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The coexistence of heart murmurs and arrhythmias in an equine hospital population – a retrospective study

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Abstract: This study was performed to characterize the coexistence of valvar insufficiencies of the mitral, tricuspid, aortic, and pulmonary valves and their possible association with atrial fibrillation in an equine clinic population. During an 11-year period, 348 horses had been examined for cardiac arrhythmias and suspected defects of the cardiac valves at the Vetmeduni Vienna, Austria. The study population included 256 male and 92 female horses. A subpopulation of 197 (57%) horses was identified with at least one valvular disorder. In these horses, mitral valve regurgitation (MR) was reported in 124 animals (63%), aortic valve regurgitation (AR) in 101 (51%), tricuspid regurgitation (TR) in 78 (39.6%), and pulmonary regurgitation (PR) in 17 animals (8.6%). Cardiac arrhythmias were found in 130 horses (37%). The horse types that were most frequently affected by a putative valve insufficiency were the warmbloods, followed by thoroughbreds. The prevalence of insufficiencies (46%) was highest among animals between 6 and 18 years of age. There was a significant negative relationship between the occurrence of MR and AR, and AR was also significantly negatively associated with TR. Atrial fibrillation (AF) and MR coexisted most often (10 out of 38), followed by TR (8 out of 38). Although these findings were significant for the subgroup with cardiac arrhythmias, they were not significant in connection with the entire population with cardiac problems. The results of the present study showed that risk factors for being diagnosed with MR are horse type, age, and sex. MR most often occurs as an isolated defect in horses and seldom occurs in combination with AR. Additionally, MR and TR are associated with AF.

Key words: Analysis, arrhythmia, heart valve insufficiency, horse

1. Introduction

Equine cardiac disorders have been extensively reported. A detailed description of cardiological problems of 200 horses was first given by Holmes et al. [1]. Both functional and clinically relevant cardiac murmurs are common in horses as are arrhythmias [2–4]. Regarding sport horses, it is a challenge for the clinician to determine the impact of any cardiovascular abnormality on present and future performance, on rider or driver as well as horse safety, and to consider any long-term effects on health and longevity [5]. Despite the frequent occurrence of murmurs and arrhythmias, the prevalence of clinically important cardiac diseases is low [3,4]. The panel that produced the European College of Equine Internal Medicine (ECEIM) consensus statement [5–7] addressed the impact of audible heart murmurs on clinical decision-making and specifically recommends performing echocardiography in horses with grade 3-6/6 left-sided murmurs suggesting mitral regurgitation (MR) or aortic regurgitation (AR). Echocardiography is also necessary to work up cases with grade 4-6/6 right-sided systolic murmurs suggestive for tricuspid regurgitation (TR).

Mild valvular regurgitation is often detected in horses with soft murmurs, and seemingly does not affect performance or health [8]. Nevertheless, the loudness of the murmur should not be associated with severity per se [6]. Thus, there are sufficient reasons to perform an echogram in any horse with soft murmurs. Even the absence of audible murmurs may not exclude the necessity of echocardiography in horses with clinical signs suggesting cardiac disorders. For instance, regurgitation of the pulmonary valve can exist without any audible murmur [4,5].

Functional cardiac murmurs are caused by valvular regurgitation. Valves may be affected by degenerative processes or infective valvular lesions. Furthermore,

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abnormalities of valves, outflow tract or septum seen in congenital heart disorders cause murmers as well [4,9,10]. Although the prevalence of murmurs suggesting valvular regurgitations have been reported for various equine populations, information on the coexistence of insufficiencies of valves at more than one anatomic site is scarce. MR and AR are the most frequently reported [11,12] in warmblood horses, whereas in trained thoroughbreds TR is most frequently observed [2,13,14]. Pulmonary regurgitation (PR), although not or only poorly audible [12], has a low prevalence and is considered to occur secondary to pulmonary hypertension [5].

We hypothesized that valvar regurgitation in our clinic population of horses with cardiac problems is associated with horse type, age, and sex and occur most often in isolation, rather than in combination with various other valve insufficiencies. We also hypothesized that valvular insufficiency is associated with atrial fibrillation (AF). AF may develop secondary to mitral valve regurgitation, eventually leading to atrial dilatation and finally to congestive heart failure CHF [3,5,9,12].

Although some risk factors for cardiac diseases and valvular defect are well described for different horse populations [12], specifications of coexistence of insufficiencies of various valves have not been explored extensively in large populations. We determined the characteristics of the coexistence of regurgitation of one valve with one or more insufficiencies of other valves as well as the association with arrhythmias.

2. Materials and methods

2.1. Study population

An electronic database including all internal medicine equine cases covering an 11 year-interval was searched for diagnoses of cardiac disease. Animals had been referred to the clinic for suspected cardiac problems or were diagnosed with a cardiac problem in the course of diagnosing another disorder. A total of 357 cases were found, but only the data of 348 patients were suitable for first analysis. Many horses were diagnosed with more than one cardiac disorder. The diagnoses made in these 348 cases are given in Tables 1–3. Data was transferred to an Excel spreadsheet. Independent variables such as sex, age, and use were included. Based on empirical conventions, ages of the horses were divided into one of the following 4 categories: juvenile, 0–3 years; young adult, 3–6 years; adult, 6–18 years; and geriatric, 18–33 years.

For analysis of horse type, breeds were clustered in five major groups: the thoroughbred-like cluster with trotters, quarter horse, Arabs, and thoroughbreds; the warmblood cluster including all European saddle horse breeds; the cold blood cluster including Noriker, Haflinger and the cold bloods from North–West Europe; the pony cluster including animals with a wither's height less than 1.48 m, and the Baroque horse cluster including Friesians, Lipizzaner, Kladrubers, Andalusians, and Lusitanos.

The sex was limited to male and female, without further separation of stallions and geldings.

Table 1. Valvular and endocardial disorders.

Disorders	N
Aorticvalve regurgitation	102
Aortic valve stenosis	1
Chronic endocarditis	1
Infective endocarditis	2
Mitral cusp prolapse	1
Mitral valve regurgitation	76
Pulmonic valve regurgitation	6
Torn aortic cusp	1
Tricuspid valve regurgitation	33
Total	223

Table 2. Arrythmias.

Arrythmias	**N**
Atrial fibrillation	51
Atrial flutter	2
Complete AV block	1
Multifocal PVCs	11
Premature ventricular complex	23
Supraventricular premature beats	22
Ventricular tachycardia	11
Wolff–Parkinson–White pattern	1
Second-degree AV block	50
Sinoatrial block	7
Sinus arrhythmia	24
Total	203

2.2. Clinical and additional cardiologic examination

A general clinical examination according to standard procedures was performed prior to an advanced cardiological exam [15]. Thorax auscultation was performed by experienced clinicians and under direct supervision of an ECEIM specialist (RvdH). Technique and interpretation of auscultation was according to Young et al. [8]. Further characterization of detected murmurs was by color flow Doppler echocardiographic technique and interpretation was according to Blissitt and Bonagura

Table 3. Congenital and general pathologies.

Congenital and general pathologies	N
Atrial septal defect	1
Common truncus arteriosis	1
Cardiac insufficiency	1
Cardiomyopathy	2
Cor pulmonale	2
Muscular ventricular septum defect	1
Myocardial disease	3
Perimembranous septal defect	7
Pulmonary hypertension	1
Right heart failure	1
Tetralogy of Fallot	1
Total	21

[16] and Young et al. [8]. Regurgitation was defined as positive when a retrograde jet was present on three or more consecutive frames from any echocardiographic imaging plane. Signals of very short duration detected only at the time of valve closure were not regarded as positive. Additionally, simultaneous electrocardiogram was obtained during cardiologic evaluations via the base apex lead.

2.3. Statistical analysis

Data capture was recorded in worksheets of Microsoft® Excel® 2007 for Windows. Statistical analysis was performed using SPSS IBM® (version 19) software. Data are presented by descriptive statistics, and for inferral statistics chi-square tests were used. The level of significance was set to $P < 0.05$.

3. Results

The study population (n = 348) included 256 males and 92 females. The cardiac disorders presented in this population is given in Tables 1–3. Horse types that were most frequently affected by cardiac problems were of warmblood followed by thoroughbred (Table 4). Ten percent of the population was juvenile, 20% adolescent, 46% adult, and 24% were of geriatric age; thus, the prevalence of cardiac disorders appear highest among animals between 6 and 18 years of age.

Clinical and cardio-echographic examinations and even necropsy in some cases identified a set of 21 horses with diverse cardiac pathologies (Table 3) that were not suitable for further analysis. Valvular disorders were diagnosed in 223 cases, but suitable data for analysis were only in a subpopulation of 197 (57%) horses with at least one valvular disorder. In these horses, mitral valve regurgitation

Table 4. Distribution of horse types with cardiac disorders.

	Numbers	% of total
Thoroughbred type	78	22
Warmblood type	220	63
Cold blood type	17	5
Pony type	20	6
Baroque horse type	13	4
Total	348	100

(MR) was reported in 124 animals (63%), aortic valve regurgitation (AR) in 101 (51%), tricuspid regurgitation (TR) in 78 (39.6%), and pulmonary valve regurgitation (PR) in 17 animals (8.6%). The distribution of the affected valves in these horses is given in Table 5. One single valvular system was affected in 105 horses, while more valvular systems were affected in 90 horses. Data from 2 horses with concurrent ventricular septal defect were excluded. The risk to suffer from an additional valvular disorder, expressed as odds ratio is given in Table 6.

Cardiac arrhythmias were found in 130 horses (37%). AF was diagnosed in 38 (29%) of these horses, while 38 (29%) horses had a grade II AV block, the rest of the horses showed sinus arrhythmia or extrasystoles. Subpopulations with murmurs and with arrhythmias overlapped. Isolated MR occurred in 44 animals and isolated AR in 42, TR in 16, and PR in only 3 horses. In the remaining 25 horses, a combination of up to 4 insufficient valves was seen.

Mitral regurgitation was most frequently seen in combination with TR. These insufficiencies were present both with and without being accompanied by AR. However, no significant connection could be shown between the occurrence of MR and TR, although the OR suggests a 1.5-fold higher chance on TR than on a healthy valve in horses suffering MR. There was a significant negative relationship between the presence of MR and the coexistence of AR; thus, a horse with a MR has a more than 2-fold smaller chance to have AR than to have a healthy valve. The coexistence of AR and PR was significant and a horse with an AR has a 2–3-fold greater chance of having also a PR than having a healthy valve. AR was significantly negatively associated with TR. A horse with AR has a 2-fold smaller chance to suffer from a coexisting TR than having a healthy valve. The most frequent coexistence between AF and a valve disorder was for MR (10 out of 38), followed by the TR (8 out of 38). Findings were significant for the subgroup with cardiac arrhythmias, but were not significant in connection with the entire study population of 348 horses.

Table 5. Distribution of affected valves and coexistence of more valvular disorders per individual (n=195).

Number of horses	Valvular lesion			
6	MR	TR	AR	PR
17	MR	TR	AR	
0	MR	TR		PR
30	MR	TR		
2	MR		AR	PR
25	MR	TR	AR	
0	MR			PR
44	MR			
4		TR	AR	PR
4		TR	AR	
1		TR		PR
16		TR		
1			AR	PR
42			AR	
3				PR

MR: Mitral valve regurgitation, TR: Tricuspid regurgitation, AR: Aortic valve regurgitation, PR: Pulmonary regurgitation.

Table 6. Odds ratios (and 95% CI) for coexisting valvular disorders**.**

AR	TR	PR
0.29 (0.16–0.54)*	1.43 (0.79–2.61)	not detected
	0.46 (0.26–0.83)	3.40 (1.07–10.8)

4. Discussion

Reported risk factors for heart valve disease are race, age, and sex [12]. Due to the absence of a paired healthy control population in our study, we could not further substantiate this for our population. Nevertheless, our results are in line with those of Leroux et al. [12] regarding the distribution of cardiac problems per horse type in a common population of a European equine university clinic. Regarding age, we observed the most cardiac cases within the mature group (6–18 years), which agrees with the results of Leroux et al. [12] and Gehlen et al. [17]. Warmblood- and thoroughbred-type horses appear to have an increased risk of being diagnosed with valvular disorders. Similar results were reported by Reef et al. [5], and Young et al. [8] also confirmed that there is a high prevalence of valvular regurgitation in thoroughbred race horses. Since both thoroughbred type horses and warmbloods are used as performance horses and thus likely will be quickly referred to diagnostic centers, results are biased. The limitations of the present study are that data analyzed in this study have been collected over 11 years which might have caused some bias in the exactness of diagnosis due to ever improving diagnostic methods. However, despite all limitations, it is very likely that there is a negative association between MR and AR. Thus, there is only a small chance that both MR and AR occur at the same time in the same horse. Besides, AR and TR are also very unlikely to occur in the same horse. In contrast, a horse with AR has a fair chance to simultaneously have PR. The other valvular insufficiencies appear to occur rather independently from each other, or at best they reduce the chance of the occurrence of another failure. In some studies, AR is the most prevalent finding [12]. Gehlen et al. [18] found MR to be the most common disorder in a population of mainly warmblood horses. This agrees with our findings. Furthermore, Gehlen et al. [19] found that AR was second in prevalence, which also agrees with our findings as do the lower prevalence of TR and PR, and results obtained by Reef et al. [7] and Stevens et al. [11] also support our results. The comparison of prevalence between various studies is compromised because different populations were sampled, but the magnitude of prevalence from most common to least common valvular disorder is equal for most studies. There are few comparable studies which report the chances for a horse with a valvular regurgitation to suffer from an additional one at another valve. The most common combinations of murmurs in our study were of the mitral and tricuspid valves. Occasionally, the aortic valve was also included. Similar results were obtained by Gehlen et al. [17]. Regarrding arrythmia, we found a prevalence of 0.11 for AF and 0.11 for AV Blocks grade II, which is in line with results obtained by Reef et al. [5], who reported that the most common cause of arrhythmia is the AF. Holmes et al. [1] estimated the prevalence in a large population to be 0.02. Interestingly, in Holmes' population, coldblood horses were affected more often than warmbloods. Gehlen et al. [18] reported a prevalence of 0.24 in a hospital population mainly of warmblood horses, which agrees with our prevalence pattern. AV Block grade II is one of the most common ECG abnormalities. Reef [6] and Holmes [20] also reported that the prevalence of second-degree AV Block grade II is around 15% to 40% in the equine population. The result of AV Block grade II in the present study is consistent with those obtained by Reef [6] and Holmes [20].

5. Conclusion

In conclusion, there is a positive relation between AF and MR, as is between AF and TR. The prevalence

of the combination of MR and AF is 0.03 and for the combination AF and TV insufficiency it is 0.02 in the entire study population. In conclusion, MR is related to the breed, age, and sex, and also MV most often occurs as an isolated defect in a clinic population of horses. Furthermore, valvular insufficiency is associated with cardiac arrhythmias, such as AF. MR or TR is likely to be found in horses suffering from AF.

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