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# TRANSPLACENTAL EFFECTS OF ANESTHETICS ON FETUSES IN SMALL ANIMALS DURING OBSTETRIC INTERVENTIONS

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## ABSTRACT

**Objective:** To evaluate the effects of anesthetics used in cesarean sections of small animals, comparing the advantages and disadvantages of inhalational and intravenous anesthetic protocols, considering postoperative recovery, maternal cardiovascular stability, fetal safety, and neonatal viability. Anesthesia in pregnant females is a challenging field, where the choice of anesthetic must minimize risks to both the mother and the fetus due to the physiological particularities of pregnancy and placental transfer. This study was based on a literature review encompassing scientific articles and experimental studies on the transplacental effects of anesthetics, focusing on protocols used in cesarean sections. The findings indicate that intravenous anesthesia, with agents such as propofol, promotes faster recovery and lower placental transfer, while inhalational anesthesia, such as isoflurane, offers precise control during longer procedures but may result in greater fetal depression. Combined protocols and the use of local anesthesia are increasingly recommended to minimize risks to fetal health. It is concluded that the choice of anesthetic protocol should be carefully tailored to the patient's clinical condition, the type of obstetric procedure, and fetal safety.

**Keywords:** Obstetric anesthesia. Maternal cardiovascular stability. Anesthetic protocol. Postoperative recovery. Fetal safety.

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## INTRODUCTION

Anesthesia in pregnant females during obstetric interventions, such as cesarean sections, poses a significant challenge in veterinary medicine. This is due to the physiological changes inherent to pregnancy, which considerably affect the pharmacokinetics and pharmacodynamics of medications, as well as the complex interaction with the fetal environment. During gestation, important changes occur, such as increased plasma volume, reduced serum protein concentration, higher cardiac output, and alterations in hepatic metabolism, which can affect the absorption, distribution, and elimination of anesthetic agents (Brancher, 2020; Johnston, Kustritz & Olson, 2001).

Although the placental barrier plays a selective role, it cannot completely block the transfer of substances between the mother and the fetus. The primary process of transplacental transfer of anesthetics is simple diffusion, which is influenced by liposolubility, ionization level, molecular weight, and protein binding of the medications (Horta & Lemonica, 2002). The placental physiology of carnivorous species, such as dogs and cats, with endotheliochorial placenta, favors the passage of certain lipophilic medications, increasing the risk of adverse effects on the fetus (Araújo, 2024; Ambrósio *et al*., 2002).

Additionally, it must be considered that fetal metabolism is immature, with reduced hepatic and renal activity, which predisposes to drug accumulation and increases the likelihood of toxic effects (Rebuelto & Loza, 2010). Therefore, the selection of an anesthetic protocol should aim not only at efficacy for the mother but also at minimizing risks to the fetus, avoiding substances with high teratogenic potential or fetal depression (Papich & Davis, 1986).

Recent research, such as the one conducted by Araújo (2024) on the toxicity of anesthetic protocols using lidocaine, ropivacaine, propofol, and isoflurane during cesarean sections in female dogs, found no genotoxic or cytotoxic effects in neonates analyzed through the micronucleus test. However, a higher level of neonatal pain was observed in puppies born from elective cesarean sections, which may be linked to the lack of natural physiological preparation for birth, affecting lung development and stress response. In contrast, Brancher (2020) and Horta and Lemonica (2002) emphasize that medication during pregnancy should be avoided whenever possible or used with

extreme caution, employing low-risk drugs and respecting the safest gestational period for interventions, typically the last third of gestation.

Thus, the objective of this article is to analyze the impacts of anesthetics used in cesarean sections of small animals, evaluating the advantages and disadvantages of inhalational and intravenous protocols, considering postoperative recovery, maternal cardiovascular stability, fetal safety, and neonatal viability.

## METHODOLOGY

This article was developed through a narrative and critical review of the scientific literature available in recognized academic databases such as PubMed, Scielo, and ScienceDirect, as well as books and dissertations related to the topic. Scientific articles, reviews, and experimental studies specifically addressing obstetric anesthesia in small animals, the transplacental effects of anesthetics, and neonatal viability were analyzed.

The selection of materials considered publications discussing the pharmacokinetics and pharmacodynamics of anesthetics in pregnant females, the mechanisms of placental transfer, and the consequences of anesthesia on the fetus. Special attention was given to studies that used fetal toxicity assessment methodologies, such as the micronucleus assay, and that correlated anesthetic techniques with neonatal outcomes.

The extracted information was critically compared and organized into topics allowing an integrated analysis of maternal physiological factors, anesthetic choices, and perioperative anesthetic care, aiming to provide support for safer clinical practices in veterinary obstetric interventions.

## RESULTS AND DISCUSSIONS

### TRANSPLACENTAL TRANSFER OF ANESTHETICS

Simple diffusion is the primary mechanism for the transplacental passage of anesthetics, favored by physicochemical properties such as high liposolubility and low molecular weight (Horta & Lemonica, 2002). Araújo's (2024) study used propofol and isoflurane in anesthetic protocols for cesarean sections. Both propofol and isoflurane rapidly cross the placental barrier. However, due to rapid metabolism (propofol) and pulmonary elimination (isoflurane), fetal levels tend to remain low in brief, controlled procedures (Brancher, 2020).

Although transfer is inevitable, neonatal analysis via the micronucleus assay revealed no genotoxic or cytotoxic effects. This reinforces that, with proper monitoring and dosing, anesthesia with these agents can be safe for the fetus. However, transplacental transfer may pose higher risks in prolonged anesthesia, where greater anesthetic accumulation occurs in the fetal system, primarily due to fetal hepatic and renal metabolic immaturity (Rebuelto & Loza, 2010).

## TOXICOKINETICS AND THE “ION TRAPPING” PHENOMENON

The so-called "ion trapping" is a fundamental aspect of fetal pharmacology. Given that uterine pH is more acidic than fetal pH, weak-base drugs like lidocaine can ionize upon crossing the placenta and become trapped in the fetal compartment (Horta & Lemonica, 2002). This may result in fetal concentrations higher than predicted by maternal levels alone, intensifying depressive effects and delaying drug clearance.

Although Araújo’s (2024) study did not identify increased toxicity with lidocaine, it is prudent to acknowledge that high or prolonged doses may pose additional risks, especially in cases of fetal acidosis, such as during prolonged dystocia.

## COMPARISON BETWEEN LIDOCAINE AND ROPIVACAINE IN EPIDURAL ANESTHESIA

When comparing topical anesthetics, lidocaine and ropivacaine provide effective nerve blocks. However, ropivacaine offers clinical advantages, such as lower incidence of maternal hypotension and less intense motor blockade (Araújo, 2024). These findings align with its pharmacological profile: ropivacaine has reduced tissue accumulation and fewer systemic effects than lidocaine, making it safer, especially in advanced pregnancies (Brancher, 2020).

Although statistical differences in neonatal toxicity between the groups were minimal, selecting anesthetics with lower systemic absorption potential is considered an effective practice for cesarean sections in both veterinary and human medicine (Mathews, 2008).

## INFLUENCE OF CESAREAN TYPE NEONATAL VIABILITY

Araújo’s (2024) research also revealed that the type of delivery significantly impacted neonatal viability. The incidence of respiratory distress, bradycardia, and

hypotonia in puppies born from elective cesareans was higher compared to those from therapeutic cesareans.

This finding aligns with existing knowledge about the role of natural birth: it triggers gradual increases in fetal cortisol, promoting lung maturation (surfactant production), hepatic glycogen utilization, and activation of respiratory mechanisms (Johnston, Kustritz & Olson, 2001; Mathews, 2008).

In elective cesareans, the absence of this physiological process results in neonates that, despite successful extraction, exhibit pulmonary immaturity and higher risk of respiratory issues in the first hours of life. Amniotic cortisol levels were lower in neonates from elective cesareans, suggesting earlier developmental stages compared to therapeutic cesareans (Araújo, 2024).

## CLINICAL IMPLICATIONS FOR OBSTETRIC ANESTHETIC MANAGEMENT

The practical conclusions drawn from this analysis are critical for obstetric anesthesia in small animals. Whenever possible, local anesthesia (e.g., epidural or spinal techniques) should be prioritized, as it significantly reduces the need for systemic anesthesia, thereby minimizing fetal exposure to potentially depressive agents (Brancher, 2020; Horta & Lemonica, 2002).

Maternal ventilation must be meticulously monitored during anesthesia. Hyperventilation may reduce uteroplacental blood flow, compromising fetal oxygen supply, while hypoventilation can lead to hypercapnia and respiratory acidosis. These conditions alter fetal pH and exacerbate ion trapping of basic anesthetics, increasing fetal toxicity risks (Horta & Lemonica, 2002; Rebuelto & Loza, 2010).

A key practice is supplemental oxygen administration throughout anesthesia to enhance the maternal-fetal oxygen diffusion gradient, reducing the risk of fetal hypoxia and systemic complications (Mathews, 2008; Johnston, Kustritz & Olson, 2001).

Short-acting anesthetics with rapid maternal metabolism (e.g., propofol for induction, isoflurane for maintenance) are preferred to limit fetal exposure to depressant substances, offering greater safety for both mother and offspring (Brancher, 2020; Araújo, 2024).

## FINAL CONSIDERATIONS

Obstetric anesthesia in small animals demands a cautious strategy that ensures maternal and fetal safety. It's crucial to opt for anesthetics that are of low-toxicity, with rapid elimination, and to employ local anesthesia techniques, such as epidural, to minimize fetal risks. Strict management of maternal ventilation, supplemental oxygen administration, and continuous monitoring throughout the procedure are fundamental to maintaining adequate fetal oxygenation and reducing neonatal complications.

Understanding anesthetic pharmacokinetics and placental transfer is essential for clinical success, as evidenced by the studies reviewed, which demonstrate the relative safety of well-administered protocols and the critical impact of cesarean timing on neonatal viability.

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