

Echocardiographic assessment of felines sedated with dexmedetomidine or xylazine associated with butorphanol

Avaliação ecocardiográfica de felinos sedados com dexmedetomidina ou xilazina associada com butorfanol

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Abstract

This prospective cohort study aimed to evaluate by echocardiogram the cardiovascular effects of α_2 agents associated with butorphanol in cats. A group of 18 mixed-breed cats with a mean weight of 3.65 ± 0.7 kg, with an approximate age of 6 months. The cats were assigned in three groups, XB (Xylazine/butorphanol group) sedation with 0.5 mg/kg of xylazine and 0.5 mg/kg of butorphanol IM; DB (Dexmedetomidine/butorphanol group): sedation with 20 μ g/kg of dexmedetomidine and 0.5 mg/kg of butorphanol IM; C: control group which received saline solution in volume approximated to those used in the other groups, IM. Echocardiographic variables as ejection fraction (Simpson's method and M-mode) and left ventricular shortening fraction (M-mode), ejection volume, end-systolic volume and cardiac output (Teichholz), tissue Doppler E' and A' wave velocities and cardiac index were evaluated. There was a reduction in echocardiographic variables compared with the control group, being statistically significant for heart rate, ejection fraction (% by Simpson), shortening fraction (% in M-mode) and end-systolic volume in XB and DB groups, and tissue Doppler E' and A' wave velocity (m/s), E'/A' ratio, cardiac output and cardiac index only in XB group. When compared to each other, XB and DB differed significantly in the tissue Doppler E' and A' wave velocity (m/s), and E'/A' ratio. Xylazine was more deleterious than dexmedetomidine in most of the variables evaluated, leading to a significant reduction in cardiac output and cardiac index at the doses used in this study.

Keywords: Adrenergic alpha-2 receptor agonists; Cardiac output; Cats; Echocardiography.

Resumo

Este estudo de coorte prospectivo teve como objetivo avaliar por ecocardiograma os efeitos cardiovasculares de agentes α_2 associados ao butorfanol em gatos. Um grupo de 18 gatos sem raça definida com peso médio de $3,65 \pm 0,7$ kg, com idade aproximada de 6 meses. Os gatos foram divididos em três grupos, sedação XB (grupo xilazina/butorfanol) com 0,5 mg/kg de xilazina e 0,5 mg/kg de butorfanol IM; DB (grupo Dexmedetomidina/butorfanol): sedação com 20 μ g/kg de dexmedetomidina e 0,5 mg/kg de butorfanol IM; C: grupo

controle que recebeu solução salina em volume próximo aos utilizados nos demais grupos, IM. Variáveis ecocardiográficas como fração de ejeção (método de Simpson e modo M) e fração de encurtamento do ventrículo esquerdo (modo M), volume de ejeção, volume sistólico e débito cardíaco (Teichholz), velocidades das ondas E' e A' do Doppler tecidual e índice cardíaco foram avaliados. Houve redução das variáveis ecocardiográficas em relação ao grupo controle, sendo estatisticamente significativa para frequência cardíaca, fração de ejeção (% por Simpson), fração de encurtamento (% em modo M) e volume sistólico final nos grupos XB e DB e tecido Velocidade das ondas E' e A' Doppler (m/s), relação E'/A', débito cardíaco e índice cardíaco apenas no grupo XB. Quando comparados entre si, XB e DB diferiram significativamente na velocidade de onda E' e A' do Doppler tecidual (m/s) e na relação E'/A'. A xilazina foi mais deletéria que a dexmedetomidina na maioria das variáveis avaliadas, levando a uma redução significativa do débito cardíaco e do índice cardíaco nas doses utilizadas neste estudo.

Palavras-chave: Agonistas de receptores adrenérgicos alfa 2; Débito cardíaco; Gatos; Ecocardiografia.

Resumen

Este estudio de cohorte prospectivo tuvo como objetivo evaluar mediante ecocardiograma los efectos cardiovasculares de los agentes α_2 asociados con butorfanol en gatos. Un grupo de 18 gatos mestizos con un peso medio de $3,65 \pm 0,7$ kg, con una edad aproximada de 6 meses. Los gatos fueron asignados en tres grupos, XB (grupo xilacina/butorfanol): sedación con 0,5 mg/kg de xilacina y 0,5 mg/kg de butorfanol IM; DB (grupo Dexmedetomidina/butorfanol): sedación con 20 μ g/kg de dexmedetomidina y 0,5 mg/kg de butorfanol IM; C: grupo control que recibió solución salina en volumen aproximado a los utilizados en los otros grupos, IM. Variables ecocardiográficas como fracción de eyección (método de Simpson y modo M) y fracción de acortamiento del ventrículo izquierdo (modo M), volumen de eyección, volumen telesistólico y gasto cardíaco (Teichholz), velocidades de onda Doppler tisular E' y A' e índice cardíaco fueron evaluados. Hubo una reducción en las variables ecocardiográficas en comparación con el grupo control, siendo estadísticamente significativas para frecuencia cardíaca, fracción de eyección (% por Simpson), fracción de acortamiento (% en modo M) y volumen telesistólico en los grupos XB y DB, y velocidad de onda Doppler tisular E' y A' (m/s), cociente E'/A', gasto cardíaco e índice cardíaco solo en el grupo XB. Cuando se compararon entre sí, XB y DB diferían significativamente en la velocidad de onda Doppler tisular E' y A' (m/s) y en la relación E'/A'. La xilacina fue más deletérea que la dexmedetomidina en la mayoría de las variables evaluadas, lo que provocó una reducción significativa del gasto cardíaco y del índice cardíaco a las dosis utilizadas en este estudio.

Palabras clave: Agonistas de receptores adrenérgicos alfa 2; Gasto cardíaco; Gatos; Ecocardiografía.

1. Introduction

Surgical and/or diagnostic procedures in cats may require intense sedation or even general anesthesia. Depending on the anesthetic protocol used, it is possible to observe prolonged recovery time of the patient, a fact that requires greater monitoring and involves a higher incidence of side effects (Papastefanou et al., 2015; Simon & Steagall, 2020). The benefits of using sedative protocols in cats aim to reduce excitability, fear and stress derived from the manipulation process (Simon & Steagall, 2020). Dexmedetomidine is a α_2 -adrenergic receptor agonists drug such as xylazine, detomidine, medetomidine, clonidine and romifidine (Papastefanou et al., 2015; Murdock et al., 2020). Using of alpha 2-adrenergic agonists has advantages in clinical anesthesia, especially dexmedetomidine, due to its pharmacological and selective for alpha-2 adrenoceptors (Weerink et al., 2017). However, its advantages and disadvantages should be further investigated. Dexmedetomidine has a predominant postsynaptic action, hyperpolarizing the nerve cell through the potassium channels (Salarian et al., 2016). It is a drug that has high affinity for plasma proteins, undergoes intense hepatic metabolism and is eliminated by the kidneys as a glucuronic acid conjugate (Weerink et al., 2017). Xylazine acts by decreasing the release of norepinephrine in the presynaptic adrenergic nerve endings, by inhibiting the calcium input that precedes the release of the neurotransmitter (Ribeiro et al., 2012).

One advantage of using α_2 -adrenergic agonists is the possibility to reverse their effects with selective antagonists such as atipamezole (Robertson et al., 2018; Simon and Steagall, 2020). When combined with opioids (Simon & Steagall, 2020), α_2 -adrenoceptor agonists have shown to exert additive and/or synergistic effects on analgesic and sedative effects (Ahsan et al., 2020). Butorphanol is a kappa opioid agonist and μ -antagonist (Murdock et al., 2020). In cats it is used in combination with dexmedetomidine for profound sedation and analgesia. According to Ahsan et al. (2020), the associated use of dexmedetomidine with butorphanol may provide better levels of sedation, analgesia, postoperative hypothermia control and

analgesic benefit when compared with the same drugs alone. The association with butorphanol also reduces the occurrence of vomiting that can be induced by dexmedetomidine, by action at the kappa receptors in the center of vomiting (Papastefanou et al., 2015; Robertson et al., 2018; Bhalla et al., 2018).

Intramuscular injections of α_2 -adrenergic agonists produce a vasoconstrictor effect, followed by a period of hypotension and bradycardia due negative effect on cardiac contractility and cardiac output (Kelliher et al., 2015). In peripheral nerve endings there is inhibition of norepinephrine release, which explains the arterial hypotensive effect and bradycardia due to the activation of these receptors. On the other hand, activation of vasopressin α_2 -receptors in the central nervous system (CNS) decreases sympathetic efflux, with progressive reduction of circulating catecholamines, potentiating parasympathetic nervous activity and, consequently, causing blood pressure decrease. Stimulation of the receptors in the vascular endothelium causes vasoconstriction, which is an explanation for the transient initial arterial hypertension (Weerink et al., 2017; Murdock et al., 2020; Ahsan et al., 2020). Since α_2 -adrenergic agonists are a group of widely used sedatives in feline medicine and they have important side effects, such as bradycardia, decreased cardiac output, increased peripheral vascular resistance, dexmedetomidine could be a better option for sedation of young cats due to its pharmacological and high specificity. The aim of the present study was to evaluate, through transthoracic echocardiography, the cardiovascular effects of xylazine or dexmedetomidine associated with butorphanol on sedation of 6-month-old cats, seeking less adverse effects on heart function with the use of dexmedetomidine.

2. Methodology

2.1 Study design

This was a prospective quantitative cohort study (Sampaio, 2015) conducted in the diagnostic imaging sector of the Veterinary Hospital of the Federal University of Minas Gerais (UFMG) and approved by the UFMG Committee for Animal Experimentation (n°. 82/2014). Eighteen 6-month old domestic shorthair cats, 9 males and 9 females, with 3.65 ± 0.7 kg were studied. The animals came from protective societies and non-governmental organizations (NGOs) and were born, cared and kept at the Small Animal Experimentation Center of the Veterinary School of UFMG. All cats received the same care regarding hygiene, health and feeding and after the end of the study were referred to the adoption. The cats were randomly assigned into three groups (three males and three females) using the following sedation protocol or placebo: Xylazine/butorphanol group (XB): xylazine (0.5 mg Kg⁻¹ : Anasedan; Ceva, Paulínia, SP; Brazil) and butorphanol (0.5 mg Kg⁻¹: Torbugesic; Zoetis, Parsippany, NJ, USA), IM; Dexmedetomidine/butorphanol group (DB): dexmedetomidine (20 μ g kg⁻¹: Dexdomitor; Zoetis, Parsippany, NJ, USA) and butorphanol (0.5 mg Kg⁻¹), IM; Control group (C): non-sedated animals which received saline solution in volume approximated to those used in the other groups, IM. Prior to the start of the experiment the animals were clinically and laboratory (complete blood count and blood biochemistry profile) evaluated for confirmation of healthiness (animals that presented clinical and/or laboratory alterations were excluded from the study). Cats were fasted for 12 hours but had free access to water until 2 hours prior to premedication.

2.2 Transthoracic echocardiogram

Echocardiogram was performed by an experienced observer, blinded to the drugs administered, using an ultrasound system (MyLab 40 Esaote, Italy) with sector transducer 3-7.5MHz. For the echocardiographic evaluation, the hair was clipped between the 3rd and 6th right and left intercostal spaces and conductive gel was then applied. The animals were positioned in the right and left lateral recumbency to obtain the images. All data were collected in triplicate, being evaluated: heart rate (HR in bpm), ejection fraction - EF (Simpson method and M-mode) and shortening fraction - SF (M-mode) of the left ventricle (%); volume of ejection (Vol.E. in mL), end-systolic volume (ESV in mL) and cardiac output (CO in mL min⁻¹), all calculated by

the Teichholz method; E' and A' waves of the tissue Doppler to obtain the E'/A' ratio and the cardiac index (CI) through the relation between the cardiac output (CO in mL) and the body surface (m²). Data are represented by their means and standard deviations (SD). The analysis of variance (ANOVA) was used to study the echocardiographic variables and the Newman-Keuls Multiple Comparison test to compare the treatments. The normality of the variables was evaluated using the Kolmogorov-Smirnov test. Data were analyzed using GraphPad Prism 5 software and a significance level of 5% (P <0.05) was set.

3. Results

Cat weights were 3.65 + 0.7 kg for XB and DB and 3.5 + 0.6 kg for the control group. The age of the animals was six months for the three groups. All animals recovered from sedation without complications. There was a reduction in echocardiographic variables in XB and DB compared with the control group (Table 1), being statistically significant for HR, EF (% by Simpson), SF (% in M-mode) and ESV in XB and DB and E' (m s⁻¹), A' (m s⁻¹), E'/A' ratio, CO and CI only in XB. When compared to each other, XB and DB differed significantly in the E'(m s⁻¹), A' (m s⁻¹), and E'/A' ratio (Table 1).

Table 1. Echocardiographic variables (mean ± SD) in 6-month-old cats after intramuscular administration of xylazine/butorphanol (0.5 mg Kg⁻¹ of both, XB group, n=6), dexmedetomidine/butorphanol (20 µg kg⁻¹ and 0.5 mg Kg⁻¹, respectively, DB group, n=6) or saline solution (Control group, n=6).

Variable	Group	Mean ± SD
HR (bpm)	C	183.8 ± 19.57
	XB	99.69 ± 21.80*
	DB	96.63 ± 12.77*
EF (Simpson method, %)	C	65.83 ± 5.68
	XB	52.28 ± 8.76*
	DB	52.15 ± 7.68*
EF (M-mode, %)	C	74.10 ± 8.67
	XB	54.22 ± 7.35*
	DB	57.44 ± 12.67*
SF (%)	C	40.53 ± 7.34
	XB	25.72 ± 4.30*
	DB	28.17 ± 7.72*
E' (m s ⁻¹)	C	0.14 ± 0.014
	XB	0.23 ± 0.06*
	DB	0.16 ± 0.07†
A' (m s ⁻¹)	C	0.14 ± 0.07
	XB	0.29 ± 0.11*
	DB	0.16 ± 0.09†
E'/A'	C	1.22 ± 0.16
	XB	0.85 ± 0.20*
	DB	1.126 ± 0.34†
CO (mL)	C	280.2 ± 37.82
	XB	157.8 ± 59.61*
	DB	217.6 ± 66.86
CI	C	65.66 ± 31.07
	XB	37.99 ± 16.27*
	DB	52.30 ± 21.26
Vol. E. (mL)	C	1.59 ± 0.62
	XB	1.61 ± 0.56
	DB	2.24 ± 0.61
ESV (mL)	C	0.36 ± 0.13
	XB	0.57 ± 0.26*
	DB	0.63 ± 0.32*

*Statistically significant difference compared with the control group (P <0.05) | † Group XB significantly different from DB group (P <0.05). Consider: HR, heart rate; EF, ejection fraction in the Simpson method and M-mode; SF., Shortening fraction; tissue Doppler E' and A' wave velocities; E'/A' ratio; CO, cardiac output; CI, cardiac index; Vol. E., Ejection volume; ESV, end-systolic volume. Source: Elaborated by the authors

In the table above (Table 1), it is possible to observe that there is a reduction in the values of the echocardiographic

variables when the comparison is made with the control group (saline solution) and in some variables when the XB and DB groups are compared.

4. Discussion

Doses used in this study were chosen according to the literature (Papastefanou et al., 2015; Robertson et al., 2018). Echocardiograms were performed properly in all cats, but in the control group the animals moved more, making the examination difficult. For this reason, the use of sedation is indicated in animals that don't tolerate the containment and positioning for echocardiography, avoiding overt stress and allowing for high quality recordings (Simon & Steagall, 2020).

Transthoracic echocardiography was used because it is a non-invasive tool for measuring CO. The geometric Teichholz method is used to calculate left ventricular (LV) volumes from M-mode measurements. According to Biermann et al. (2012) for assessment of stroke volume (SV) and CO in clinically healthy cats, the Teichholz method were acceptably repeatable and appeared to give the most representative values (such as the Trace Method) and they might be the most useful methods for measurement of SV and CO in cats. As thermodilution techniques are the reference standard for measuring CO, but in cats this is an invasive method that entails the placement of a pulmonary catheter which requires anaesthesia and fluoroscopic control (Siao et al., 2017), our study suggests transthoracic echocardiographic measurements that can be used in clinical routine in cats.

Echocardiographic evaluations in 6-month-old cats showed a significant reduction in HR compared to the control group, regardless of the sedation protocol used. In the xylazine/butorphanol group, this fall represented 47% reduction from baseline. In one study, the reduction in HR in cats receiving xylazine was similar (Escobar et al., 2011). In the dexmedetomidine/butorphanol group, this drop was of 50%. Carvalho et al. (2019) reported that the administration of dexmedetomidine at the dose of 5 µg kg⁻¹ promotes reduction of heart rate compared from baseline. The intensity of the fall of the HR (47% for XB and 50% for DB) could be explained because of the age of the cats in this study, but it is prove only in dogs that the heart rate varies according to age (Hezzell et al., 2013).

The reduction of the HR can also be explained by the activation of the presynaptic receptors of the peripheral nerve endings, with reduction of norepinephrine release, and by the sympatolytic effect on the central nervous system caused by such drugs (Weerink et al., 2017). Reader et al. (2021) compared the effects of 2 sedation protocols in relation to echocardiographic variables in cats for blood donation. The protocols were composed of 2 mg/kg alfaxalone + 0.2 mg/kg butorphanol (AB) and 10 µg/kg dexmedetomidine + 0.2 mg/kg butorphanol (DB) (Reader et al., 2021). Cats that received the DB protocol, followed by transfusion showed: reduced heart rate, shortening fraction, ejection fraction and cardiac output (Reader et al., 2021). When compared with AB, the DB group presented a decrease in HR and fractional shortening, and an increase in systolic and end-diastolic volume (Reader et al., 2021). In addition, post-donation mitral, aortic and pulmonary regurgitant flows increased (Reader et al., 2021).

Ejection and shortening fractions are indices that quantitatively assess left ventricular systolic function, being easily altered due to cardiac preload and afterload (Ware & Ward, 2020). In most normal cats, without the effect of anesthetics or sedatives, the shortening fraction is 35-65%, although there is variability (Ware & Ward, 2020). In this study, both the ejection fraction and the shortening fraction were statistically reduced compared to the control group. This may be explained by drug-induced bradycardia, leading to impairment in diastolic function, and by increased systemic vascular resistance, which is the biphasic behavior of α₂-adrenergic agonist drugs (Weerink et al., 2017). The ejection fraction by the Simpson method and M-mode also decreased for both DB and XB compared with the control group (reduction of 21% in both in Simpson method, 22% and 27% respectively in the M-mode). The shortening fraction decreased 30% and 37%, respectively. The control group presented a shortening fraction within the range expected for the feline species (35-65%), proving that young cats have this

variable similar to adult cats. Schille and Skrodzki (1999) found $79 \pm 3\%$ as the mean value of ejection fraction in 3-month-old cats. In the studies of Ward et al. (2012) the value was $62 + 1.8\%$ for adult cats (1 to 3 years old). Silva et al. (2019) carried out a study with 125 mixed-breed cats of varying ages and observed an ejection fraction of around $85.74\% \pm 7.25$ (coefficient of variation 8%). Although there was no proven correlation of age with ejection fraction, it was observed in the present study that 6-month-old cats have values closer to that of adult cats.

Tissue Doppler is an echocardiographic method associated with the evaluation of diastolic function that allows demonstrating changes in the speed of movement of the cardiac muscle (Ware & Ward, 2020). The E' wave, or velocity peak, corresponds to the rapid phase of ventricular filling, being influenced by the atrioventricular pressure gradient. This gradient is influenced by a variety of factors including left atrial pressure, left ventricular relaxation and compliance, and preload. The ventricular filling during atrial contraction is represented by the wave A', being influenced by the left ventricle compliance and left atrial contractility (Boon, 2011; Madron, 2015). The ratio of E' and A' wave values should always be greater than 1 in normal animals. Therefore, it is possible to observe that tachycardia and bradycardia influence this ratio. In bradycardia there is an increase in A' wave and in tachycardia there is a decrease in E' wave (Boon, 2011). In the present study, both drugs led to a statistically reduced heart rate, but only XB animals presented a statistically increased A' wave, with a reduction in the ratio E'/A' ($0.85 + 0.20$) demonstrating impairment to diastolic function. In the DB group, bradycardia was similar to XB, but without A' wave increase and E'/A' ratio greater than one ($1.126 + 0.34$) and similar to that observed in the control group ($1.22 + 0.16$).

Madron et al. (2015) stated that the preload seems to have a great influence on the E' wave and that the increase in the end-systolic volume is inversely proportional to the velocity peak of the E' wave. In the present study, both dexmedetomidine and xylazine combine with butorphanol, led to a higher end-systolic volume. These results were statistically significant ($0.63 + 0.32$ and $0.57 + 0.26$ for DB and XB respectively) when compared with the control group ($0.36 + 0.13$), which may explain the differences found in relation to the values of the E' and A' waves. Xylazine showed lower value of E'/A' ratio. It can be hypothesized that xylazine produces negative effects on the preload, since the animals in the present study did not present structural cardiac alterations of the left ventricular compliance.

The α_2 -agonists produce a sympatholytic effect due to vasomotor center depression and increase vagal tone, which leads to a reduction in myocardial contractility (Rankin, 2015). In the present study, an increase in end-systolic volume was observed in both groups treated with α_2 -agonists. In addition, changes in atrioventricular synchrony may imply marked changes in the left ventricle filling pattern, such increase of PR interval, where E' waves of different dimensions may occur with the absence of an organized A' wave (Madron et al., 2015; Ward & Ware, 2020). Although electrocardiography is not the focus of the present study, it is known that due to the increase in vagal tonus caused by α_2 -adrenergic agonist, there is a negative dromotropic effect on the atrioventricular electrical conduction (Posner, 2018), which also may have contributed to the observed differences in the relationship between the E' and A' waves between the DB and XB groups.

The cardiac index (CI) relates body mass to cardiac output (CO), being a more accurate measurement to evaluate the function of the ventricles. Cardiac output is usually decreased with α_2 -adrenergic agonist administration and it is reduced by up to 50% in dogs and horses (Rankin, 2015). This is usually secondary to the reduction in heart rate in an attempt to maintain physiological blood pressure in the face of increased systemic vascular resistance (Rankin, 2015). There may be reduction in CO and CI related to bradycardia and increased peripheral vascular resistance, attributed to the effects of direct vasoconstriction produced by the use of dexmedetomidine (Kelliher et al., 2015). The present study reveals statistically significant reduction in CO and CI only for XB group. Thus, it was observed that xylazine combined with butorphanol was more deleterious to ventricular function compared with DB group.

Xylazine reduced CO in 43.7% and CI in 41.9%, while dexmedetomidine, even without statistical difference

compared with the control group, reduced CO in 22.3% and CI in 20.3%. This difference can be attributed to the fact that dexmedetomidine is a more selective α_2 -adrenoceptor agonist compared to xylazine (Simon & Steagall, 2020). Murrell and Hellebrekers (2005) stated that the exact mechanism of these drugs on cardiac output is unknown, but several mechanisms are suggested to explain these effects such as direct effect as myocardial depressants; decrease in cardiac function in response to the increase in afterload mediated by the α_2 -adrenergic agonist; degree of myocardial hypoxia and dysfunction in response to coronary vasoconstriction. Previous studies have shown that it is unlikely that α_2 -adrenergic receptor agonists have direct effects on myocardial contractility (Flacke et al., 1990), and decreases in CO are more likely related to increases in afterload and decreases in HR (Bloor et al., 1992). In Wistar rats, Picollo et al. (2012) evaluated the cardiovascular and thermoregulatory effects of the combined use of xylazine (50 mg/kg) and ketamine (10 mg/kg) via the intraperitoneal route. The authors observed that the combination of drugs made it possible to decrease systolic and diastolic pressures, hypotension, drop in heart rate and bradycardia at different times after pharmacological administration. Picollo et al. (2012) also found that hemodynamic effects remained even after complete anesthetic recovery. Carvalho et al. (2019) also observed a decrease in CO in dexmedetomidine infusion in isoflurane-anesthetized cats, the opposite found in this study in DB group. However, we used only one application of dexmedetomidine, while Carvalho et al. (2019) associated inhalation anesthesia (isoflurane) and dexmedetomidine (CRI). On the other hand, comparing the initial dose of dexmedetomidine (5 $\mu\text{g kg}^{-1}$) used by Carvalho et al. (2019) and the dose used in this study (20 $\mu\text{g kg}^{-1}$), it can be stated that the CO reduction (25.55% and 22.3%, respectively) was similar to that found here, both without statistical difference from baseline.

The ejection volume corresponds to the amount of blood leaving the heart and is estimated from the measure of velocity-time integral obtained by pulsed Doppler recorded in the left ventricular outflow tract and multiplied by the cross-sectional area of this region (Tan et al., 2017). In this study no statistical differences were observed between groups and in comparison to the control group, showing that the drugs used didn't interfere with ejection volume, although both xylazine and dexmedetomidine cause peripheral and central cardiovascular changes (Simon & Steagall, 2020). In addition, Lamont et al. (2001) stated that cats do not appear to have the same degree of hypertension associated with the administration of α_2 -adrenergic agonist drugs. These differences in response would be associated with the fact that they are potentially stressed animals with elevated levels of circulating catecholamines even before the application of the drugs and these authors also suggested that there is a predominance of central α_2 -adrenergic effects in cats compared to the peripheral ones, which could explain the results found regarding ejection volume.

5. Conclusion

In 6-month-old cats, xylazine combined with butorphanol was shown to be more deleterious than dexmedetomidine/butorphanol in some echocardiographic variables evaluated, leading to impairment in diastolic function, negative effects on the preload and a significant reduction in cardiac output and cardiac index at the doses used in this study. Given the changes observed in echocardiographic variables, further research and studies are needed in order to verify the influence of certain drugs on cardiovascular physiology.

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