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# ABNORMAL ELECTROCARDIOGRAMS IN THE HORSE

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In the diseases of the abdomen or bowels of a horse, especially in acute pains of the organs, the condition of the heart is an important factor as one of the prognostic signs; the acceleration of the heart beat, irregular changes of the heart sounds and remarkable increase of the heart rate to a frequency of over 100 beats per minute, are all noteworthy symptoms for the patient in connection with the disease. Especially, remarkable increase of the heart rate is diagnosed as prognosis infausta generally. The characters and degrees of the heart dysfunctions take various forms, and the author has had clinical experience in many kinds of heart irregularities in disease. It is necessary to learn what kind of heart irregularities are occurring, in order to decide a prognosis of the patient.

In this paper, the author describes the results obtained from the electrocardiographical tests on one case of horse, which was suffering from an attack of colic with concomitant heart dysfunctions. Abnormal electrocardiograms, containing several factors, which are evidences of sinus arrhythmia, ectopic focus stimulation arising in the auricle, premature ventricular beats and paroxysmal ventricular tachycardia, were recorded.

## MATERIAL

The patient was a female, 15-year-old Percheron breed horse. As informed by the owner, the animal indicated slight colic symptoms 48 hours previously and received veterinary attention 24 hours before, however the patient did not take a favourable turn. So, the owner brought her to our clinic. Main clinical signs of the patient were as follows:

1. The patient showed remarkable colic symptoms.
2. Filling with gas in the coecum and large colons was recognized by rectal examination.
3. Irregularity of pulse beats, weakness of pulse force and abnormalities of the heart sounds were distinguished clinically.

Three electrocardiogram recordings were conducted till the patient showed complete recovery. Treatments using a laxative, clysmas and puncture of the coecum and colon were conducted. Consequently, the patient recovered after 3 days. The heart dysfunctions

also returned to normal and electrocardiographic pictures showed normal pattern according with the disappearance of the symptoms.

#### ELECTROCARDIOGRAPHIC FINDINGS

For recording the electrocardiogram in the present experiment, Model ED-1 (photorecording system) and cardiate (direct recording system) electrocardiographs both made by the Fukuda Medical Instrument Company were used. Limb lead (I, II & III) and augmented unipolar limb lead (aVRLF) were applied. Phonocardiograms of the patient were recorded synchronously with electrocardiogram. A needle electrode was used in this experiment.

In order to interpret the electrocardiogram, the author referred to BROOIJMANS' report and medical reference books.<sup>3,4)</sup>

#### I. Irregularity of impulse arising in sinus node, ectopic focus in the auricle and incomplete A-V block (Fig. 1)

Continuous waves in lead II were studied in connection with PP interval, PQ interval and P duration. The measurement values are shown in the table.

TABLE *Measurement Values of PP and PQ Intervals, and P Durations (in second)*

BEAT NOS.	PP	PQ	P
1~2	1.12	0.25	0.175*
2~3	0.975		0.100
3~4	0.875		0.075
4~5	0.675	0.195	0.100
5~6	1.20	0.25	0.175*
6~7	1.09		0.100
7~8	1.04	0.262	0.100
8~9	0.99	0.20	0.100
9~10	2.25		0.075
10~11	1.03	0.15	0.100
11~(12)		0.175	0.100

Notes: \*—P' wave

Beat numbers were decided on the basis of the P deflections.  
(Comparison could be made with figure 1)

1) PP interval varied within the range of 0.675~2.25 sec; no regularity of the interval was observed. This fact shows that the impulse from sinus node arose with great irregularity.

2) PQ intervals were measured on the waves of the normal contractions. Seven out of 11 beats showed normal activation. PQ intervals varied in the range of 0.15 sec to 0.262 sec. These variations mean that a disturbance of impulse conduction existed in the

course from the S-A node to the A-V node. It is considered that the disturbance was an incomplete A-V block.

3) Durations of P waves varied within the range of 0.075 sec to 0.100 sec except P' waves of 2 beats showing 0.175 sec durations. The form of P' waves took diphasic pattern and both waves were different in pattern from that of P waves. The author considered that the P' waves were caused by ectopic focus of the stimulation in the auricle.

From the above findings, the author considered and understood that the spread of excitation through the atria from S-A node to A-V node was as follows: PP interval showed great irregularity and the position of origin of impulse was always the same in sinus node except for the P' waves, because the figures and durations of the P waves indicated the same pattern and duration. In the 2 P' waves of diphasic pattern, the figure and duration of both waves indicated quite similar pattern and the same value respectively. These facts show that the position of ectopic focus in P' waves is the same and that the position is not on the sinus node; it may be situated somewhere in the auricle. The author also deduced that the position was under the sinus node level, perhaps in the left auricle. PQ intervals showed variations without showing typical inclination as they gradually increased in value. This means the existence of an incomplete A-V block. So, in these pictures, the activations of the auricles and a part of the ventricle activations showed entire independence of each other.

## II. Ventricular Premature Beat (VPB)

Speaking generally, many factors may become the cause of the ventricular premature beat or ventricular extrasystole.

In this case, multiformity in VPB was observed as a characteristic picture in the electrocardiograms. In one group of them, the figure of the main wave of QRS complex of VPB showed the same direction as in normal beat, which showed QS type of QRS and amplitudes of the wave indicated about 3 times as high as normal beat. The VPB of the other group showed opposite direction of deflection in QRS complex to normal beat. The deflection of QRS complex was R type and amplitudes were measured as about 3 times voltage. The VPB activated independently of normal beat and the VPB did not seem to reflect the impulse from the sinus node. The P wave which led the QRS complex of VPB was never seen, however the P waves which were activated from normal S-A node pace were recorded regularly on the waves of VPB. The difference of VPB pattern between both groups was caused by positional changes of ectopic focus in the ventricles, however the position of the focus could not be located.

## III. Paroxysmal Ventricular Tachycardia (Fig. 2)

At the later stage of the course, a paroxysmal ventricular tachycardia was recorded. In this stage, the VPB was already destroyed and the electrocardiogram returned to normal except for an occurrence of tachycardia.

The paroxysmal ventricular tachycardia in this case was of the so-called short run type. The duration of the tachycardia continued for 28 seconds, and 43 ventricular beats were comprized during the tachycardia. The ventricular rate was measured as about 90 per minute in frequency. Activation of the auricles (P wave), when the tachycardia occurred, kept its own pace. The P waves were not apparently recorded because they

were covered by the ventricular deflection of the tachycardia. The figure of the paroxysmal ventricular tachycardia was as follows: The amplitude of QRS complex showed about 3 times as high in voltage as compared with normal deflection in present recording and the duration of the wave indicated 1.5 times as long in second. The figure of each complex was like the pattern of VPB. RR interval indicated moderate variation.

From these particulars, the ventricular paroxysmal tachycardia may be characterized as follows :

1. QRS complex was similar to the pattern of VPB.
2. T wave indicated high voltage and ischemic pattern.
3. QRS complex showed constant pattern during paroxysmal ventricular tachycardia.
4. The electrocardiograms made just before and after the paroxysmal ventricular tachycardia showed almost normal figures.
5. Sinus rhythm was not disturbed by the tachycardia. These characteristic signs are similar to the descriptions of BROOIJMANS.

#### IV. Electrocardiogram and Phonocardiogram (Fig. 3)

The phonocardiogram was recorded synchronously with the electrocardiographic recording. The figure of the phonocardiogram of VPB differed from that of normal on the same paper. The amplitude and duration of the 1st heart sound indicated decrease in voltage and also in second respectively. This means that the contraction of the ventricle and action of the semi-lunar valve were not sufficient. So, the volume of the 1st heart sound was low. The picture of 1st heart sound of normal contraction showed slight variation in amplitude and duration while 2nd sound curve did not indicate any variation.

### DISCUSSION

Electrocardiographical studies of disturbances of the heart function in colic of horses were reported by BROOIJMANS. In his report, a paroxysmal ventricular tachycardia was seen in 3 cases out of 5 digestive organ sickness of horses. The existence of heart dysfunction in sickness have been accepted generally, although a conclusive description has not been made. In connection with the heart dysfunction in colic, problems of the nervous system, hemodynamic disturbances and decrease of oxygen metabolism have been discussed by many workers. In this case, the author considered that abnormal nervous stimulations are the primary causal agent for the heart dysfunction especially for the VPB. In addition to this, hemodynamic unbalance and decrease of ability of oxygen metabolism were considered as secondary factors.

The characteristic sign in present recordings was the premature ventricular beats. Concerning the etiology of VPB in this case, the author could not be absolutely certain, but it was considered that the VPB may be initiated by reflex stimulation of the vagus and the sympathetic nervous system as described in the report of BROOIJMANS, and also such reflex may originate in the carotid sinus and other presso-receptor areas, in the respiratory tract or in the gastrointestinal

tract; VPB may be also precipitated by the central nervous system. There is close relation between the occurrences of the VPB and the paroxysmal ventricular tachycardia, in connection with the presence of stimulation focus in the ventricles. It seems that the extrasystolic arrhythmias in this case were not accompanied by specific morphological changes in the heart, because the electrocardiographical changes endured for only three days, and especially the duration of the ventricular tachycardia was for only one day. It may be also considered that the slight alteration of the cellular membrane of one single or a small group of cells may have precipitated the extrasystolic arrhythmias.

Irregularity of impulse arising in the sinus node and incomplete or partially complete A-V block may have resulted in the VPB secondarily. In the phonocardiographical studies, the changes of the 1st heart sound were observed especially in the VPB. Concerning this, BROOIJMANS reported that the intensity of the 1st sound may be valuable, because of the varying relationship between auricular and ventricular contractions, which results in variations in the end-diastolic position of the auriculo-ventricular valves, which in turn determine the character of the 1st sound.

Special treatment was not applied to the heart dysfunctions, because the heart irregularity disappeared in 3 days and heart functions recovered when the colic symptoms disappeared.

#### SUMMARY

The author studied the abnormal electrocardiogram which was obtained from a horse showing gas colic with heart dysfunctions, and also he recorded the phonocardiogram. The electrocardiogram exhibited several factors such as irregularity of impulse arising at the sinus node, incomplete A-V block; first degree of A-V block, ectopic focus in the auricle; diphasic P' waves, multiform ventricular premature beats; ventricular extrasystoles, and the paroxysmal ventricular tachycardia; short run type. These changes continued for 3 days with having close relation with each other. Phonocardiogram of the VPB showed remarkable changes such as decrease in amplitude and shortage in duration, which differ from those of normal curves. Discussion of the significance of the waves was also added.

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## EXPLANATION OF PLATES

## PLATE I

## Fig. 1.

Lead II reveals a sinus arrhythmia with incomplete A-V block. P' waves were activated by an ectopic stimulation in the atrium. The form of P' waves shows diphasic patterns different from that of normal one. Eight ventricular premature beats (VPB) are seen. The major deflection of the first to sixth is downward: that of the seventh and eighth is upright. Diagram of cardiac conduction: The type of diagrams will be showed to illustrate the electrocardiographic tracings of normal and abnormal conductions (referenced from GOLDMAN).

## PLATE II

## Fig. 2.

Leads aVR and aVF reveal a tachycardia with a ventricular rate of 90. There is suggestive evidence of atrial activity, but one could not be positive of this. The QRS complex is wide and slurred. The T wave with high deflection is like ischemia of ventricular muscle. Normal electrocardiograms were seen with low amplitude deflection.

## Fig. 3.

One VPB from lead aVF and the phonocardiogram seen at center in this photograph. Phonocardiogram of 1st heart sound in VPB shows low amplitude and short duration.

FIG. 1. *Sinus Arrhythmia, Ectopic Focus in the Auricle (P' Waves), Incomplete A-V Block and Ventricular Premature Beats (VPB)*

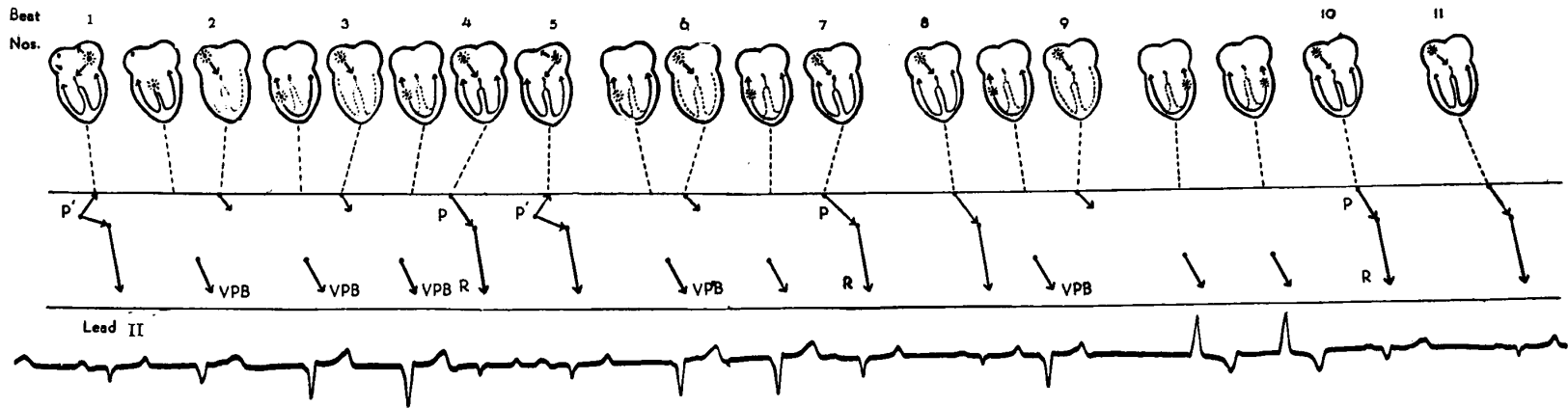
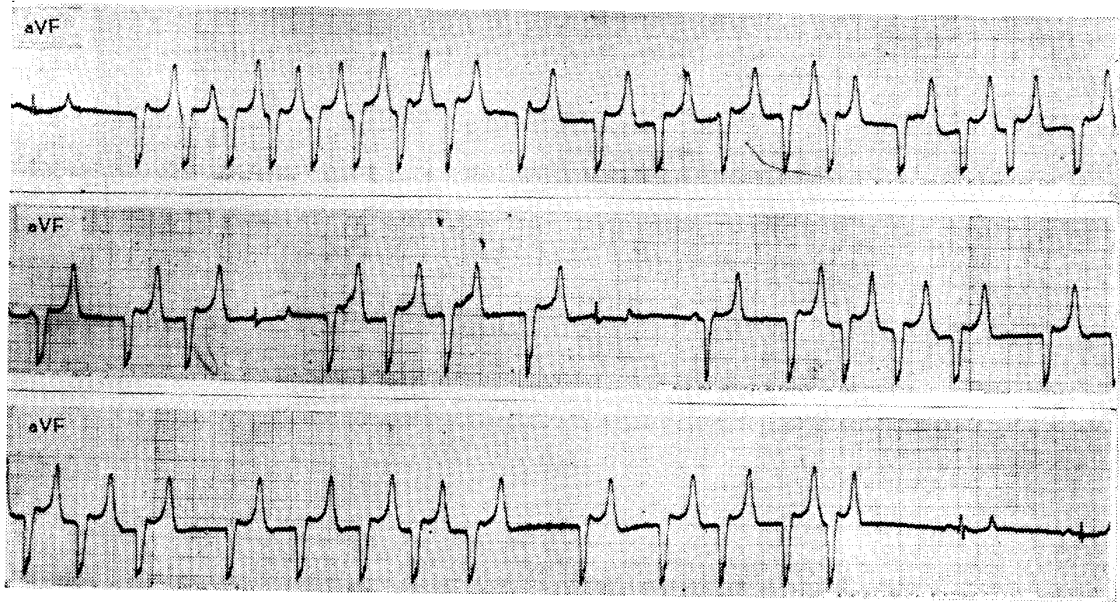
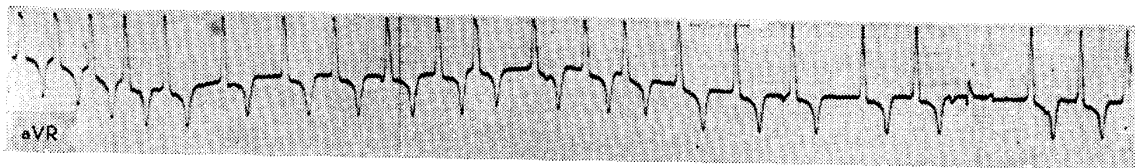




FIG. 2. *Paroxysmal Ventricular Tachycardia*



The above is the whole portion of a continuous strip taken during the tachycardia in lead aVF.



The above is a strip taken during the tachycardia in lead aVR.

FIG. 3. *Electrocardiogram and Phonocardiogram*

