

Physiologic flow murmurs are murmurs associated with normal blood flow through the heart and great vessels. Physiological flow murmurs over the aorta and pulmonary artery have been detected in a large percentage of horses and may be difficult to distinguish from murmurs of valvular regurgitation or from murmurs associated with other cardiac disease. The advent of echocardiography has enabled the veterinarian to precisely determine the cause of the murmurs and their significance.

Murmur Characteristics

Careful auscultation of each horse should be performed and the murmur(s) detected described in terms of their timing, duration, intensity, quality, pitch, shape, point of maximal intensity (PMI) and radiation. These characteristics of the murmur will help to distinguish the physiological flow murmur from the murmur associated with cardiac disease. The murmur's characteristics are particularly helpful in distinguishing a functional murmur from a murmur of valvular insufficiency when the murmur is of lower intensity. These findings will determine when echocardiographic evaluation is indicated to help determine the significance of the murmur detected. The phase of the cardiac cycle (systolic, diastolic or continuous) occupied by the murmur is its timing. The duration is the length of time the murmur is detectable during the cardiac cycle (early, mid, late, holo or pan systolic or diastolic). The murmur's intensity, 1-6/6, is determined by the blood flow through the murmur's origin (quantity and velocity), its distance from the stethoscope and the acoustic properties of the thoracic wall. The radiation of the murmur is usually from the murmur's origin in the direction of abnormal blood flow. The murmur's radiation is also determined by the murmur's intensity and physical characteristics of the chest. The shape of the murmur auscultated is determined by the phonocardiographic depiction of the intensity of the murmur over time. The quality of the murmur is harsh, coarse, rumbling, scratchy, musical, honking or blowing and may be high, medium or low pitched. Musical or honking murmurs are usually created by the vibration of an intracardiac structure such as a valve leaflet or chordae tendineae and have a narrow frequency range while harsh murmurs are usually mixed high and medium frequency murmurs.

Physiological Flow Murmurs

The systolic physiological flow murmur is a low intensity (grade 1-3/6) murmur that occurs in early, mid or late systole or is a holosystolic ejection murmur. The murmur has its point of maximal intensity over the aortic (usually) or pulmonic valve with little or no radiation of the murmur. The murmur is usually low frequency and crescendo-decrescendo in quality, often described as soft and blowing. These murmurs are generated by ejection of blood through the great vessels (aorta and pulmonary artery) during systole and are common in horses because of their large diameter great vessels. The larger the diameter of the vessel, the more likely that flow through the vessel will be nonlaminar. Increased blood flow velocity and decreased blood viscosity also will increase the likelihood that nonlaminar blood flow will occur. Physiological systolic murmurs typically become more intense after exercise, although in some horses they are not detectable after exercise. Functional systolic murmurs also occur in horses with severe anemia or fever. In contrast, most murmurs associated with cardiac disease change little with excitement or exercise.

Early or late diastolic murmurs are physiologic but not murmurs that occur throughout diastole. These murmurs are decrescendo or squeaky, low intensity (grade 3/6 or less), with their point of maximal intensity over the aortic valve area. Early diastolic murmurs are more frequently ausculted in racehorses than in other types of performance horses and are more common in younger horses.

Mitral Regurgitation

Mitral regurgitation murmurs are usually harsh, plateau (band) shaped, > grade 3/6 (but can be a grade 1-2/6), holosystolic or pansystolic with their point of maximal intensity at the left atrioventricular valve area radiating dorsally and cranially or caudally.

Mitral valve prolapse usually produces crescendo mid to late systolic murmurs while honking or harmonic musical systolic murmurs are found in horses with ruptured chordae tendineae. Mid or late systolic clicks may also occasionally be heard in horses with mitral valve prolapse. The loud crescendo mid to late or holosystolic murmur detected in colicky horses is usually associated with mitral valve prolapse and volume depletion. This murmur usually resolves or improves significantly with correction of the colic.

There is no direct correlation between the intensity of the systolic murmur and the severity of the mitral regurgitation present. Murmurs of mitral regurgitation have also been reported to increase in prevalence and intensity in horses in race training. In general, however, murmurs of mitral valve prolapse that are crescendo in quality and only present in mid to late systole have only mild mitral regurgitation associated with them and tend not to progress or the amount of mitral regurgitation increases very slowly over many years. The pansystolic band shaped mitral regurgitation murmurs that are grade \geq 4/6 are usually associated with significant mitral regurgitation (at least moderate). Murmurs of mitral regurgitation often become softer as the mitral regurgitation becomes more severe. An echocardiogram is always indicated in all horses with a grade 4-6/6 holosystolic or pansystolic murmur is detected, when the murmur is band shaped and holosystolic or pansystolic (regardless of its intensity), when the horse is in atrial fibrillation, when there are clinical signs of cardiovascular disease or when the horse has poor performance or respiratory signs consistent with lower airway disease. The valvular insufficiency most likely to cause clinical signs is mitral regurgitation. Once the mitral regurgitation becomes hemodynamically significant, it is likely to affect performance particularly for more rigorous types of athletic endeavor.

Tricuspid Regurgitation

Murmurs of tricuspid regurgitation are common systolic murmurs, particularly in Standardbred racehorses and National Hunt horses. These murmurs are usually holosystolic or pansystolic; plateau (band) shaped; grade 2/6 or louder; coarse or blowing in quality; with their point of maximal intensity at the right atrioventricular valve area radiating dorsally. Murmurs of tricuspid valve prolapse are usually mid to late systolic and crescendo in shape but are otherwise similar. Tricuspid regurgitation murmurs are also occasionally ausculted in the left second intercostal space. Murmurs of tricuspid regurgitation also increase in prevalence in young Thoroughbreds in training and the intensity of the murmurs also increase. An echocardiogram is always indicated in horses with a right sided systolic murmur when the murmur is grade 4-6/6 and holosystolic or pansystolic, when the horse is in atrial fibrillation, when there is a murmur of pulmonic stenosis present, when there is a murmur of mitral regurgitation present, when the horse has clinical signs of cardiovascular disease and when the horse has poor performance or has respiratory signs consistent with lower airway disease. Tricuspid regurgitation, although very common in horses, is usually clinically insignificant.

Ventricular Septal Defect

Ventricular septal defects (VSDs) are the most common congenital heart defects in horses and most are located in the membranous portion of the interventricular septum. The characteristic murmur is a grade \geq 3/6 harsh bandshaped pansystolic murmur with the point of maximal intensity in the tricuspid valve area. This murmur usually has a precordial thrill in the tricuspid valve area when the defect is located in the inflow portion of the interventricular septum. An ejection murmur (crescendo-decrescendo) with its point of maximal intensity over the pulmonic valve area is usually detected which is one grade softer. The loudest murmur is caused by the left to right shunt through the VSD just underneath the septal leaflet of the tricuspid valve (typical location of the most common perimembranous VSD). The slightly softer ejection murmur with the PMI at the pulmonic valve area is caused by increased blood flow through a normal pulmonic valve (relative pulmonic stenosis). If the VSD is located in the right ventricular outlet portion of the interventricular septum, the pulmonic stenosis murmur is usually louder than the murmur in the right 3rd to 4th intercostal space.

Aortic Regurgitation

Murmurs of aortic regurgitation are holodiastolic, range from grade 1-6/6 and are usually decrescendo or musical. These murmurs are loudest in the aortic valve area and radiate towards the cardiac apex. The quality of the horse's arterial pulses (bounding) is a good indication of the hemodynamic significance of the aortic regurgitation. An echocardiogram is always indicated in horses with a diastolic murmur when the arterial pulses are bounding, when the horse is in atrial fibrillation, when the horse has ventricular premature beats, when there is a VSD murmur present, when there is a murmur of mitral regurgitation present, when the horse has clinical signs of cardiovascular disease and when the horse has poor performance or has respiratory signs consistent with lower airway disease.

Aortic Cardiac Fistula

The murmur associated with an aorticocardiac fistula is usually grade 4-6/6 (although can be lower in intensity), is continuous and machinery or musical with its point of maximal intensity on the right side of the chest in the tricuspid valve area. This murmur usually radiates apically on the right as well as cranially on the left and out the aorta. An echocardiogram is always indicated in a horse with a continuous machinery murmur that is older than 96 hours.

Myocardial Disease

Cardiac auscultation may be normal or cardiac arrhythmias or murmurs of valvular regurgitation may be detected. Frequent atrial or ventricular extrasystoles, sustained atrial or ventricular tachycardia or multifocal arrhythmias are usually indicative of primary myocardial disease. Resting heart rates in horses with myocardial disease may be normal or elevated but affected animals usually have elevated exercising heart rates and prolonged heart rate recovery after exercise.

Pericardial Disease

Cardiac auscultation usually reveals tachycardia, muffled heart sounds and/or pericardial friction rubs and absent lung sounds in the ventral portion of the thorax. Pericardial friction rubs are usually triphasic but can be biphasic or monophasic. In some horses with little pericardial effusion, the pericardial friction rubs can mimic a cardiac murmur and have a palpable precordial thrill.

Cardiac Arrhythmias

Cardiac arrhythmias are categorized by their origin, above or below the ventricle and by their rate. Most bradyarrhythmias are associated with high vagal tone and are normal findings in the horse. Most tachyarrhythmias other than sinus tachycardia are abnormal. An electrocardiogram is needed to definitively diagnose the arrhythmia and to determine if treatment is needed.

Second degree A-V block

Second degree A-V block is the most common vagally mediated arrhythmia. Horses with second degree A-V block have a slow to normal heart rate (usually 20 - 40 beats/minute) but can occur at higher heart rates in the immediate post exercise period. The first (S1) and second (S2) heart sounds are regularly spaced and a fourth (S4) heart sound precedes each S1. S4 is also present in the diastolic pause during the period of second degree A-V block. Excitement, exercise or the administration of a vagolytic or sympathomimetic drug should result in the horse developing a sinus tachycardia.

Sinus bradycardia and sinus arrhythmia

Sinus bradycardia and sinus arrhythmia occur infrequently in normal fit horses associated with high vagal tone. Sinus arrhythmia is usually also present in horses with sinus bradycardia with heart rates of 20 - 30 beats/minute. Auscultation reveals regular first (S1) and second (S2) heart sounds with rhythmic variation of diastolic intervals. The diastolic pause is equal to the number of beats blocked at the sino-atrial node. These rhythms should disappear with exercise or the administration of a vagolytic or sympathomimetic drug.

Supraventricular premature depolarizations

Supraventricular premature depolarizations are common in horses at rest and in the immediate post exercise period, associated with the high autonomic imbalance that occurs at this time. Supraventricular premature depolarizations are often clinically insignificant but may be associated with exercise intolerance. Auscultation reveals a regular rhythm (most common) interrupted by a premature beat that is usually fully intercalated (there is continuation of the regular sinus rhythm following the supraventricular premature contraction). Occasionally, there may be a pause in the rhythm if the next sinus signal is blocked or the sinus rhythm is reset. The fourth heart sound associated with the supraventricular premature depolarization may be auscultable if the PR interval equals or exceeds 280 msec. The intensity of the heart sounds associated with the supraventricular premature depolarization is usually normal.

Atrial tachycardia

Sustained atrial tachycardia is often associated with frequent second degree A-V block. Atrial rates of 120-300 beats/minute occur in resting horses with sustained atrial tachycardia with much slower ventricular rates. Sustained atrial tachycardia is most commonly detected during treatment of horses for atrial fibrillation with quinidine sulfate.

Atrial fibrillation

Horses with atrial fibrillation usually have normal resting heart rates (28 - 44 beats/minute), although the rhythm is irregularly irregular and no fourth heart sound (S4) is produced. The intensity of the peripheral arterial pulses is also irregularly irregular. Pulse deficits may be present, particularly in horses with two conducted beats occurring in rapid succession.

Ventricular premature depolarizations

A premature depolarization, followed by a compensatory pause is most frequently ausculted in horses with ventricular premature depolarizations. The compensatory pause occurs because the next sinus impulse is usually blocked by the ventricular premature depolarization. Interpolated ventricular premature depolarizations occur if the sinus rate is slow or the ventricular premature depolarization is closely coupled to the preceding normal sinus beat. The premature ventricular depolarization often has a loud first heart sound and a softer second heart sound. A pulse deficit occurs associated with the ventricular premature depolarization if the coupling interval is short.

Ventricular tachycardia

Auscultation reveals a rapid regular rhythm if uniform ventricular tachycardia is present and an irregular rhythm if the ventricular tachycardia is multiform. Heart sounds are loud and their intensity varies. Loud booming heart sounds ("bruit de cannon") is detected in some horses associated with the simultaneous production of 2 heart sounds during periods of atrioventricular dissociation. The heart rate (ventricular rate) in horses with ventricular tachycardia is usually elevated (> 60 beats/minute) with a slower independent atrial rate. Jugular pulsations occur in association with the atrioventricular dissociation.