthesia a multiparametric monitor should be used to record vital parameters and in particular pulse oximeters should be used to evaluate oxygen saturation and capnometers to indicate the adequacy of ventilation. Maternal hypoventilation can lead to fetal hypoxia and either manual or mechanical intermittent positive pressure ventilation may be required. The operating table should be inclined in reverse Trendelenburg position to decrease the weight of the pregnant uterus on the diaphragm and ensure greater respiratory excursion. Recovery can often be the most critical phase of

anesthesia in patients with airway disease and dysfunction, so monitoring and support should continue into the recovery period. Of fundamental importance for the success of a caesarean section, is the perfect coordination between anesthetist, surgeon and support staff and the minimization of excitement and stress for the dogs in the perioperative and recovery period.

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