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THE EFFECT OF GENERAL ANESTHESIA ON UREA AND CREATININE VALUES IN A GROUP OF DOGS

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Abstract

All anesthetic drugs act on renal function, the kidney being the primary organ involved in the excretion of the anesthetic drugs. Also, anesthesia influences kidney function, especially through hemodynamic and neuroendocrine changes. Anesthesia and renal function are highly interconnected and can potentially influence each other. Understanding the anesthetic effects on renal function can help to develop safe perioperative care and to optimize the after-surgery outcome. The study will focus on how general anesthesia influences renal parameters, blood urea nitrogen (BUN) and creatinine (CREA). The results of our study show the impact of general anesthesia for both BUN and CREA, in correlation with the medication used for premedication, and the patient`s condition.

Key words: *general anesthesia, kidneys, urea, creatinine.*

INTRODUCTION

In a healthy organism, the kidney plays an important role in fluid, electrolyte, and acid-base regulation and also in filtration, reabsorption and secretion. Under normal physiological conditions, all these roles can be performed properly and the kidneys will need to receive about 20- 25% of the cardiac output via renal arteries, being among the most highly perfused organs in the body (Evans et al., 2020) and highly metabolically active. Even a short period of renal ischemia can lead to acute renal injury (Tranquili et al., 2013).

Blood urea nitrogen (BUN) is synthetized in the liver from the amino acids that arise from the catabolism of both exogenous and endogenous proteins. The excretion of BUN is achieved through glomerular filtration. Creatinine is a molecule that is synthesized mainly in the liver, kidneys, and pancreas and found in tissues with high-energy demands, like muscles (Bonilla et al., 2021). Crea is metabolized and excreted almost entirely through kidneys, via glomerular filtration. For healthy canine patients, the normal BUN concentration is 8 to 25 mg/dL, while in CREA is 0.3 to 1.3 mg/dL (Nelson & Couto, 2019).

Unfortunately, the renal disease frequently goes undiagnosed because the elevation in BUN and CREA occurs when the renal function is 50-70% compromised (Rezende & Mama, 2015).

MATERIALS AND METHODS

The study was conducted on 25 canine patients, aged between 1 and 14 years old. The study took place at the Faculty of Veterinary Medicine Bucharest and describes how general anesthesia affects the BUN and Crea values.

For biochemical blood determinations, we used the veterinary biochemical analyzer SMT-120V (Figure 1.).

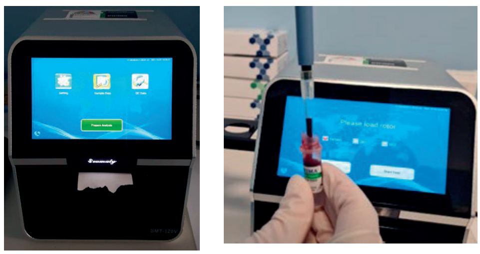

Figure 1. Biochemical lab analyzer SMT-120V.
Preparing the blood for the analysis

The operating system is based on the spectrometry technique. The sample used for this machine can be serum, plasma, or blood and it needs to be collected in lithium heparin tubs.

All general identification data were recorded for the entire group: breed, age, gender, and body weight.

Before surgery, every patient had a pre-anesthetic examination that included: heart rate, pulse, respiratory rate, non-invasive blood pressure, assessing the colour of the mucosa membranes, and rectal temperature. Also, every patient had a complete blood count and biochemistry evaluation that included BUN and CREA. All patients were assigned an anesthesia risk score according to the American Society of Anesthesiologists (ASA) physical status classification system modified for veterinary medicine (Costea, 2016).

Table 1. ASA score of every patient

	ASA1	ASA2	ASA3	ASA4	ASA5
Number of dogs	8	9	8	0	0

Patients underwent different types of surgeries, ophthalmological surgeries, and urogenital surgeries, including emergency surgery for pyometra. Depending on the type of the procedure the animal underwent, different time duration existed. For example, the ophthalmological surgeries were shorter compared with the urogenital surgeries.

Multiple anesthetic protocols were taken into consideration based on the ASA score (Table 1). The premedication was administered intramuscularly to all the patients. Apart from the premedication, all patients benefit of induction with Propofol (2-5 mg/kg, intravenous), intubation and maintenance with Isoflurane and Oxygen 100%. Lactated Ringer was administrated throughout the surgery and in the recovery period, at a rate of 5 ml/kg/h.

The group was divided into 4 categories based on the premedication used, as follows:

- First group: Butorphanol (0.3 mg/kg), Midazolam (0.2 mg/kg) and Ketamine (2 mg/kg);
- Second group: Butorphanol (0.3 mg/kg) and Ketamine (2 mg/kg);
- Third group: Dexmedetomidine (2 mcg/kg), Butoraphanol (0.3 mg/kg) and Ketamine (2 mg/kg);
- Fourth group: Acepromazine (0.02 mg/kg), Butorfanol (0.3 mg/kg) and Ketamine (2 mg/kg).

For the purpose of this study, the parameters taken into consideration were BUN and CREA, and the tests were taken on the same device for a better comparison of the results.

RESULTS AND DISCUSSIONS

The patients selected for this study were included in the I-II-III ASA score (Table 1) and the anesthetic protocols were chosen based on the classification of patients in these anesthetic risk groups (Table 2).

The type of the procedure influenced the duration of the surgery and also the postoperative analgesia. The type of the procedure also influenced the duration of the general anesthesia. For example, the ophthalmological surgeries were shorter and, in some situations, did not require such depth anesthesia compared to the urogenital surgeries.

From the total of 25 cases, the premedication was distributed as follows (Figure 2):

- The first group (MBK) consisted of 8 cases, which represented 32% of the total number of cases, and was premedicated with Butorphanol (0.3 mg/kg), Midazolam (0.2 mg/kg) and Ketamine (2 mg/kg)
- The second group (BK) consisted of 9 cases, which represented 36% of the total number of cases was premedicated with Butorphanol (0.2 mg/kg) and Ketamine (2 mg/kg);
- The third group (DBK) consisted of 7 cases, which represented 28% of the total number of cases was premedicated with Dexmedetomidine (2 mcg/kg), Butorphanol (0.3 mg/kg) and Ketamine (2 mg/kg);
- The fourth group (ABK) consisted of 1 case, which represented 4% of the total number of cases was premedicated with Acepromazine (0.02 mg/kg), Butorphanol (0.3 mg/kg) and Ketamine (2 mg/kg).

The first part of the study aimed to quantify the effect of anesthesia in relation to the age groups of the patients studied. In Figure 3, are presented the data obtained for the total number of patients divided into age groups: the first group is represented by dogs aged 1 to 6 years old, and the second group dogs aged 7 to 14 years old. Globally, for the whole study group, an increase in both BUN and CREA was registered, but different results emerged in different age groups.

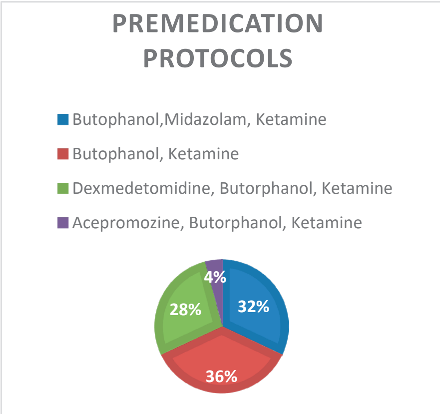

Figure 2. The premedication distribution in the study group

Table 2. Classification of patients in anesthetic risk groups

ASA group	Number of patients	Protocol
I	7	DBK
I	1	ABK
II	9	BK
III	8	MBK

BUN increased by 5% and CREA increased by 13% in the group of dogs aged between 1 and 6 years old. As a comparison, the BUN increased by 3% and CREA decreased by 1% in the group were the dogs where between 7 and 14 years old (Figure 3).

Date from the hole group		
Row label	Average of BUN (mg/dl)	Average of Crea (mg/dl)
Before	21.972	1.2136
After	21.168	1.1624
Difference	4%	4%

Dogs with age between 1 and 6 years		
Row label	Average of BUN (mg/dl)	Average of Crea (mg/dl)
Before	17.770	0.897
After	16.957	0.794
Difference	5%	13%

Dogs with age between 7 and 14 years		
Row label	Average of BUN (mg/dl)	Average of Crea (mg/dl)
Before	27.318	1.616
After	26.527	1.630
Difference	3%	-1%

Figure 3. Date obtained in the study group divided by age

For geriatric patients, the renal system shows important structural changes. A 50% decrease in functional nephrons is not unusual in the aging animal, along with decreased renal blood flow and a decreased glomerular filtration rate (Baetge & Matthews, 2012). Ketamine metabolization and excretion can be longer, especially for this category of patients. The CREA level varied in the sense of increase or decrease values, correlated with the pathologies and protocols chosen, data confirmed by the literature (Patel, 2009).

The second part of the study aimed to quantify the effect of anesthesia in relation to the different protocols used. Figure 4 illustrates the difference between BUN and CREA before and after premedication based on the drugs that were used. For the protocol Dexmedetomidine-Butorphanol-Ketamine (DBK) the BUN increased by 7% and CREA decreased by 7%. On the Butorphanol-Midazolam-Ketamine group (MBK) BUN increased by 1% and CREA increased spectacularly by 59%. Midazolam decreases the glomerular filtration rate and the renal plasma flow while Ketamine increases levels of urea and creatinine (Alizadeh & Fard, 2019). Finally, in the group Butorphanol-Ketamine (BK), BUN decreased by 2% and CREA increased by 24%. Possibly the differences compared to the MBK group, are correlated with the lack of Midazolam in the protocol.

Dexmedetomidine-Butorphanol-Ketamine		
Row label	Average of BUN (mg/dl)	Average of Crea (mg/dl)
Before	15.985	0.825
After	14.885	0.888
Difference	7%	-7%

Butorphanol-Midazolam-Ketamine		
Row label	Average of BUN (mg/dl)	Average of Crea (mg/dl)
Before	16.337	0.931
After	16.212	0.587
Difference	1%	59%

Butorphanol-Ketamine		
Row label	Average of BUN (mg/dl)	Average of Crea (mg/dl)
Before	18.522	0.79
After	18.811	0.637
Difference	-2%	24%

Figure 4. Data obtained in the study group divided based on premedication

The important variations for the MBK and BK protocols can be correlated with the ASA status of the patients, respectively with the important pre-anesthetic status of the patients. The values obtained for the DBK protocol can be correlated with the synergistic effects of the alpha-2 agonist dexmedetomidine and respectively ketamine, on the cardiovascular system, respectively on metabolism and renal excretion.

In addition to the premedication protocols used, the potential effect on renal function of the medication used for induction and maintenance should also be considered Propofol, used for the induction of anesthesia, is metabolized by the process of glucuronidation in hepatic and extrahepatic sites including the kidney (Hiraoka et al., 2005). Halogenated agents can have a significant impact, more important for sevoflurane versus isoflurane, since the production of fluoride ions by sevoflurane is the main difference (Tsukamoto et al., 1996).

CONCLUSIONS

In conclusion, there are differences in the renal parameters that were taken into account for this study (BUN and CREA). The parameters were measured before premedication and in the early phase of recovery. Changes can be associated with the age of the patient, the type of surgery and different anesthetic protocols used.

ASA II-III patients, as well as geriatric patients, are more exposed to BUN and CREA variations during anesthesia

The DBK protocol used for ASA I and II patients had a medium impact on BUN and CREA variations

The important differences between the protocols are very likely based on the doses used for premedication, in relation to the patient's condition.

Further studies, implying a detailed correlation between the patient's clinical condition, the surgical procedure, its duration and the chosen protocol are necessary.

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