REGRESSION PATTERN OF AMPLITUDE OF ELECTROCARDIOGRAPHIC WAVES DURING INTRAVENOUS INFUSION IN INTACT, BUFFER NERVE DENERVATED AND SPINAL DOGS*

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Summary: Electrocardiographic (ECG) amplitude changes during clinically feasible rate of infusion of normal saline (NS), Ringer-Locke (RL) solution and tender coconut water (TCW) upto a dose of 100 *ml/kg* in paraldehyde (PLD) and chloralose and urethane (C&U) anaesthetised dogs were studied. The infusion caused a net decrease in P and QRS amplitudes but had varied effect on T wave amplitude in intact PLD and C&U anaesthetised dogs.

Infusion of RL in vagotomised and/or carotid sinus (CS) denervated dogs and in spinal dogs indicated that these neural pathways had a significant effect on basal amplitude of ECG waves but their influence on infusion induced ECG changes was only marginal; in this the vagi seem to have a greater influence than the other pathways. The T wave changes during infusion were independent of simultaneous P and QRS changes and appeared to depend on the ionic composition of the infusion fluid. TCW infusion was very well tolerated, particularly by the C&U anaesthetised dogs. It would seem that the evaluation of ECG from patients on parenteral fluid be done in the context of the present observation that infusion *per se* decreases the amplitude of ECG.

Key words: infusion ECG buffer nerves spinal dogs

INTRODUCTION

The importance of electrocardiogram (ECG), its normal variation, nervous and ionic influence on ECG have been brilliantly reviewed by Schefer and Haas (31). However, literature on ECG changes during intravenous infusion is very scanty. Few workers (1,2,18,35) have shown changes in ECG wave amplitudes during infusion of fluids. The rate and volume of fluid infused had no relevance on the clinical feasibility of such infusion. Hence, the progressive changes in ECG amplitude was studied during normal saline (NS), Ringer-Locke (RL) solution and tender coconut water (TCW) infusion at a clinically feasible rate of about 0.5 *ml/kg/min*. To reveal the role played by an anaesthetic agent *per se* in causing such ECG changes during infusion, the infusions were performed in paraldehyde (PLD) and chloralose and urethane (C&U) anaesthetised dogs. The ECG changes observed in intact dogs were compared with those of vagotomised and/or carotid sinus (CS) denervated and spinal dogs with or without intact vagi to reveal their influences in causing such ECG changes.

MATERIALS AND METHODS

Seventy-eight mongrel dogs of both sexes (7 to 20 *kg*) were used for studying the simultaneous and sequential changes in cardiovascular, respiratory and renal profiles during infusion.

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The details of grouping and treatments are given in Table I. The ECG (lead II) was recorded in a four channel physiograph (E&M Instrument Co., Houston, Texas, USA) and the amplitude of P, QRS and T waves were measured in mV. The PLD (2.2 *ml/kg*) was given *I.M.* After premedication (morphine hydrochloride 1 *mg/kg S.C.*) the dogs were anaesthetised with C & U mixture prepared in 15:85 polyethylene glycol 600 (S.D.'s Lab-Chem. Industry, Bombay-59, India) in normal saline. A total of 0.068 to 0.102 *g/kg* chloralose (BDH or Kochlight) and 1.02 to 1.52 *g/kg* urethane (Reidel) were used including supplementary doses (33).

Intact groups (G1 to G6): Basal preparations included intratracheal intubation, ECG lead attachment, femoral artery and vein and bladder catheterization. The ECG amplitude in these preparations are called "basal values".

Experimental surgery groups (G7 to G12): These dogs in addition to basal preparations underwent any one of the experimental surgeries as shown in Table I. The ECG amplitude recorded after these surgeries are called "new basal values".

TABLE I: Details of Materials and Methods.

Intact groups	*G1*	*G2*	*G3*	*G4*	*G5*	*G6*
Number of dogs	6	4	4	6	6	6
Anaesthesia	PLD	PLD	PLD	C&U	C&U	C&U
Infusion fluid	NS	RL	TCW	NS	RL	TCW
Rate *ml/kg/min*	0.6	0.75	0.6	0.5	0.5	0.5
Maximal dose infused *ml/kg*	130	140	120	100	100	100
Experimental surgery groups	*G7*	*G8*	*G9*	*G10*	*G11*	*G12*
Number of dogs	9	6	6	6	10	9
Anaesthesia	PLD	C&U	C&U	C&U	C&U	C&U
Experimental surgery	I	I	II	1&II	III	III & I
Fluid infused	RL	RL	RL	RL	RL	RL
Rate *ml/kg/min*	0.9	0.5	0.5	0.5	0.5	0.5
Maximal dose infused *ml/kg*	150	100	100	100	100	100

PLD = Paraldehyde
C&U = Chloralose and urethane
NS = Normal saline
RL = Ringer-Locke
TCW = Tender coconut water
I = Vagotomy
II = Carotid sinus denervation
III = Spinal transection

Recording and infusion of fluids: The ECG was recorded in the basal preparation, after experimental surgery (stabilization period 30 to 60 min) and at regular intervals during infusion, i.e., after completion of each incremental infusion dose of 5 *ml/kg* body weight until 100 *ml/kg* dose or more was reached. The fluids were infused through femoral vein at a constant rate (Table I) from gravity bottle system. Fresh NS, RL (pH 7.4) and TCW (prepared as per 34,35) were used. The aliquots of TCW infused, and the blood and urine samples collected at regular intervals during TCW infusion schedules were analysed for the electrolytes.

Analysis: The basal ECG amplitudes were compared with new basal amplitude and amplitude at each infusion stage by paired 't' test. The regression curves were fitted to the mean per cent amplitude changes by using orthogonal polynomials. Multiple correlation coefficient (R) of the regression curves were computed (32). The net per cent changes in amplitude (mean of per cent changes at all the infusion stages) observed in various groups were compared by Bartlett's test (32).

RESULTS

Tables II and III give respectively the mean amplitudes of P, QRS and T waves of ECG in intact and experimental surgery groups at selected infusion stages. Table IV gives net per cent changes, R values of regression curves and intergroup comparison of net per cent change. Fig. 1 to 4 give the fitted regression curves. The regression curves had high R values (Table IV) indicating good fit and predictability of these changes.

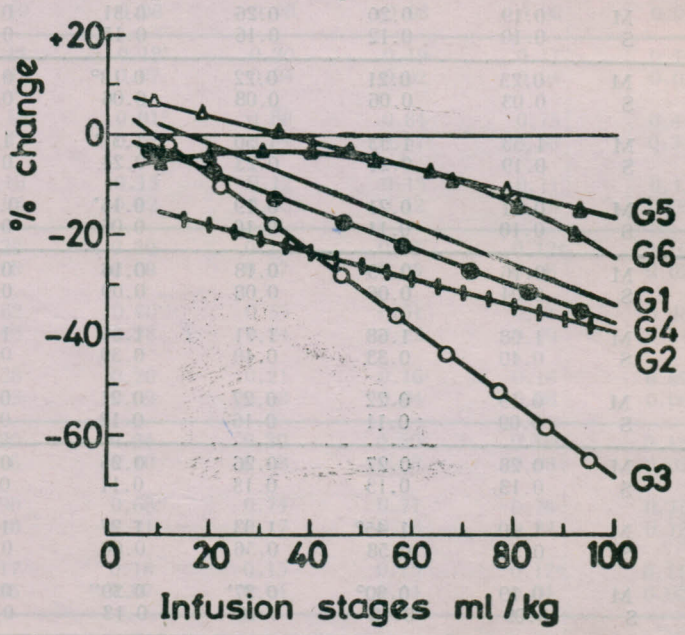

Fig. 1: Regression curves of % changes in basal amplitude of P wave of ECG during 0 to 100 *ml* stages of infusion in intact groups of dogs.

TABLE II: Amplitude of ECG waves (in mV) during infusion schedule in intact group of dogs.

			Basal	*Infusion stages (ml/kg) body weight*				
				10	25	50	75	100
G1	P	M	0.30	0.28	0.29	0.30	0.21°	0.22°
		S	0.14	0.12	0.11	0.15	0.11	0.09
	QRS	M	1.01	1.12'	1.10	1.00	0.77	0.76
		S	0.50	0.53	0.51	0.48	0.47	0.46
	T	M	0.12	0.12	0.14	0.14	0.14	0.11
		S	0.05	0.05	0.06	0.08	0.09	0.09
G2	P	M	0.30	0.24'	0.25''	0.23'	0.17'	0.18'
		S	0.05	0.06	0.05	0.03	0.06	0.03
	QRS	M	0.93	1.06'	0.96	0.90	0.73	0.67
		S	0.44	0.41	0.48	0.49	0.49	0.51
	T	M	0.13	0.14	0.13	0.14	0.11	0.13
		S	0.08	0.11	0.08	0.11	0.08	0.08
G3	P	M	0.36	0.31	0.34	0.33°	0.15'	0.10'
		S	0.05	0.06	0.02	0.04	0.11	0.14
	QRS	M	1.27	1.13	1.18	1.13°	1.03	1.00
		S	0.61	0.57	0.55	0.55	0.50	0.00
	T	M	0.19	0.20	0.26	0.31	0.29	0.33
		S	0.10	0.12	0.16	0.15	0.17	0.03
G4	P	M	0.23	0.21	0.22	0.18°	0.17'	0.15'
		S	0.03	0.06	0.08	0.06	0.05	0.06
	QRS	M	1.53	1.53	1.50	1.37'	1.32''	1.21''
		S	0.19	0.21	0.23	0.24	0.21	0.21
	T	M	0.21	0.21	0.19	0.15'	0.14'	0.13'
		S	0.10	0.11	0.10	0.06	0.05	0.05
G5	P	M	0.16	0.15	0.18	0.16	0.17	0.12'
		S	0.04	0.06	0.08	0.09	0.08	0.02
	QRS	M	1.68	1.68	1.71	1.56	1.47	1.45°
		S	0.40	0.33	0.40	0.39	0.29	0.26
	T	M	0.19	0.22	0.27	0.21	0.22	0.20
		S	0.09	0.11	0.16	0.12	0.12	0.12
G6	P	M	0.28	0.27	0.26	0.25	0.24	0.19°
		S	0.13	0.13	0.13	0.11	0.14	0.08
	QRS	M	1.40	1.45°	1.33	1.27	1.25°	1.15'
		S	0.55	0.58	0.56	0.60	0.57	0.57
	T	M	0.19	0.30°	0.37'	0.39''	0.38'	0.36'
		S	0.09	0.18	0.16	0.13	0.17	0.15

M = Mean, S = Standard deviation, °, ', '', = significant at P <0.1, 0.05, 0.01, respectively over their basal value. See Table I for other abbreviations.

TABLE III: Amplitude of ECG waves (in mV) during infusion schedules in experimental surgery groups.

			Basal	*New basal*	*Infusion stages (ml/kg) body weight*				
					10	25	50	75	100
	P	M	0.41	0.41	0.36+	0.33+	0.32*	0.27*	0.24*
		S	0.12	0.12	0.12	0.12	0.10	0.11	0.08
G7	QRS	M	1.00	0.88'	0.97+	0.99+	0.98	0.87	0.78
		S	0.36	0.36	0.36	0.34	0.34	0.34	0.35
	T	M	0.28	0.27	0.24+	0.23+	0.23c	0.23	0.23
		S	0.19	0.19	0.17	0.17	0.16	0.13	0.13
	P	M	0.19	0.31'	0.34	0.30	0.28	0.24+	0.23*
		S	0.13	0.05	0.07	0.05	0.08	0.05	0.06
G8	QRS	M	1.65	1.62	1.49+	1.48*	1.38+	1.23+	1.30+
		S	0.54	0.46	0.46	0.48	0.29	0.28	0.32
	T	M	0.15	0.11	0.14	0.13	0.11	0.10	0.09
		S	0.08	0.10	0.10	0.04	0.05	0.06	0.02
	P	M	0.16	0.23	0.23	0.21	0.18+	0.15+	0.12*
		S	0.07	0.05	0.05	0.05	0.07	0.04	0.02
G9	QRS	M	1.35	1.20	1.10	1.16	1.09	0.98c	0.94c
		S	0.29	0.35	0.28	0.27	0.25	0.20	0.20
	T	M	0.17	0.11	0.13	0.13	0.12	0.11	0.11
		S	0.10	0.08	0.08	0.08	0.08	0.07	0.07
	P	M	0.11	0.18'	0.20	0.19	0.17	0.14	0.12+
		S	0.02	0.07	0.04	0.02	0.04	0.02	0.02
G10	QRS	M	1.18	0.91°	0.88	0.84	0.75	0.44+	0.38+
		S	0.32	0.51	0.54	0.57	0.58	0.31	0.25
	T	M	0.10	0.13	0.12	0.13	0.11	0.11	0.10
		S	0.05	0.12	0.10	0.12	0.10	0.07	0.07
	P	M	0.23	0.20	0.21	0.15	0.12c	0.10+	0.13
		S	0.08	0.08	0.07	0.05	0.06	0.02	0.04
G11	QRS	M	1.62	0.60"	0.55	0.51	0.51	0.43c	0.37+
		S	0.63	0.28	0.24	0.22	0.29	0.24	0.21
	T	M	0.28	0.20	0.21	0.16	0.16	0.09c	0.09+
		S	0.23	0.09	0.08	0.04	0.08	0.06	0.02
	P	M	0.20	0.24	0.20	0.20	0.18c	0.15+	0.15+
		S	0.06	0.10	0.08	0.08	0.08	0.05	0.05
G12	QRS	M	1.90	0.68"	0.74	0.71	0.76	0.73	0.72
		S	0.48	0.21	0.17	0.18	0.22	0.18	0.19
	T	M	0.17	0.18	0.15	0.15	0.12c	0.11c	0.09+
		S	0.05	0.07	0.04	0.04	0.04	0.02	0.02

M = Mean, S = Standard deviation, c,+, * = Significant at $P < 0.1$, 0.05 and 0.01, respectively over the respective new basal value. See Table I and II for other abbreviations.

TABLE IV: Net effect of entire infusion schedule on ECG wave amplitude.

			Intact groups						*Experimental surgery groups*					
			G1	*G2*	*G3*	*G4*	*G5*	*G6*	*G7*	*G8*	*G9*	*G10*	*G11*	*G12*
P	(1)		-15.7	-27.6	-32.4	-19.7	-4.8	-9.1	-26.1	42.6	15.4	46.0	-39.5	-13.2
									(0.0)	(63.0)	(47.5)	(64.9)	(-14.5)	(20.5)
	(2)		0.72	0.77	0.91	0.90	0.61	0.78	0.97	0.94	0.98	0.96	0.91	0.93
	(3)	G	G11	G3	G2	G7	G4	G1	G12	G6	G5	G9	G8	G10
		M	-39.5	-32.4	-27.6	-26.1	-19.7	-15.7	-13.2	-9.1	-4.8	15.4	42.6	46.0
QRS	(1)		-6.6	-8.2	-16.5	-9.6	-5.8	-8.5	-6.8	-16.9	-21.7	-44.1	-70.9	-60.9
									(-12.0)	(-1.0)	(-11.1)	(-23.2)	(-62.9)	(-64.1)
	(2)		0.88	0.99	0.94	0.97	0.83	0.99	0.92	0.93	0.92	0.98	0.94	@
	(3)	G	G11	G12	G10	G9	G8	G3	G4	G6	G2	G7	G1	G5
		M	-70.9	-60.9	-44.1	-21.7	-16.9	-16.5	-9.6	-8.5	-8.2	-6.8	-6.6	-5.8
T	(1)		8.4	-0.7	51.9	-23.2	17.6	95.7	-17.9	-23.8	-32.5	18.4	-51.1	-31.3
									(-4.0)	(-26.0)	(-35.0)	(29.1)	(-26.7)	(5.2)
	(2)		0.73	0.64	0.90	0.90	0.88	0.60	0.80	0.97	0.46*	0.58	0.90	0.90
	(3)	G	G11	G9	G12	G8	G4	G7	G2	G1	G5	G10	G3	G6
		M	-51.1	-32.5	-31.3	-23.8	-23.2	-17.9	-0.7	8.4	17.6	18.4	51.9	95.7

Note : (1) Net % change in basal values during entire infusion schedule; values in the parentheses indicate % change in basal value after experimental surgery.

(2) R-value of the fitted regression curve; all the R-values are significant at $P<0.01$, $*P<0.05$; @ No regression

(3) Intergroup comparison of net % changes: (Note : (a) net % changes have been arranged in the ascending order, (b) values connected by lines do not differ significantly among them. $P>0.05$).

G = Group, M = Net % change during entire infusion schedule

Intact groups:

NS infusion (G1): This infusion schedule caused 15.7% and 6.6% net decrease in P and QRS amplitudes but T wave showed 8.4% net increase. The P and QRS amplitudes decreased

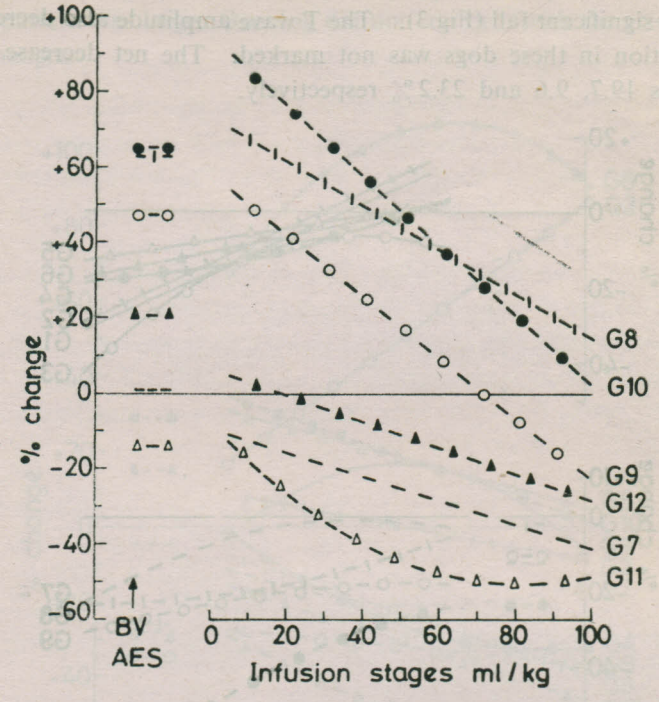

Fig. 2: Regression curves of % changes in basal amplitude of P wave of ECG during 0 to 100 *ml* stages of infusion schedule in experimental surgery groups of dogs. BV AES- Basal values after experimental surgery.

linearly and inversely (not significant) after showing slight increase in their amplitude during early infusion stages (Fig. 1 and 3). The T wave regression curve (Fig. 4) resembled the rainbow terminating below basal line at the end of infusion schedule. There was vast individual variation in the magnitude of response in this group.

RL infusion (G2): During this infusion schedule, there was 26.7%, 8.2% and 0.7% net decrease in P, QRS and T waves. P wave showed sustained significant fall but the QRS and T waves showed an initial increase (not significant) and then a decrease. Large individual variation was present in QRS and T wave changes.

TCW infusion (G3): The P and QRS amplitude decreased significantly (Fig. 1 and 3) during this infusion; in contrast the T wave amplitude increased linearly and significantly (Fig.4). In this group, one dog died at 90 *ml* infusion stage while others withstood a 120 *ml/kg* body weight

dose. Intra-group variation was less marked. The P and QRS amplitudes showed 32.4% and 16.5% net decrease while the increase in T wave was 51.9%.

NS infusion (G4): This NS infusion caused a linear and significant decrease in P wave (Fig. 1), but the QRS showed a biphasic response of initial increase (upto 20 *ml* stage) followed by a prolonged linear and significant fall (Fig.3). The T wave amplitude also decreased progressively. The individual variation in these dogs was not marked. The net decrease in P, QRS and T wave amplitudes was 19.7, 9.6 and 23.2% respectively.

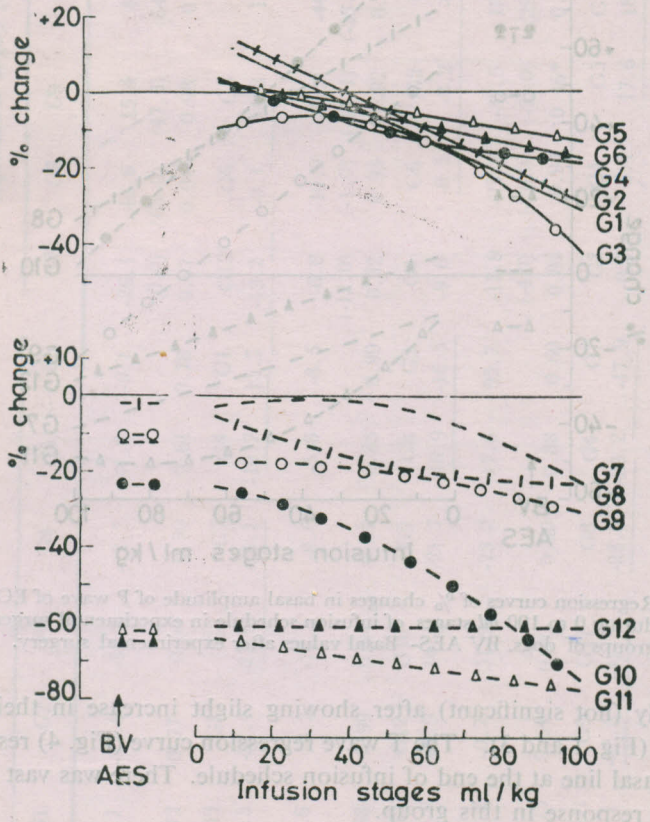

Fig. 3: Regression curves of % changes in basal amplitude of QRS complex of ECG during 0 to 100 *ml* stages of infusion schedule. *Top* - Intact groups; *Bottom* - Experimental surgery groups.

RL infusion (G5): RL infusion caused a biphasic response of initial increase not (significant) followed by a gradual decrease in P wave. The change in QRS amplitude was qualitatively similar to that of P wave. In contrast, the T wave amplitude increased rapidly during early infusion stages but as the infusion progressed it decreased towards the basal values. Intragroup variation in the response pattern was large.

TCW infusion (G6): This caused a 9.1% and 8.5% net decrease in P and QRS amplitudes which were significant at many infusion stages. In contrast to this, T wave amplitude

showed a marked net increase (95.7%). The P wave regression curve was quadratic and ran below the basal line throughout the infusion schedule (Fig. 1), while the QRS regression curve showed a linear and inverse decrease (Fig. 3). The T Wave regression curve was hyperbolic and was high above the basal curve (Fig. 4). The individual variation in P wave and QRS response pattern was large. One dog did not conform with the group behaviour in respect of T wave changes.

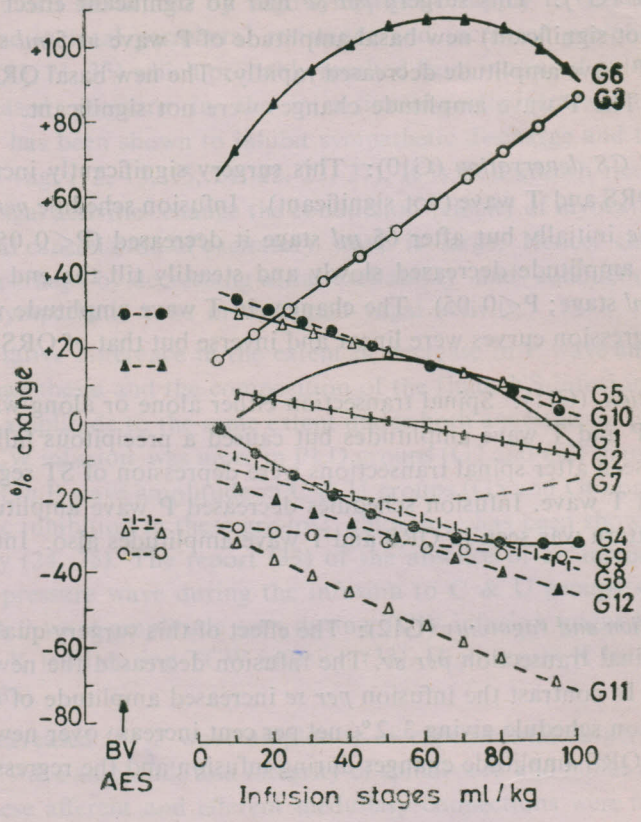

Fig. 4: Regression curves of % changes in basal amplitude of T wave of ECG during 0 to 100 *ml* stages of infusion schedule in intact (G1 to G6) and experimental surgery groups of dogs (G7 to G12).

Experimental surgery groups:

Vagotomised dogs (G7): Vagotomy had no significant effect on P and T wave amplitudes but reduced the QRS amplitude significantly ($P<0.05$). Infusion of RL *per se* significantly decreased the P and T wave amplitudes. The P wave regression curve was inverse and linear, while T wave regression curve had a parabolic relation. The infusion increased the QRS amplitude over the new basal value upto 70 *ml* stage after which it decreased below it. The net per cent P, QRS and T wave amplitude changes over new basal values were –26.1, +5.2 and –13.9%, respectively.

Vagotomised dogs (G8): Vagotomy in C & U group increased ($P<0.05$) amplitude of P bu had no significant effect on QRS and T waves. However, the infusion *per se* significantly decreas the new basal amplitude of P and QRS waves while the changes in T wave were not significant ($P>0.1$). The P and T wave regression curves (Fig. 2 and 4) showed an inverse linear relationship except during initial stages of infusion. The QRS regression curve (Fig 3) had an inverse quadratic relationship. Intragroup variation was less.

CS denervation (G9): This surgery *per se* had no significant effect on ECG amplitude. Infusion increased (not significant) new basal amplitude of P wave at 5 *ml* stage but as the infusion progressed the P wave amplitude decreased rapidly. The new basal QRS amplitude was decreased by infusion. The T wave amplitude changes were not significant.

Vagotomy and CS denervation (G10): This surgery significantly increased P wave amplitude but decreased QRS and T wave (not significant). Infusion schedule *per se* slightly increased the P wave amplitude initially but after 65 *ml* stage it decreased ($P<0.05$ after 85 *ml* stage). The new basal QRS amplitude decreased slowly and steadily till the end of infusion schedule (significant after 70 *ml* stage; $P<0.05$). The changes in T wave amplitude were highly variable. The P and T wave regression curves were linear and inverse but that of QRS wave was quadratic.

Spinal transection (G11): Spinal transection either alone or along with vagotomy had no significant effect on P and T wave amplitudes but caused a precipitous fall in QRS amplitude. Other ECG changes seen after spinal transections were depression of ST segment and depressed, indistinct or inversed T wave. Infusion schedules decreased P wave amplitude gradually. Same type of regression pattern was seen in QRS and T wave amplitudes also. Intragroup variation in this was less.

Spinal transection and vagotomy (G12): The effect of this surgery qualitatively and quantitatively similar to spinal transection *per se*. The infusion decreased the new basal amplitude of P and T like in G11. In contrast the infusion *per se* increased amplitude of QRS complex almost throughout the infusion schedule giving 3.2% net per cent increase over new basal values. There was no regression in QRS amplitude changes during infusion and the regression line was parallel to basal line.

DISCUSSION

The NS, RL and TCW infusions to PLD and C & U anaesthetised dogs decreased the P and QRS amplitudes but the T wave changes depended upon the anaesthesia and the type of fluid infused. In experimental surgery group also the RL infusion decreased the P wave and QRS amplitudes irrespective of the integrity of the vagus, CS nerve and spinal cord but T wave changes varied. This indicates that irrespective of the type of fluid infused, anaesthetic agents employed and the connectivity of the baroreceptors and the spinal cord, the fluid infusion decreases the amplitude of ECG waves.

P wave:

The present findings could not be compared directly with the infusion induced ECG changes reported by earlier workers (1, 2, 18, 35) because the changes reported in literature were not of progressive in nature. Occurrence of consistent decrease in P and QRS amplitudes points out to the possibility that the increase in blood volume had some effect on the electrodynamics of the heart which lead to decreased amplitude of ECG waves. The excitability and conduction in myocardium is very much influenced by vago-sympathetic supply to heart. Many workers have reported a decrease in total peripheral resistance and increased peripheral blood flow during infusion of fluids (13, 21, 33) which probably resulted from increased pulmonary arterial pressure (6, 7). An increased pressure in the intra-sinusal-aortic/intracardiac and other regions of circulatory system has been shown to inhibit sympathetic discharge and to increase the impulse activity in cardiac vagi (12, 13, 15, 21, 22, 23, 27). It is well known that alterations in cardiac sympathetic and vagal activities change the conduction velocity of myocardium (31). During slow conduction, mutual cancellation of excitatory wave is large. Hence, the infusion decreased P wave amplitude perhaps by decreasing atrial excitability and conduction velocity subsequent to the decreased sympathetic tone or increased vagal activity.

The quantitative difference in the extent of decrease in P wave amplitude appeared to be the function of anaesthesia and the composition of the fluid. NS infusion (G1 and G4, Table II) decreased P wave amplitude to the same extent under both anaesthesia. Fall in P wave amplitude during RL and TCW infusion was more in PLD groups (G2 and G3) than C & U groups (G5 and G6). Marginal fall in P wave amplitude in C & U groups (G5 and G6) probably resulted because of less sympathetic inhibition in these groups: chloralose has been shown to depress the CS baroreceptor activity (24, 25). The report (33) of the absence of an increase in the amplitude of peripheral blood pressure wave during the infusion to C & U groups support this conclusion. The largest fall in P wave amplitude seen during TCW infusion might have resulted from high increase in serum K level during TCW infusion (33). High serum K has been reported to cause such effects (5, 35).

Infusion decreased the P wave amplitude of experimental surgery groups irrespective of the pre-infusion P wave amplitude and integrity of spinal cord and buffer nerves. This observation suggested that these afferent and efferent medullary connections were not essential for such inhibition. Many workers have shown that visceral and autonomic reflexes including cardiovascular reflexes were operative in spinal animals (3, 4, 8, 9, 14,16, 17, 19, 20) and may account for the present finding. The P wave amplitude decreased even in vagotomised-spinal dogs. These evidences confirm the above conclusion that P wave amplitude change probably resulted from direct effect of mere increase in circulating fluid volume on heart or through cardiospinal reflexes.

QRS complex:

The QRS amplitude decreased during all the infusion schedules except in vagotomised (PLD dogs) and vagotomised-spinal dogs. The QRS amplitude increased during initial infusion

stages, and as the infusion progressed it decreased (Fig. 3). This, in some respects, agrees with the observations of earlier workers (1, 2, 18). The initial increase in QRS probably results from the increased cardiac dynamics due to increased venous return. The reports of increased blood pressure, cardiac output, stroke volume and mean systemic, pulmonary and venous pressure and intracardiac pressures during infusion of fluids (10, 11, 13, 30, 37) give support to the above conclusion. As this increase was also seen in vagotomised and vagotomised-spinal dogs, this effect did not appear to be a centrally modulated reflex.

Progressive fall in QRS amplitude (as in G3, G8, G9, G10 and G11) and the fall during later stages of infusion schedule (as in G1, G2, G4, G5, G6 and G7) was difficult to account for. As this decrease was seen even after buffer nerve denervation and spinal transection, this effect also did not appear to be a centrally modulated reflex but rather as a direct effect of increased fluid volume on the heart. Depression of myocardium by spinal cardiac centers and haemodilution induced myocardial hypoxia could be the other contributory factors. The large net decrease in QRS amplitude, in contrast to the report of Suresh and Hegde (35), seen during TCW infusion in PLD group (G3) probably resulted from an increased serum K and Ca concentration as reported by Suresh (33) during TCW infusion. Butcher *et al.* (5) observed that excess of K and Ca decreased QRS amplitude. The large amplitude of fibrillatory waves reported by Suresh and Hegde (35) were not seen in the present study. The infusion of 100 *ml/kg* of TCW with high K and Ca and low Na content (33, 34) to C & U groups (G6) caused only non fatal morphological changes in ECG. This indicated that C & U anaesthetised dogs can withstand infusion of large quantity of K and Ca ions as against PLD groups. Probably the high concentration of Ca in TCW antagonised the myocardial depression effect of K ions.

T wave :

Infusion had varied effects on T wave amplitude in intact dogs. Increased vagal tone augmented and sympathetic decreased T wave (31). NS infusion decreased T wave in C & U group (G4) while it caused a small net increase in PLD group (G1). This significant decrease seen in G4 might have resulted in increased vagal tone or from accumulation of Na^+ ions during saline infusion (28) which might depress the myocardium. However, this effect was not seen in G1 probably because of the cholinergic blocking effect of PLD (26, 29). The TCW infusion increased T wave. This sustained increase might have resulted from increased serum Ca and K levels caused by TCW infusion (5, 33). RL infusion had no significant effect in PLD group but in C & U group it caused a 17.6% net increase. It is concluded that infusion induced T wave changes depend upon the type of anaesthesia and composition of infusion fluid, the changes being minimal in PLD groups. Inhibition of cholinergic transmission by PLD (26) and baroreceptor sensitivity by chloralose (24,25) might play a role. The consistent increase in T wave during Ca^+ and K^+ rich TCW infusion and its absence during RL infusion (balanced fluid) and its fall during NS infusion indicated that Na, K and Ca ions may also play a very important role in causing infusion induced T wave changes.

In contrast to intact dogs (G2) the infusion decreased the T wave amplitude of vagotomised PLD groups (G7). This effect of vagotomy in modifying T wave changes in this group was difficult to explain. Infusion decreased the T wave of spinal and vagotomised spinal dogs (G11 and G12). The ECG of spinal dogs showed changes like depression of ST segment, and depressed, indistinct or inverted T waves which indicated myocardial hypoxia (36). Further, a fall in T wave amplitude during infusion appeared to be due to a further deterioration of oxygen supply to myocardium and the infusion induced haemodilution. However, the simultaneous increase in QRS amplitude in G12 did not favour this assumption. Infusion caused only minor changes in new basal T wave amplitude of vagotomised and /or CS denervated dogs (G8, G9 and G10) which was similar to the changes seen in intact dogs (G5). This indicated that vagi and /or CS nerve had virtually no influence on infusion induced T wave changes in C & U groups. It is concluded that the intravenous infusion of fluids even at slow rate induces significant ECG amplitude changes. The buffer nerves and cerebrospinal continuity play only a minor role in further modulating the infusion induced ECG changes.

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