Ventricular Parasystole in a Racing Thoroughbred: A Case Report

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Intermittent ventricular parasystole was observed in a racing Thoroughbred filly. Electrocardiograms showed a marked variation in the coupling of ectopic beats and the regular appearance of ectopic beats. The electrocardiographic tracings recorded during exercise, revealed that ectopic beats appeared at walking, and trotting, except for canter. The etiology of arrhythmia was briefly discussed.

Parasystole is an arrhythmia in which a regular sinus rhythm is complicated with regularly recurring ectopic beats that compete with the sinus rhythm for the stimulation of the ventricles. The definition of the parasystole is somewhat different from one investigator to another. In 1964, SCHMROTH presented a paper concerning the definition of parasystole. He analyzed the properties of the protective mechanism in parasystole and defined arrhythmia in terms of these properties in the following manner: Arrhythmia is a dual rhythm in which (a) two pacemakers concurrently and independently contribute to the rhythm of the heart; (b) the ectopic pacemaker is protected from the impulses of the other pacemaker. Such protection is situated within, or in the immediate vicinity of, the ectopic pacemaker and appears throughout the whole phases of the ectopic cycle; i.e., the refractory phase and the apparently non-refractory phase.

Parasystole is recognized by the following three electrocardiographic signs: (1) Marked variation in the coupling of the ectopic beats; (2) the regular appearance of the ectopic beats; and (3) the appearance of combination, fusion, or summation beats (mixed systoles). In human beings, parasystole is not an infrequent arrhythmia, but is closely correlated with the presence of heart disease. KATZ and PICK found 153 instances of parasystole in 100,000 electrocardiograms of 50,000 consecutive patients. On the contrary, reports on this phenomenon found in domestic animals are quite rare. Examining a total of 3,000 dogs, PATTERSON et al. found 4 instances of ventricular parasystole in...
95 dogs affected with spontaneous abnormal arrhythmia and conduction disturbances. In horses, BROOIJMANS\(^5\) may probably be the first author to report the occurrence of intermittent parasystole with simple interference in a horse manifesting atrial fibrillation. Since then, literature dealing with equine parasystole is scanty. In this paper, the authors present a recently observed case in a racing Thoroughbred horse which may be regarded as intermittent ventricular parasystole.

**Case Report**

**Subject:** A racing Thoroughbred filly born in 1965 (Prot. No. H67-1).

Since the beginning of 3 years of age*, the filly had been repeating catarrhal laryngitis and catarrhal bronchitis. A practicing veterinarian happened to detect an intermittent pulse and edema at the four limbs at the time of routine physical examination in early June, 1967. Then the filly received digitalis powder in two courses by the oral route. The first course of digitalization consisted of a total dose of 6 g and was administered on 3 separate days. The second course was composed of a total 10 g and administered two weeks later on 3 separate days. On July 12, 1967, the filly was examined for irregular pulse at the Veterinary Clinic of the Hanshin Race Course. Physical examination revealed no significant abnormalities in the general conditions, except irregular pulse. In order to clarify the real condition of the irregular pulse, the filly underwent an electrocardiographic examination. As the conventional electrocardiograph was broken down at that time, the electrocardiogram was temporarily recorded by a radiotelemeter during exercise. The filly was subjected to exercise in the order of 1,600-meter warming-up trotting, 2,400-meter canter, and 300-meter cooling-off walking on a training track. Electrocardiograms were continuously recorded throughout exercise and recovery. Tracing at rest was a failure because the filly became temperamental in examination. Tracings conducted in warming-up trotting, canter, cooling-off walking, and recovery are shown in Fig. 1. A diagram of heart beats per 10 seconds during the exercise examination is presented in Fig. 2.

In electrocardiographic tracing at the time of warming-up trotting (A in Fig. 1), two types of ventricular complexes were seen. The one type was a QRS of [QS] type, being sinus beats. The other type (indicated by vertical arrows) was a QRS of [RS] type, showed a somewhat prolonged duration, being ectopic ventricular beats. All ectopic beats appeared with a relatively fixed coupling time (ranging from 50 to 60\(**\)) and with fully compensatory pauses. Furthermore every third ventricular beat was an ectopic beat with relatively regular interectopic intervals (ranging from 177 to 189 with an average of 183). These findings indicate the presence of ventricular trigeminy. In electrocardiographic tracings at the time of canter and cooling-off walking (B and C in Fig. 1), no ectopic beats appeared. During the recovery period after the exercise, however, electrocardiographic tracing showed ectopic beats which had longer interectopic intervals than during warming-up trotting, being multiples of 216. The coupling times of the ectopic beats showed a relatively fixed time of 62, 67, and 59, respectively. These findings suggest that the ectopic beats may have originated from the ventricular parasystolic focus. It may perhaps be better to interpret ectopic beats as fixed ventricular premature beats. As shown in Fig. 2, the ectopic beats appeared sporadically in the electrocardiographic tracings at rest are shown in Fig. 3. A basic sinus rhythm showed cycle length ranging

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\* In this paper, the age of the horse is counted in the Japanese way; that is, the fraction of a year is counted as one full year.

\** All time intervals are expressed in hundredths of a second; for example, 50 represents 0.50 second.
The coupling intervals of the ectopic beats varied a little, or from 123 to 136. The spacing of the ectopic beats resulted in both short and long interectopic intervals. The shorter interectopic intervals showed a relatively wide variation, ranging from 167 to 281 with an average of 209. The interectopic intervals of the consecutively appearing ectopic beats which could be observed on the bottom strip showed a relatively closed variation, ranging from 167 to 209. The long interectopic intervals were about two times as long as the interectopic interval. The ectopic rhythm was dominant over the greater part of the tracing. As shown in the bottom strip of Fig. 3, although the ectopic rate was slower than the sinus rate, ectopic beats appeared consecutively, and only three sinus beats were recognized in a total of eleven

Fig. 1. Electrocardiogram during exercise, recorded on July 12, 1967

The lead system used was a bipolar chest lead (a positive electrode was placed at one hand-breadth behind the posterior edge of the girth in the median line over the xiphoid cartilage, and a negative electrode at a point on the left shoulder).

These strips are not continuous. A is tracing at the time of warming-up trotting, B of canter, C of cooling-off walking, and D at recovery. Vertical arrows above electrocardiographic tracing indicate ectopic beats. The number above the electrocardiographic tracing indicates the coupling time of the ectopic beats to the preceding sinus beats. The number below the tracing indicates the interectopic interval. All time values are expressed by the hundredth of a second. For full explanation see the text.
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Fig. 3. Electrocardiogram at rest, recorded on December 15, 1967

Electrocardiogram was recorded from the same lead as used in Fig. 1 by means of a radiotelemeter. The strips are continuous. The abbreviations used the diagram are as follows: A, atrial level; A-V, atrioventricular nodal level; V, ventricular level; and E, ectopic focus. Time intervals are expressed in hundredths of a second. Vertical arrows above the electrocardiographic tracing indicate ectopic beats. For full explanation see the text.

Fig. 4. Electrocardiogram at rest, recorded on September 18, 1968

Electrocardiogram was recorded from lead A-B (a positive electrode was placed at a point in the left apex region and a negative electrode at a point on the left shoulder) with a conventional electrocardiograph. The strips are continuous. The abbreviations in the diagrams are the same as shown in Fig. 3. For full explanation see the text.
ventricular beats.

Nine months later, or on September 18, 1968, the third electrocardiographic examination was carried out. Electrocardiographic tracing at rest is shown in Fig. 4. Two types of ventricular complexes were observed as presented in Fig. 3. The ectopic beat in Fig. 4 has an [Rs] type against that in Fig. 3 which has an [RS] type. Both ectopic beats of the two types may be considered to be originated from the same focus, because the electrocardiographic lead system used for each tracing were somewhat different. Both normal sinus beat and abnormal ectopic beat were measured electrocardiographically. Their values are shown in Table 1. The durations of QRS, QT, and RR intervals in the ectopic beat were a little longer than those in the sinus beat. Both activation and recovery of the ventricles in the ectopic beat were prolonged, and the interectopic cycle lengths were a little longer than the sinus cycle lengths. A basic sinus rhythm showed a cycle length ranging from 132 to 178. Variations in the coupling time of the ectopic beats were evident to the naked eye. The spacing of the ectopic beats resulted in both short and long interectopic intervals, as shown in Fig. 3. The shorter interectopic intervals showed a relatively wide variation, ranging from 182 to 309. The ectopic cycle lengths, measured from the consecutively appearing ectopic beats alone (presented in the bottom strip), ranged from 182 to 190 and showed a close grouping around the mean of 186. The longer interectopic intervals showed a wide variation, ranging from 372 to 640. Each of these interectopic beats was considered to be multiples of a certain ectopic cycle length. Consequently, the assumed interectopic cycle lengths contained in the longer interectopic intervals ranged from 205 to 219. These values were a little greater than those of the ectopic cycle lengths in the consecutively appearing ectopic beats. A further interpretation based on the electrocardiogram is the appearance of partial atrioventricular block with dropped beats. The atrioventricular block with dropped beats makes the arrhythmia more complicated.

The finding obtained from Figs. 3 and 4 indicate the presence of a ventricular parasystole.

On the same day, electrocardiograms during exercise were also recorded. The filly was subjected to exercise in almost the same manner as in the previous telemetric examination. Electrocardiograms in each type of gait during exercise are presented in Fig. 5. The diagram of heart beats per 10 seconds during the exercise examination is given in Fig. 6. As shown in Figs. 5 and 6, ectopic beats appeared in tracing at the time of all types of gait, except canter. Ectopic beats were not once recorded in the entire tracing at the time of canter. Both the coupling time of the ectopic beats and the interectopic intervals varied widely.

The fourth electrocardiographic examination was carried out on September 27, 1968. Electrocardiographic tracings at rest are shown in Fig. 7. The ectopic beat has the same QRS complex as observed in Fig. 4. The entire electrocardiographic tracing revealed that the ectopic beats had a tendency to recur after a series of sinus beats. The first
Comment

The filly was diagnosed as a case of parasystole on the basis of the following two electrocardiographic signs: (1) marked variation in the coupling of ectopic beats, and (2) the regular appearance of ectopic beats.

In the first electrocardiographic examination, the ectopic beats in tracing at the time of warming-up trotting and of recovery had a fixed coupling time and the ectopic beats in tracing at the time of warming-up trotting presented ventricular trigeminy. Therefore, the ectopic beats may be considered to indicate ventricular premature beats with...
a fixed coupling time rather than ventricular parasystole. In ventricular parasystole, since two impulses from the sinus node and parasystolic focus, respectively, are initiated independently from each other, the coupling could not be fixed and would vary continuously. However, as later electrocardiographic examinations (Figs. 3 and 4) showed the presence of almost the same interectopic cycle length, there is a suspicion that the ectopic beats may have originated from the parasystolic focus in the ventricles.

In the second, third, and fourth electrocardiographic examinations, electrocardiograms exhibited a marked variation in the coupling of ectopic beats and the appearance of regular ectopic beats (Figs. 3, 4, and 7). However, the fusion beats, the occurrence of which is one of the three electrocardiographic criteria for the identification of parasystole, were not observed at all in any of the electrocardiographic examinations. In parasystole, since two centers independent from each other send out impulses, both the ectopic and the sinus impulses will occasionally spread over the heart simultaneously. Under these conditions each impulse will activate a part of the ventricles, leading to the appearance of a mixed ventricular complex which is known as a combination, summation, or fusion beat. In the present case, all the three criteria for the identification of parasystole were not satisfied. However, since the electrocardiographic findings obtained are considered to satisfy the definition of parasystole given by Schamroth, the arrhythmia of the present case may be said to be parasystole.

In the present case, the ectopic beats had a tendency to appear without being interrupted by sinus beats, as observed especially in Fig. 7. Accordingly, it is assumed to be difficult for both the ectopic and the sinus impulses to spread over the heart simultaneously. The frequently occurring atrioventricular block may partially be responsible for protecting the parasystolic discharge from the sinus discharge. Thus, for these reasons, the fusion beat may not appear.

In the present case, a manifest ectopic discharge occurred at a relatively fast rate. The shortest interectopic interval, that was referred to as the ectopic cycle length, was approximately equal to the sinus beat interval. Scherf and Boyd reported that in parasystole the ectopic and the sinus rhythm were approximately equal. It may happen that a series of ectopic beats will appear without being interrupted by sinus beats. Accordingly, in the present case the ectopic beats had tendency to recur after a series of sinus beats (Fig. 7).

In order to explain parasystole, a mechanism of protection, which is referred to as protective block or entrance block, has been proposed. In this mechanism, the ectopic pacemaker is protected in some way from premature discharge by the impulses of the dominant rhythm. The protection is not always permanent, and this has caused arrhythmia to be called intermittent parasystole. In the present case, since parasystole appeared to recur after a series of sinus beats (Fig. 7), it may be regarded as intermittent ventricular parasystole. In the period of shifting from a series of sinus beats to bouts of ectopic beats, however, relatively long interectopic intervals were observed (Fig. 7). The reason why this occurred is considered to be the existence of exit block. Exit block may develop around the ectopic focus. So that, although the ectopic focus discharges on time, some of its impulses encounter a refractory tissue on their path and are thus prevented from invading the rest of the myocardium which is outside of the refractory phase. The relatively long interectopic intervals observed in Figs. 3, 4, and 7 may be explained by the concept of exit block. As a result, the expected ectopic beat
will fail to appear, even though it falls outside of the refractory period.

In the present case, electrocardiograms were recorded during exercise. As shown in Figs. 5 and 6, ectopic beats appeared in tracing at the time of all the types of gait, except canter. At the time of canter, the heart rate was above 160 beats per minute, and no ectopic beat may readily occur, because the dominant sinus rate is remarkably rapid.

The filly had endured racing and hard training exercise. Her electrocardiograms were normal at the time of canter. Her cardiac function was considered to be normal during exercise. Although many kinds of cardiac arrhythmia have been recognized in horses, the clinical significance of cardiac arrhythmia has not been clarified satisfactorily. Accordingly, an electrocardiographic examination during exercise by means of the radiotelemeter has an important significance in judging whether a horse manifesting arrhythmia can endure racing or not.

The etiology of arrhythmia in the present case is unknown. In human beings, it has been reported that the presence of parasystole indicates heart disease. In veterinary medicine, DETWEILER and PATTERTON, and Spörri described in the respective monograph that parasystole might occur spontaneously in organic heart disease. It is not infrequent for arrhythmia to occur in digitalis intoxication. As parasystolic beats were very frequently observed in every electrocardiographic examination, it is presumed that the filly may have possessed organic heart disease. However, since the filly has endured racing and hard training exercise and remained normal in every respect of health conditions, except irregular pulse, it is not considered that the filly has possessed any severe organic heart disease. Before the electrocardiographic examination, the filly was given digitalis in such manner as mentioned above. It is known that the characteristic clinical manifestations of digitalis intoxication in animals consist of such gastrointestinal disturbances as inappetence, diarrhea, and emesis, weakness and depression, cardiac arrhythmias and conduction disturbances. The electrocardiographic changes indicating a toxic action on the heart are incomplete atrioventricular block with dropped beats, ST segment shifts, and the occurrence of coupled ventricular ectopic beats. DETWEILER mentioned that the dose of digitalis powder employed for horses ranged from 0.03 to 0.06 g per kg of body weight. Since the body weight of the filly was about 470 kg, the digitalization dose for the filly was 14 to 28 g, according to DETWEILER. Consequently it is not considered that either 6 g as the first course or 10 g as the second course may have led to the occurrence of digitalis intoxication. In the present case, thorough pathologic-anatomical investigation of the heart is necessary to clarify the etiology of arrhythmia.

References

Ventricular Parasystole in a Racing Thoroughbred


競走馬にみられた心室性副収縮の1例

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競走馬にみられた心室性副収縮の1例について心電図学的検索を行なった。心電図所見では、洞性収縮と心室性異所性収縮が混在し、さらに第2度房室ブロックを伴って複雑な不整脈の様相を示した。異所性収縮の連結時間は著しく変動し（移動連結性），また、異所性収縮の周期は殆ど一定であり、洞性収縮の周期と殆ど同じであった。この異所性収縮は連続して出現せず、時々出現した。以上の所見から、本例の心電図を、間欠性の心室性副収縮と診断した。なお、本症の病因について簡単に考察した。