

Return Extrasystoles.*

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In previous reports it has been demonstrated that "return extrasystoles" are observed in dogs during auriculo-ventricular rhythm and simultaneous vagus stimulation or following fatigue of the conduction system by a short lasting tachycardia.^{1,2} The resulting disturbance of rhythm closely resembled tracings which were registered from patients in rare cases.^{3,4} Whenever the auricles, during auriculo-ventricular rhythm, contracted at a certain time *after* the QRS complexes the return extrasystole was observed.

Of importance is the answer to the problem whether the longitudinal dissociation is always present as an intrinsic quality of the specific conduction system between auricle and ventricle so that the reentry mechanism works whenever the R-P interval reaches a certain length or whether some damage of the conduction system must be added. This would consist in the experiments just mentioned, in vagal stimulation or fatigue. An answer may be possible when more experimental or clinical instances of this arrhythmia become known, particularly when more conditions are studied under which this disturbance of rhythm occurs.

In view of the paucity of experimental observations on this subject 2 more situations, in which the phenomenon of return extrasystoles was observed will be described in this report. It was seen (1) during direct warming of the auriculo-ventricular node of the dog's heart *in situ* by a thermode, and (2) during depression of the sinus and the

auriculo-ventricular node by mechanical stimulation of the sinus node area.

(1) *Warming of the auriculo-ventricular node.* These experiments were described in a previous communication in this journal.⁵

The wall of the right auricle was opened after clamping both venae cavae; the area of the auriculo-ventricular node near the orifice of the coronary sinus vein was warmed with a thermode. The warming took place within 30 seconds after clamping of the veins was started, that is, at a time when a high degree of anoxia could not have as yet developed.

This experiment was performed in 17 dogs. Return extrasystoles were observed each time in these experiments when an auriculo-ventricular rhythm appeared in which the auricles contracted after the ventricles during the warming. This happened 4 times.

Fig. 1a shows a tracing obtained in such an experiment. Before the warming the vagi were divided in the neck. During the warming a relatively slow auriculo-ventricular rhythm appeared. Deep, peaked inverted P waves are visible after the QRS complexes. Whenever the auricles contracted 0.14 second or later after the ventricles, a return extrasystole, due to a reentry mechanism appeared. The intraventricular conduction of the return extrasystoles was aberrant. Such extrasystoles appear after the second, fifth, sixth and seventh auriculo-ventricular beat in the tracing. Such return extrasystoles were absent after all the other beats unless the R-P interval was long.

Fig. 1b shows the same phenomenon in another experiment of the same type. The warming caused at first a tachycardia and the P waves were not visible. Here again return extrasystoles appeared when the auricles contracted after the ventricles and

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¹ Scherf, D., and Shookhoff, C., *Wien Arch. inn. Med.*, 1926, **12**, 501.

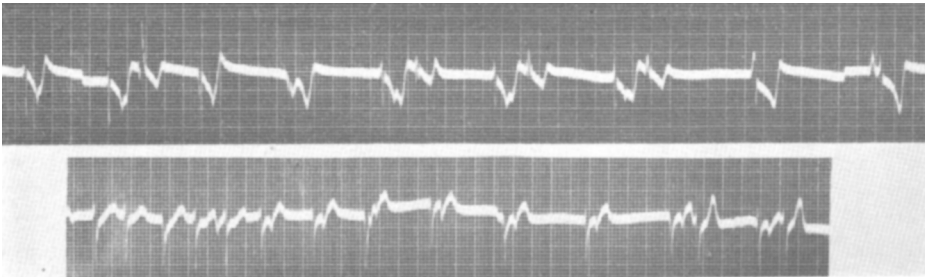
² Scherf, D., *Arch. int. Med.*, 1941, **67**, 372.

³ Drury, A. N., *Heart*, 1924, **11**, 405.

⁴ Decherd, G., and Ruskin, A., *Texas Rep. Biol. and Med.*, 1943, **1**, 299.

⁵ Scherf, D., *Proc. Soc. Exp. Biol. and Med.*, 1944, **56**, 220.

a



b

FIG. 1a.

Return extrasystoles which appeared during warming of the auriculo-ventricular node.

FIG. 1b.

Return extrasystoles during warming of the auriculo-ventricular node, appearing regularly with a long R-P interval.

TABLE I.

Experiment of Feb. 28, Fig. 1b		Experiment of Feb. 28, Fig. 1a		Experiment of April 18	
R-P	P-R	R-P	P-R	R-P	P-R
0	0	12	19	0	0
0	0	14	17	13	10
9	0	11	20	12	0
16	10	11	21	14	9
0	0	11	21	8	0
0	0	10	22	9	15
0	0	9	24	0	0
0	0	10	22	16	9
0	0	9	24	0	0
24	9	7	0	0	0
12	0	7	0	7	0
11	0	7	0	4	0
10	0	8	0	6	0
10	0	8	0	0	0
11	0	10	24		
10	0	7	0		
12	16	7	0		
12	17				
10	0	13	0		
0	0	14	20		
0	0	12	0		
		4	0		
		14	20		
		12	25		
		14	22		
		0	0		
		0	0		

the R-P interval reached a length of 0.12 second. Premature contractions did not follow any other beat. Therefore a reentry mechanism can be assumed.

The tracings from the 2 other experiments of this series showed the same picture.

Table I gives the measurements obtained in 3 tracings with return extrasystoles. They show clearly that a return extrasystole oc-

curs when the R-P distance reaches a certain length. The reciprocal duration of the R-P distance and of the following R-P interval is evident. All beats in which the P waves were hidden in the QRS complex or in which positive P waves preceded the QRS complex are designated with "O". Following beats of this type return extrasystoles were absent, for obvious reasons.

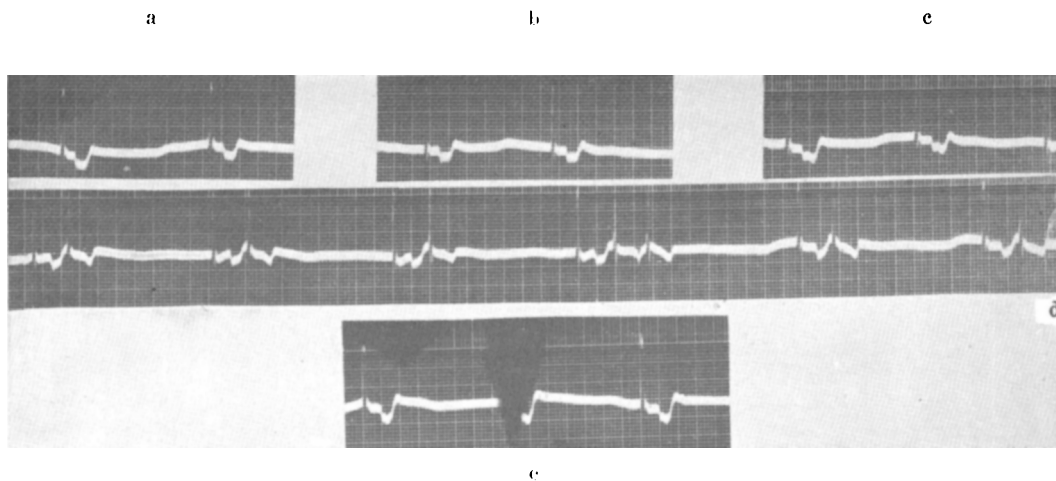


FIG. 2.

Return extrasystoles during reflex inhibition of the sinus- and the auriculo-ventricular node.

(2) *Depression of sinus and auriculo-ventricular node.* This phenomenon was described in a previous paper in this journal.⁶ The subepicardial injection of hypertonic solutions of sodium chloride or calcium chloride, as well as digitalis or strophanthin in the sinus node area of the right auricle led in a certain percentage of experiments on dogs to a depression of the sinus node. Frequently the deeper auriculo-ventricular nodal centers were also inhibited. This depression was particularly pronounced in one experiment in which during the auriculo-ventricular rhythm the auricles contracted *after* the ventricles.

The heart of the dog was exposed during nembutal-morphine anesthesia. Both vagi were severed in the neck. Then 0.1 cc of a 5% solution of calcium chloride was injected subepicardially in the area of the head of the sinus node. Immediately a marked bradycardia appeared and an auriculo-ventricular rhythm was registered with an R-P interval of 0.16 second (Fig. 2a). Without any other means the length of the R-P distance gradually increased in the following minutes. In Fig. 2b it is 0.17 second and in Fig. 2c it measures 0.18 second. As soon as it reached the value of 0.20 second,

bigeminy and trigeminy appeared (Fig. 2d). About 2 minutes later and 3.5 minutes after the injection, the extrasystoles disappeared and the R-P interval at that time was again shortened to 0.18 second (Fig. 2e). The occurrence of trigeminy due to return extrasystoles was described before.²

Discussion. These experiments show 2 new ways which lead to the appearance of return extrasystoles. In both, however, a change of the condition of the auriculo-ventricular conduction system cannot be completely excluded. This damage could be due to anoxia in the first experiments in which the exposed auriculo-ventricular node was warmed although it is rather improbable in view of the early appearance of the return extrasystoles and the shortness of the P-R and R-P intervals. In the second type of experiment the depression of the nodal centers may also have extended to the deeper sections of the specific tissue.

Conclusion. Two new methods are described which lead to the appearance of return extrasystoles during auriculo-ventricular rhythm in the dog. Such extrasystoles appeared during direct warming of the exposed auriculo-ventricular node *in situ* and during depression of the nodal centers by the subepicardial injection of a hypertonic solution of calcium chloride.

⁶ Scherf, D., PROC. SOC. EXP. BIOL. AND. MED., 1946, **61**, 286.