

# ELECTROCARDIOGRAPHIC CHANGES ON SUBLETHAL POISONING OF VACOR<sup>®</sup> AND SILMURIN<sup>®</sup> TO *BANDICOTA BENGALENSIS*

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**Summary :** A single sublethal dose of Vacor (1 mg/rat) or Silmurin (50 µg/rat) brought about dissimilar changes in cardiac physiology of bandicoot rats. Delayed myocardial repolarization and stress on cardiac tissues were noticed. Elevation of S-T segment above the isoelectric axis diagnostic of recent myocardial infarction was observed. Vacor and Silmurin induced differential changes in heartbeat; Vacor poisoning resulted in bradycardia, whereas Silmurin tachycardia. It is inferred that Vacor deaths may be due to bradycardia associated with atrioventricular block and that of Silmurin to delayed myocardial repolarization and tachycardia.

**Key words:** single dose rodenticides      Vacor    Silmurin      electrocardiography  
bradycardia      tachycardia      delayed myocardial repolarization  
atrioventricular block

## INTRODUCTION

Vacor (N-3-pyridylmethyl N'-p-nitrophenyl urea) and Silmurin (6β-(acetyloxy)-3β(β-D-glucopyranosyloxy)-8,14-dihydroxy-bufa-4, 20, 22-trienolide) are two single dose rodenticides from Rohm and Hass Company, Philadelphia, and Sandoz Ltd., Switzerland, respectively (2, 6, 7). Vacor inhibits niacinamide metabolism (1) whereas Silmurin affects cardiac function as it is a cardiac glycoside (2). Literature about the effects of these rodenticides on the physiology of rat is scanty (8, 9). Cardiac physiological study in the present work is considered as one of the parameters to know the effects of these rodenticides at sublethal level on the physiological state of the rat *Bandicota bengalensis*. Such an approach would also help understanding the effects of rodenticides on non-target species.

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## MATERIALS AND METHODS

The lesser bandicoot rats *Bandicota bengalensis* were captured by burrow excavations in paddy fields around Bangalore, stocked in metal cages in the laboratory and maintained on rat feed (supplied by Hindustan Lever Ltd., India) and water *ad lib*. After conditioning to the laboratory, the rats were given a single sublethal dose of Vacor or Silmurin. Vacor (1 mg/individual) or Silmurin (50  $\mu$ g/individual) mixed in 1 g bait (rice flour, groundnut oil, groundnut kernel and garlic; 79:20:0.5:0.5 by weight) was administered to the rats to ensure that all the poison mixed was ingested. This bait formulation and dose requirement were fixed based on the LD<sub>50</sub> studies (10). One day after poisoning, the rats were used for electrocardiographic studies. Fifteen to twenty minutes prior to the recordings, both normal and poisoned rats were injected with 1-2 mg/kg Sequil<sup>R</sup> (Triflupromazine hydrochloride, supplied by Sarabhai Chemicals) intraperitoneally. This dose requirement was formulated after the initial trials of various concentrations of Sequil<sup>R</sup>. The 1-2 mg/kg Sequil<sup>R</sup> dose did not interfere with either the heart rate or heart functioning. The hair on the regions just above the palm and foot of the rats on the ventral side was clipped off. In these regions the steel electrodes (crocodile clips) were clamped and a little amount of electrogel applied to ensure conduction.

The ECG was recorded on a physiograph supplied by E and M Instrument Co. Inc., Houston, Texas, U.S.A., using three standard limb leads. The ECG recordings were analysed according to Armstrong (3) and Burch and Winsor (5).

## RESULTS

Figures 1-3 illustrate the typical ECG recordings of normal, Vacor and Silmurin poisoned rats. Lead II which is represented in figure-2 shows all the components of ECG. Elevation of S-T segment above the isoelectric axis was visible in I and II leads on Vacor poisoning and in II and III leads on Silmurin poisoning (Figs. 1-3).

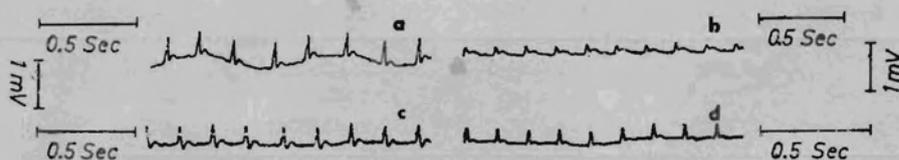
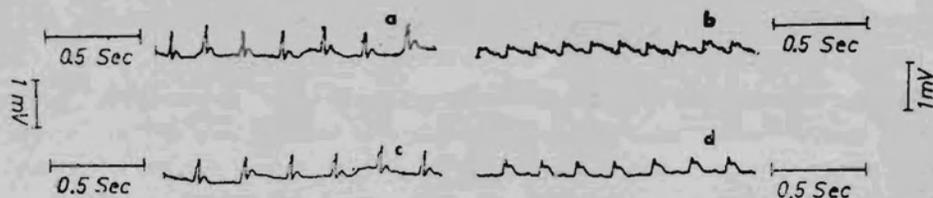
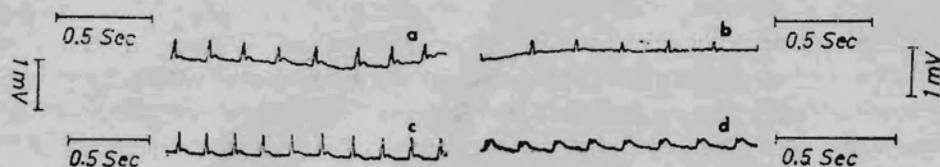


Fig. 1 : Electrocardiographic recordings - Lead I :

Normal (a,c), sublethal Vacor (b) (1 mg/individual) and Silmurin (d) (50  $\mu$ g/individual) poisoned rats. The animals were injected with 'Sequil' (2 mg/kg body weight) intraperitoneally while recording.

Fig. 2 : *Electrocardiographic recording - Lead II :*

Normal (a,c), sublethal Vacor (b) (1 mg/individual) and Silmurin (d) (50  $\mu$ g/individuals) poisoned rats. The animals were injected with 'Sequil' (2 mg/kg body weight) intraperitoneally while recording.

Fig. 3 : *Electrocardiographic recordings - Lead III :*

Normal (a,c), sublethal Vacor (b) (1 mg/individual) and Silmurin (d) (50  $\mu$ g/individual) poisoned rats. The animals were injected with 'Sequil' (2 mg/kg body weight) intraperitoneally while recording.

Table I presents the changes in magnitude of P, Q, R, S and T waves in rats after poisoning. In all categories i.e., both in normal and poisoned rats, the P wave was inconspicuous in the ECGs of leads I and III. Only normal animals showed a significant P wave

TABLE I : *Electrocardiographic changes in Bandicota bengalensis on Vacor and Silmurin poisoning in sublethal doses.*

Limb leads	Rat	Electrical potential of ECG waves in millivolts				
		P	Q	R	S	T
I	Normal	NM	0.04 $\pm$ 0.004	0.37 $\pm$ 0.09	0.03 $\pm$ 0.0	0.09 $\pm$ 0.02
	Vacor poisoned	ND	ND	0.25 $\pm$ 0.016*	ND	0.05 $\pm$ 0.0**
	Silmurin poisoned	ND	ND	0.25 $\pm$ 0.016*	ND	0.03 $\pm$ 0.008***
II	Normal	0.06 $\pm$ 0.008	0.05 $\pm$ 0.0	0.43 $\pm$ 0.05	0.05 $\pm$ 0.0	0.10 $\pm$ 0.016
	Vacor poisoned	NM	ND	0.30 $\pm$ 0.0**	ND	0.06 $\pm$ 0.016**
	Silmurin poisoned	NM	ND	0.35 $\pm$ 0.16**	ND	0.05 $\pm$ 0.0***
III	Normal	NM	0.03 $\pm$ 0.0	0.21 $\pm$ 0.05	ND	0.08 $\pm$ 0.008
	Vacor poisoned	ND	ND	0.11 $\pm$ 0.016**	ND	ND
	Silmurin poisoned	NM	ND	0.12 $\pm$ 0.008†	ND	ND

All values are mean  $\pm$  S.D. of 8 observations (8 rats). All animals were injected with 1-2 mg/kg Sequil intraperitoneally.

NM - Electrical potential could not be measured. ND - Not detected.

\*P < 0.1; \*\*P < 0.02; \*\*\*Highly significant; †P < 0.01

(which could be measured) in the lead II and this disappeared after poisoning with Vacor or Silmurin (Figs. 1 and 3). Q wave which was noted in normal animals, became inconspicuous on poisoning (Figs. 1-3). The R and T waves were noted in all leads and in all experimental rats. However, the potential of R and T waves was reduced on poisoning. The reduction of T wave potential was more on Silmurin poisoning (Fig. 3). The S wave which disappeared on poisoning was seen only in leads I and II of normal rats.

Vacor and Silmurin induced changes not only in the electrical potential of the cardiac waves but also in the duration of the intervals (Table II). Both Vacor and Silmurin increased the P-R interval significantly. The two rodenticides Vacor and Silmurin bring about dissimilar changes with respect to heartbeat. Vacor brings about bradycardia (decrease in the rate) whereas Silmurin brings about tachycardia (increase in the rate) in the poisoned rats.

TABLE II : Changes in the P-R interval and rate of heart beat in *Bandicota bengalensis* on Vacor and Silmurin poisoning.

Parameter	Normal rats	Vacor poisoned rats*	Silmurin poisoned rats*
P-R interval (in seconds)	0.02 ± 0.0063	0.047 ± 0.0054	0.055 ± 0.001
Rate of heart-beat (beats/min)	324 ± 35	260 ± 31	405 ± 28

Values are Mean ± S.D. of 8 observations (8 rats).

\*Highly significant.  $P < 0.001$ .

## DISCUSSION

The electrocardiographic changes observed with reference to sublethal Vacor and Silmurin poisoning indicated that Vacor and Silmurin affect the cardiac function to a varied degree. Present results not only characterized but also illustrated the effects of sublethal dose poisons on the heart function.

The P wave which represents depolarization or activation of atria is inconspicuous in I and III leads of normal rats. As in human ECG, which shows P wave to be positive in all the three limb leads (3), the P wave in normal rat is positive (Fig. 2). The disappearance of P wave on Vacor and Silmurin poisoning indicates that the rhythm is affected. Idioventricular rhythm, wherein P waves are absent results in the non-emergence of impulses from the atrioventricular node to stimulate the ventricles which eventually beat at their own slow rate (4). Absence of P wave on Vacor poisoning depicts idioventricular rhythm. Thus idioventricular rhythm associated with bradycardia is noticed on Vacor poisoning.

The QRS complex which denotes the depolarization or activation of ventricles is normal in all the three leads of normal rats. The amplitude of the QRS complex reduced in all the leads on poisoning with Vacor or Silmurin. The low voltage of QRS complex denotes either pericardial effusion or pericarditis (3).

The T wave which is visible in all the three leads is positive in normal rats. The amplitude of the T wave is greatly reduced in leads I and II and completely absent in lead III on Vacor and Silmurin poisoning. In lead II, T wave was negative in some of the poisoned rats. This indicates myocardial infarction and ischaemia (3). The elevation of the S-T segment above the isoelectric axis on poisoning also indicates myocardial infarction. The prolonged P-R interval, twice that of normal in Vacor poisoned rats and approximately thrice the normal in Silmurin poisoned rats is indicative of first degree heart block. In humans and canines prolonged P-R interval (due to disease) is associated with bradycardia (3,4). This is concordant to the ECG changes on Vacor poisoning. But, on Silmurin poisoning prolonged P-R interval is associated with tachycardia. This invariably indicates that eventhough some of the eletrocardiographic changes in rats on poisoning with Vacor and Silmurin resemble that of the diseased electrocardiography, some show idiopathic changes on poisoning.

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#### REFERENCES

1. Anon. Rat poison does deed in only one feeding. *Chem. and Eng. News*, March 8, 1975.
2. Anon. Silmurin rodenticide bait. *Sandoz Ltd., AGRODOK* No. E-4329/DG, 1977.
3. Armstrong, M.L. 'Electrocardiograms - a systematic method of reading them'. John Wright and Sons Ltd., Bristol, 1965.
4. Bolton, G.B. 'Handbook of canine electrocardiography'. W.B. Saunders Company, Philadelphia, 1975.
5. Burch, G.E. and T. Winsor. 'A primer of Electrocardiography'. Lea and Febiger, Philadelphia, 1966.
6. Peardon, D.L. A new series of selective rodenticides. *In Proc. VI Vert. Pest Conference*, pp- 58-62. Johnson, W.V. (Ed.), 1974.
7. Peardon, D.L. RH-787. A new selective rodenticide. *Pest Control*, **42** : 14, 16, 18 and 27, 1974.
8. Ushadevi, S.V. and R.V. Krishnamoorthy. Liver necrosis and hypertrophy in 'Vacor' administered field rats. *Curr. Sci.*, **48** (18): 830-832, 1979.
9. Ushadevi, S.V. and R.V. Krishnamoorthy. Non-competitive inhibition of serum acetylcholinesterase (E.C.3.1.1.7) by Vacor (N-3-pyridylmethyl-N'-p-nitrophenyl urea) in bandicoot rats. *Ind. J. Physiol. Pharmac.*, **23** (4) : 285-290, 1979.
10. Ushadevi, S.V. and R.V. Krishnamoorthy. Efficacy and Economics of 'Vacor' on lesser bandicoot rats, *Bandicota bengalensis bengalensis* Gray in Rabi season. *Ind. J. Rodentology*, 1980. (in press).