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Myocardial Function of Horses Under Sedation with Romifidine Using Two-Dimensional Speckle Tracking

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ABSTRACT

Two-dimensional speckle tracking echocardiography (2DST) provides the assessment of the left ventricle deformation parameters strain (St) and strain rate (SR). The objective of this study was to evaluate St and SR under the influence of romifidine in healthy horses and horses affected with heart disease. The study subjects were 45 privately owned horses. Valvular insufficiencies were identified by color Doppler in 21 out of 45 horses. Dimensional changes were identified in 13 of these 21 horses. These dimensional changes included dilatations of the left ventricle (130 ± 8.95 mm) and/or the left atrium (141 ± 4.8 mm). The other 24 horses were without echocardiographic findings and had normal heart dimensions. Based on clinical signs, echo-, and electrocardiographic examinations, 24 horses were categorized as group 1 (healthy), 13 as group 2 (heart disease without dimensional changes), and 8 as group 3 (heart disease with dimensional changes). The radial St and SR were assessed in the left ventricular free wall and the interventricular septum using 2DST. After application of romifidine, a significant reduction of St and the systolic peak of SR were found in all three groups. Group 3 showed the most significant reduction of these parameters (41.5%). The reduction of St and SR under romifidine showed a reduced myocardial function, which is more obvious in horses with cardiac dilatation. It can be assumed that heart disease with myocardial dilatation leads to decreasing myocardial function, which becomes more obvious after romifidine application and of clinical importance in horses with severe heart disease and cardiac dilatation.

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1. Introduction

Alpha-2-adrenergic agonists are used in equine medicine for sedation and premedication for general anesthesia [1]. In addition to xylazine and detomidine, the imidazoline derivate romifidine is a part of this pharmacological group [2,3]. α_2 -Adrenoceptor agonists have sedative and analgesic effects, which accompany cardiovascular depression, including bradycardia, an initial increase of blood pressure

followed by hypotension and negative effects on heart function. These side effects on the cardiovascular system are considered the main disadvantage of these agents [4,5].

During the last few years, echocardiography (ECG) has become a well-accepted technique to evaluate cardiac function because of its wide range of indications and noninvasive nature [6]. Romifidine seems to affect myocardial contractility less than other α_2 -adrenoceptor agonists, such as detomidine. Sensitive diagnostic techniques are essential in two-dimensional echocardiography (2DE), motion mode (MM), and color Doppler ECG [7,8] to evaluate the myocardial function during romifidine sedation. Pulse wave-Tissue Doppler Imaging (PW-TDI) examinations revealed a significant decrease in left ventricular myocardial velocities after romifidine administration [9]. Besides TDI ECG, two-dimensional speckle tracking (2DST) ECG is highly

This study was performed at the Equine Clinic, Ludwig-Maximilian-University Munich, Germany and the Equine Clinic, Free University of Berlin, Germany.

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Table 1

Sex, age, height, and weight of the horses

Group	Mares	Geldings	Age (y)	Height (cm)	Body weight (kg)
Free of cardiovascular disease (1)	11	13	10 ± 4	167 ± 8	545 ± 66
Cardiovascular disease without dimensional changes (2)	2	11	14 ± 5	165 ± 8	544 ± 62
Cardiovascular disease with dimensional changes (3)	2	6	16 ± 4	165 ± 9	542 ± 59

regarded in human and veterinary cardiology [10,11]. Two-dimensional speckle tracking evaluates myocardial deformation and allows more objective evaluation of myocardial function than conventional 2DE and MM ECG [12]. Two-dimensional speckle tracking offers the advantage of analyzing the deformation parameters, strain (St) and strain rate (SR), without great affection of these parameters by global movements of the heart. The deformation parameter St (ϵ) is defined as the change of length of an object divided by its original length. Stretching or an increase of length leads to a positive St, whereas shortening leads to a negative St value. Strain rate is the change of St over a defined time interval ($\Delta\epsilon/\Delta t$) and is given in a unit of 1/s. Myocardial deformation or St is a three-dimensional parameter. Longitudinal and circumferential systolic increase of myocardial thickness (negative St) is accommodated by a positive St in the radial dimension [13–18]. Strain and SR measurements can be performed using Doppler technique or 2DST [16–19].

Two-dimensional speckle tracking allows the evaluation of tissue velocities and deformation of angle errors independently [16–21]; therefore, this technique has gained a high degree of acceptance.

Although 2DST has already been well accepted in small animal medicine as a reproducible method for the evaluation of radial St and SR that allows an accurate estimation of systolic function in dogs [22], only a few authors have reported on 2DST in equine medicine [7,23,24]. In the horse, higher reliability was found for radial measurements in comparison with circumferential values [6,10,11]. Studies on 2DST during sedation and general anesthesia of the horse have not been published so far. Therefore, it was the aim of this study to evaluate the myocardial function of horses before and under romifidine sedation using 2DST. In particular, horses with heart murmurs challenge the veterinarian, who cannot be sure about the definite effects of the sedative on myocardial function and possible following effects on the cardiovascular system. Therefore, in addition to healthy horses, individuals also affected by different heart diseases were included in this study.

2. Material and Methods

2.1. Animals

A total of 45 horses aged 4–23 years were included in this study. Their body weight varied between 390 and 650 kg and their height from 143–181 cm. In all, 30 geldings and 15 mares were examined that were mainly German Warmbloods (40 horses, Table 1). A clinical examination and a cardiovascular examination including standard echo- and electrocardiographic examinations were carried out on all horses. Afterward, the left ventricular myocardial function was evaluated using 2DST. This examination was

repeated after the application of the sedative romifidine. The sedation was performed for different reasons (i.e. operative premedication, endoscopic examination, and dental examination and/or therapy). All owners agreed to the additional cardiac examination before and after sedation. Ethical guidelines have been taken into account.

2.2. Enrollment Criteria

Inclusion criteria: Adult Horses were eligible for participation in the study provided that the owner had given informed consent.

Exclusion criteria: Horses were ineligible for inclusion in the study if they had clinical signs of lung disease or if they were affected by pathologic arrhythmias, such as atrial fibrillation.

2.3. Electrocardiographic Examination

An electrocardiographic examination (base-apex lead) was performed on all horses.

2.4. Echocardiographic Examination

Echocardiographic examinations were performed by one observer throughout the entire study period using a Vivid i echocardiograph (General Electric [GE] Healthcare; Medical Sy2DSTms Application Software 6.1.110, Sy2DSTm Software 1.36.18) with continuous base-apex ECG. A 3.5 MHz annular, phased-array probe (Vivid i, 3s-RS probe; GE Medical Sy2DSTms) with a maximum depth of 30 cm was used. Standardized right and left parasternal B-mode and color flow Doppler images were performed and recorded for the evaluation of cardiac dimensions and valvular functions.

Concerning 2DST, a right parasternal short-axis image of the left ventricle was acquired at the chordal level immediately below the mitral valve. A depth of 25 cm and an image angle of 65° were chosen. Using these presets, a frame rate of at least 63.3 fps was achieved. If the ventricle could not be completely visualized using a depth of 25 cm because of its size, the depth was increased and the image angle decreased to ensure a frame rate of 63.3 fps. At least three cardiac cycles in a row were recorded and stored for the following offline analysis using Echopac software (version 7.0; Firma GE Healthcare, Horton, Norway).

2.5. Application of the Sedative

The α_2 -adrenoceptor agonist romifidine (Sedivet; Boehringer Ingelheim, Germany) was given IV at a dosage of 0.04 mg/kg (1 mL = 10 mg romifidine hydrochloride). This dosage was chosen because it was the usual initial sedation dosage of romifidine we use in our clinic for

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