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Original Research

Evaluation of Echocardiographic Parameters During Increasing Infusion Rates of Dobutamine in Isoflurane-Anesthetized Horses

Valentina Vitale DVM [a], Micaela Sgorbini DVM, PhD, MS [a], Angela Briganti DVM, PhD [a], Michele Corazza DVM [a], Gloria Breghi DVM [a], Francesco Staffieri DVM, PhD [b]

[a] Department of Veterinary Sciences, Faculty of Veterinary Medicine, University of Pisa, Pisa, Italy
[b] Dipartimento dell'Emergenza e dei Trapianti di Organi (DETO), Department of Veterinary Surgery, Faculty of Veterinary Medicine, University of Bari, Bari, Italy

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ABSTRACT

The purpose of this study was to evaluate changes in echocardiographic parameters during increasing infusion rates of dobutamine in isoflurane-anesthetized horses and to compare our results with those of previous studies. Six Standardbred female healthy horses were included in this study. All animals were anesthetized and infused with dobutamine at different rates. mean arterial pressure (MAP), heart rate (HR), and some echocardiographic measurements were recorded. Statistical analysis was applied. Under basal conditions (time 0 [T0]), HR ranged between 32 and 42 beats per minute (bpm), and MAP was between 39 and 63 mm Hg. MAP increased significantly from T0 compared with values at T2, T2, and T3 in a dose-dependent manner, while HR increased significantly only at T3 if compared to the other measuring times. Left ventricular internal diameter during diastole (LVDs) decreased significantly in a dose-dependent manner, with increasing of the infusion rate of dobutamine. Interventricular septal dimension during diastole (IVSs) increased significantly, and end-systole left ventricular volumes (LVVols) decreased significantly at T2 and T3 compared to T1. Ejection fraction (%) increased significantly between T0 and T1, T2, and T3. Cardiac output increased significantly only at the higher dosage (T3 vs. others) of dobutamine, but cardiac power output was enhanced significantly at T2 versus that at T0 and T1 and at T3 versus all the previous measurements. Arrhythmias were diagnosed in 5 of 6 (83.3%). In this study, the increase of MAP was found to be dose-dependent, according with literature. The HR and MAP values registered at T0 were comparable to previous results obtained both in anesthetized and conscious horses, while at T1, T2, and T3, HR and MAP values were similar only too those reported in anesthetized horses. IVSs increased and LVDs decreased significantly with the increment of dobutamine infusion rate. These findings suggest that dobutamine, even at low infusion rates, induces an enhancement in cardiac systolic function. The dose-dependent increase of IVSs and decrease of LVDs measurements are in line with those reported for dobutamine administered in conscious horses but with lower values. The LVVols dose-dependent reduction obtained in this study is in line with that in other reports, but both LVold and LVVols values after dobutamine infusion at different dosages are lower if compared to previous studies. The low LVol values and the wide standard deviation have influenced consequently the derived indices values (stroke volume [SV], EF, cardiac output [CO]). In the present study, SV did not significantly increase during dobutamine infusion. These results disagree with those reported by others. The increment of CO might be due mainly to the enhanced HR rather

Corresponding author at: Dr. Micaela Sgorbini, DVM, PhD, MS, Department of Veterinary Sciences, Veterinary Teaching Hospital Mario Modenato, Via Livornese Snc, San Piero A Grado (PI)−56124.
E-mail address: sgorbini@vet.unipi.it (M. Sgorbini).

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than to the weak changes of SV. Cardiac power output increased significantly from the 5 mcg/kg/min dosage in a dose-dependent manner, as reported by others.

1. Introduction

Cardiovascular effects and echocardiographic measurement changes due to dobutamine have been previously studied by many authors both in anesthetized and conscious horses (1-10). Studies of anesthetized horses investigated principally the changes in heart rate (HR), arterial blood pressure, pulmonary artery wedge pressure, aortic blood flow, and cardiac output (CO) after dobutamine administration at different doses and infusion rates [2-7]. In fact, dobutamine is used commonly during anesthesia to treat hypotension [11] by increasing the mean arterial pressure (MAP) [1-3]. Moreover, dobutamine at low dosages produces a dose-dependent increase in CO and renal, splanchnic, coronary, and skeletal muscle blood flow [1,11].

Studies of conscious healthy horses have investigated echocardiographic and electrocardiographic changes during cardiac stress test induced by infusion of dobutamine at different dosages, used alone [12], or associated with atropine [9,10].

The purpose of this study was to evaluate changes in echocardiographic parameters during increasing infusion rates of dobutamine in isoflurane-anesthetized horses and to compare our results with those of previous studies.

2. Materials and Methods

The study protocol was approved by the ethics committee of the University of Pisa and transmitted to the Italian Ministry of Health (D.L. 116/92).

Six Standardbred female horses aged 8 $\pm$ 1.5 years old and weighing 468 $\pm$ 24 kg were included in this experimental protocol. The Department of Veterinary Sciences, Faculty of Veterinary Medicine of Pisa owned the horses. Horses were housed together in paddocks (75 $\times$ 75 m) with free access to hay and water and fed with grain twice daily. All the animals were considered healthy on the basis of physical examination of respiratory, cardiovascular, or musculoskeletal systems, thoracic ultrasound (US), and complete two-dimensional (2D) and M-mode echocardiography.

Food, but not water, was withheld after 8:00 PM of the day before the experimental study. A 13-gauge over-the-needle catheter was placed in the left jugular vein. Horses were premedicated with acepromazine (20 mcg/kg intravenous [IV]) 20 minutes before induction. In the induction box, detomidine (0.02 mg/kg IV) was administered 5 minutes before induction with ketamine (2 mg/kg IV) and diazepam (0.1 mg/kg IV). The trachea was intubated with a 26-mm cuffed endotracheal tube.

Subsequently, horses were transferred to an operating table in left lateral recumbency, and general anesthesia was maintained with isoflurane in oxygen, using a large animal anesthetic rebreathing system. The vaporizer was set to maintain an end tidal isoflurane (EtIso) concentration of 1.2%, which was eventually increased or decreased ($\pm$0.1%) in case of severe hypotension (MAP $<$ 50 mm Hg) or lightening of the anesthetic plane (strong palpebral reflex, blinking of the eye, nystagmus, or voluntary movements). Horses were mechanically ventilated with a fraction of inspired oxygen of 1 at 6 breaths per minute with a tidal volume of 5.5–6 L.

MAP was measured with a catheter percutaneously placed in the facial artery and connected by a three-way stopcock to a calibrated transducer (Transpac disposable pressure transducer; Hospira, IL) positioned at heart level and zeroed. Invasive blood pressure, HR, electrocardiogram, and EtIso were obtained from a calibrated multiparametrical monitor (Mindray Beneview T5, China) during the study period. The catheter for the aspiration of the air sample was introduced inside the endotracheal tube up to the tip of the tube in order to have an adequate sample corresponding to the alveolar content. No surgical procedure was carried out, and fluid therapy with saline solution at the infusion rate of 5 mL/kg/hr was administered during the study protocol.

When an EtIso of 1.2% was reached and maintained for 20 minutes, baseline values (T0) of HR, MAP, and echocardiographic measurements were obtained. Subsequently, dobutamine at constant rate infusion was infused intravenously at an initial rate of 2.5 mcg/kg/min, using an intravenous fluid pump (model 3500 syringe pump; Graseby, Hertfordshire, UK). After 20 minutes, the dosage rate of dobutamine was increased to 5 mcg/kg/min for an additional 20 minutes or until the appearance of ectopic beats. Finally the infusion rate was increased to 7.5 mcg/kg/min for the last 20 minutes or until the appearance of ectopic beats.

HR, MAP, and measurement of the different echocardiographic parameters were measured throughout general anesthesia and registered 15 minutes after the beginning of each dosage (T1, T2, and T3, respectively).

Echocardiographic measurements were performed from 2D and M-mode images obtained with a 3-MHz sector probe with a 2.5-MHz Doppler translator (Toshiba, Japan) by using recommended measurement techniques [13-15]. Images were recorded from the third to fifth intercostal spaces [16] with the horse in left lateral recumbency, because the operator could not scan beneath the operating table. Measurements, recorded with the M-mode technique, included interventricular septal dimension during diastole (IVSd, mm) and systole (IVSs, mm), left ventricular internal diameter during diastole (LVDd, mm) and systole (LVDs, mm). The left ventricular free wall (LVFW) was not measured because the US beam was not sufficient for an accurate measurement. The appropriate M-mode trace was obtained from the right parasternal short-axis view at the level of the chordae tendinae. When the left ventricle appeared as close to circular as possible, the M-mode cursor was placed across the major axis of the ventricle, between the chordae. Once an appropriate image was