EFFECT OF INTRAVENOUS INFUSION OF CALCIUM ON SHEEP E.C.G.

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Summary: The effect of intravenous infusion of 18% calcium gluconate on sheep heart as revealed by ECG has been studied. There was significant prolongation of P Wave, shortening of QT interval and ST segment at a serum calcium varying from 21.36 to 41.45 mg%. The PR interval and duration of QRS complex were prolonged but the former was not significant at all dose levels. The amplitudes of R and T waves were significantly increased.

The infusion of calcium gluconate also caused sinus arrhythmia with varying degrees of bradycardia followed by tachycardia. Atrioventricular blocks and premature beats were also encountered.

Key words: calcium gluconate ECG sheep

INTRODUCTION

The electrocardiographic changes in hypercalcaemia in dog (7), in rabbit (5, 6), in dairy calves (1, 2) and in anaesthetized sheep (12) have been reported.

In the present study effects of intravenous infusion of 18% calcium gluconate injected at the rate of 2 *ml* per minute on ECG in unanaesthetized sheep have been reported. Calcium concentration in the serum has been estimated and an attempt has been made to study the relationship between the calcium-induced arrhythmias and serum concentration.

MATERIALS AND METHODS

A total of nine healthy sheep (34 to 41 *kg*) were used. The study was conducted using a special type of stock (Fig. 1) constructed for restraining the head of the animal steady during the experiment. Both the jugular veins were cannulated with polythylene catheters after passing them through 14 gauge needle and were kept in position by means of adhesive tapes. One of these was employed for infusing 18% calcium gluconate at the rate of 2 *ml* per min. This was made possible by designing a special arrangement through which a constant pressure could be applied to a combination of burettes and a chosen amount of resistance was applied to the outflow from the infusion tubing (Fig. 1). The other was used for withdrawing blood samples at various dose levels. Total serum calcium was estimated according to Clarke-Collip

method (4). Single channel Sanborn Visocardiette was used for recording ECG, at different levels of infusion. Axial lead designed by Sellers *et al.* (11) was employed.

The ECG data were statistically analysed by student 't' test (8).

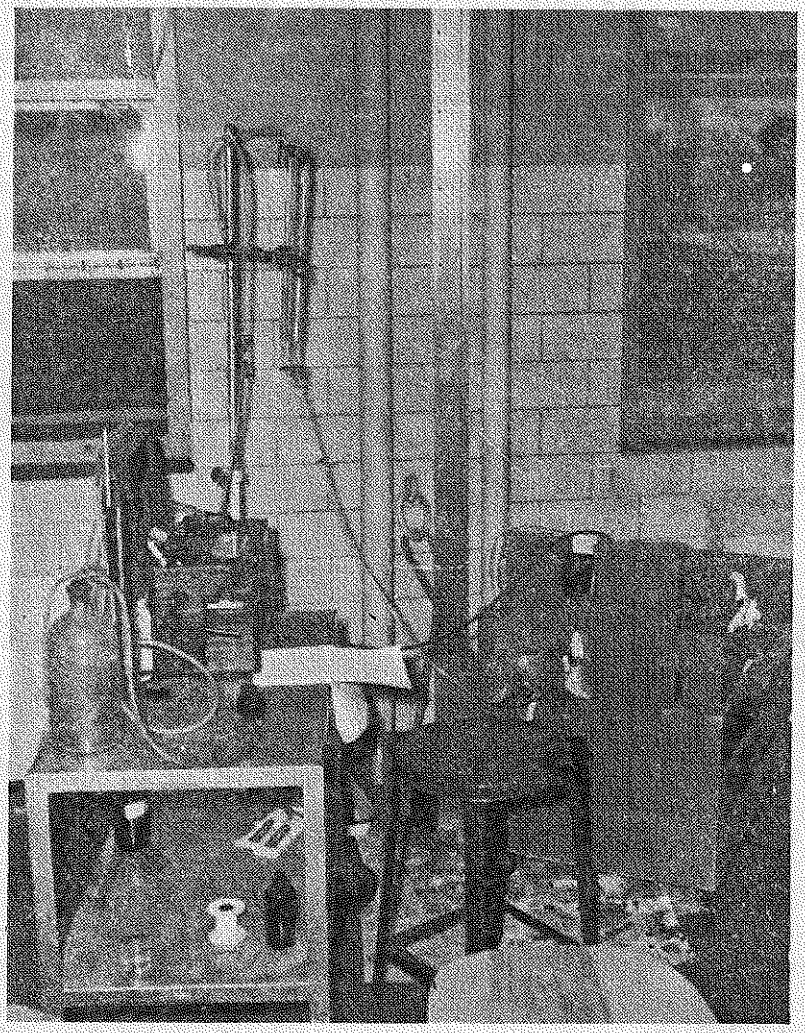

Fig. 1: Arrangement of the experiment for restraining the animal and for intravenous infusion of 18% calcium gluconate.

RESULTS

The effects of intravenous infusion of 18% calcium gluconate on various components of ECG, viz. intervals and amplitude are shown in Tables I and II respectively.

INTERVALS

P Wave: There was significant prolongation with 245±4.50 to 730±20.90 *mg/kg* doses of calcium gluconate.

PR: It was prolonged at all dose levels and was significant at 245±4.50 and 730±20.90 *mg/kg* doses.

QRS: The duration of QRS complex was significantly prolonged with 245±4.50 to 587±12.70 *mg/kg* doses of calcium gluconate.

QT: The QT interval was significantly shortned with 245±4.50 to 730±20.90 *mg/kg* doses.

Heart rate: The changes in the heart rate were not significant.

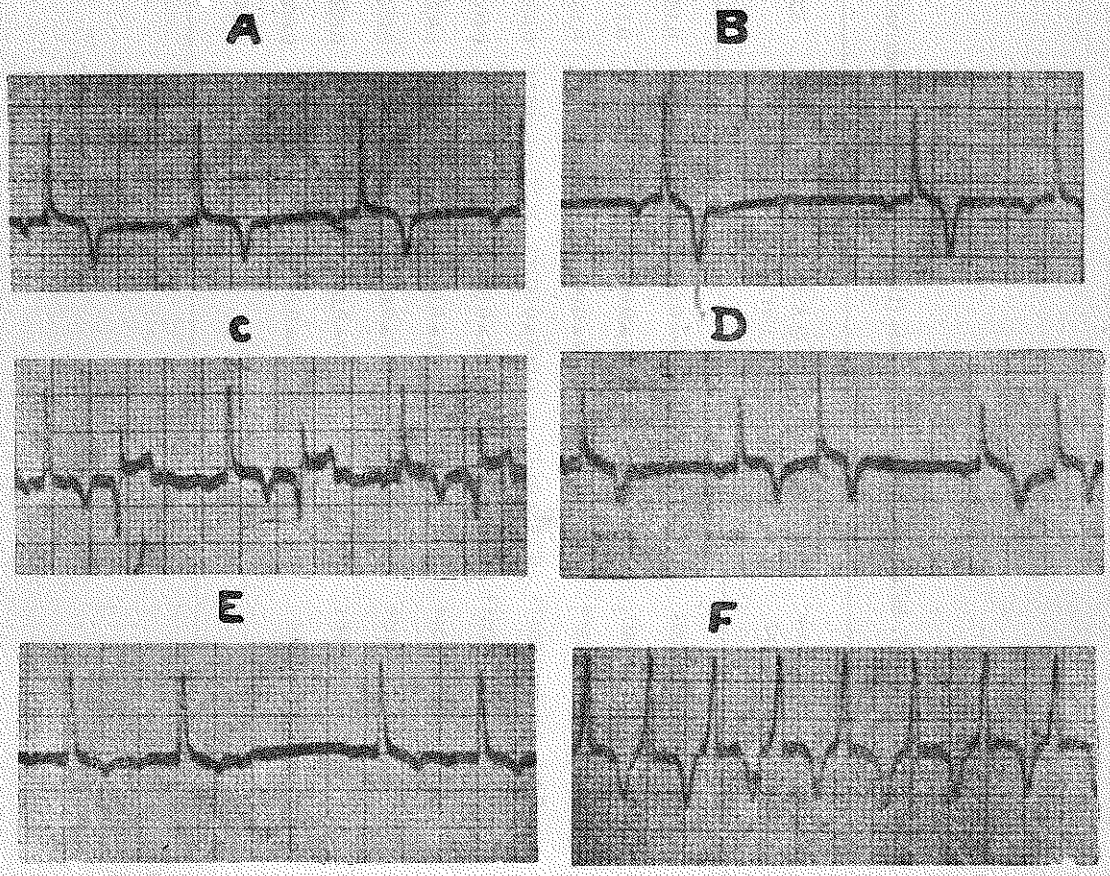

Fig. 2: ECG changes during i.v. infusion of 18% calcium-gluconate in sheep
A. Control ECG record-axial lead
B. Sinus arrhythmia (irregular pacing of heart beats) with bradycardia
C. Rhythm disturbed with premature beats
D. Bigeminal rhythm
E. Atrio-ventricular blocks
F. Sinus tachycardia

TABLE I: Effect of I.V. infusion of calcium gluconate (18%) on sheep ECG (Intervals).

	Dose	*No. of animals*	*P wave (Sec)*	*P R interval (Sec)*	*Q R S (Sec)*	*Q T intervals (Sec)*	*ST Segment (Sec)*	*Heart rate per min.*
Control	—	9	0.066 ± 0.003	0.144 ± 0.005	0.058 ± 0.003	0.278 ± 0.009	0.153 ± 0.009	91.111 ± 5.879
20	98 ± 2.00	9	0.071 ± 0.003	0.136 ± 0.005	0.064 ± 0.005	0.278 ± 0.002	0.116 ± 0.012	80.000 ± 4.714*
50	245 ± 4.50	9	0.078 ± 0.02**	0.172 ± 0.010*	0.069 ± 0.003**	0.256 ± 0.005**	0.104 ± 0.010**	81.111 ± 5.638
80	392 ± 6.10	9	0.082 ± 0.004**	0.167 ± 0.012	0.069 ± 0.003**	0.258 ± 0.005**	0.085 ± 0.010**	93.333 ± 6.500
100	490 ± 6.70	9	0.080 ± 0.004**	0.170 ± 0.013	0.076 ± 0.004**	0.247 ± 0.006**	0.063 ± 0.009**	95.550 ± 12.700
120	587 ± 12.70	8	0.080 ± 0.004*	0.160 ± 0.018	0.078 ± 0.005*	0.245 ± 0.014**	0.057 ± 0.010**	103.750 ± 12.950
150	730 ± 20.90	7	0.080 ± 0.005*	0.170 ± 0.009*	0.071 ± 0.005	0.240 ± 0.006**	0.052 ± 0.011**	102.850 ± 9.870
180	884 ± 36.00	4	0.075 ± 0.006	0.150 ± 0.006	0.080 ± 0.008	0.225 ± 0.009	0.050 ± 0.009	130.000 ± 13.840
200	1030 ± 29.90	2	0.080 ± 0.006	0.180 ± 0.020	0.070 ± 0.010	0.240 ± 0.020	0.050 ± 0.009	110.000 ± 10.000
250	1325	1	0.080	0.180	0.100	0.240	0.040	120.000

*Significant at $P<0.05$

**Significant a $P<0.01$

TABLE II: Effect of intravenous infusion of calcium gluconate (18%) on Sheep ECG (Amplitudes).

Dose		No. of animals	Serum calcium (mg/100 cc)	P wave (mm)	R wave (QRS) (mm)	T wave (mm)
ml	mg/kg					
Control	—	9	9.21±0.25	0.966±0.311	10.388±3.443	3.611±1.026
20	98±2.00	9	15.04±0.69	0.838±0.139	10.500±1.305	4.611±1.393
50	245±4.50	9	21.36±0.06	0.777±0.120	14.000±1.224*	5.111±1.450
80	392±6.10	9	26.54±1.16	0.833±0.117	14.440±1.405**	5.888±1.195
100	490±6.70	9	31.48±1.76	0.875±0.182	14.888±1.206**	6.888±1.130*
120	587±12.70	9	35.28±0.77	0.714±0.147	15.125±1.366**	6.875±1.171*
150	730±20.90	7	41.56±1.30	0.714±0.147	16.071±2.019*	7.428±1.302*
180	884±36.00	4	47.63±1.92	0.750±0.249	20.750±2.982*	8.500±1.500*
200	1030±29.90	2	54.65±1.41	0.500±0.000	17.500±4.500	8.250±2.749
250	1325	1	60.00	1.000	21.000	10.000

*Significant at $P<0.05$
**Significant at $P<0.01$

AMPLITUDE

QRS: (R Wave): The amplitude was significantly increased with 245±4.50 to 884±36.00 *mg/kg* dose of calcium gluconate.

T Wave: The amplitude was significantly increased with 490±6.70 to 884±36.00 *mg/kg* doses.

Arrhythmias in relation to serum calcium levels: Serum calcium levels achieved against different doses of calcium gluconate have been shown in Table II. Fig. 2 shows the different types of arrhythmias induced at varying serum calcium levels.

Sinus arrhythmia (irregular pacing of heart beats) with varying degrees of bradycardia was seen at serum calcium levels ranging from 15.04±0.69 to 21.36±0.06 *mg%* (Fig. 2B). In some records, the rhythm was also disturbed with premature beats at these calcium levels (Fig. 2C). Serum calcium levels ranging from 26.54±1.16 to 31.48±1.76 *mg%* resulted in bigeminal rhythm (Fig. 2D) and atrio-ventricular blocks of varying degrees (Fig. 2E). Higher serum calcium levels (35.28±0.77 to 60.00 *mg%*) usually produced tachycardia (Fig. 2F) and occasionally atrio-ventricular block.

DISCUSSION

The ECG changes after infusion of 18% calcium gluconate in this study, where the animals were unanaesthetized are similar to those reported by Souza (12) in the anaesthetized sheep. However, it took lesser doses of calcium to produce these changes as compared to anaethetized sheep.

Calcium infusion resulted in varying types of arrhythmias. The initial sinus arrhythmia with varying degrees of bradycardia may be attributed to vagal stimulation as reported by Hoff *et al.* in dog (7). Sporri and Raggenbars (10) and Craige (3) in cows have also reported initial bradycardia during calcium administration. Further increase in calcium level may have a suppressing effect on cardiac vagal activity and slowing of the spontaneous rhythm which may lead to varying types of atrioventricular blocks as seen in this study. Alternatively changes in the cardiac adrenergic mechanisms may be responsible for tachycardia and increase in the ventricular automaticity leading to different types of ectopic beats. Leonard and Hadju (9) have also suggested that increased calcium concentration may slow the spontaneous rhythm which leads to blocks in impulse conduction. However, further work is required to be done in order to elucidate the exact mechanism of the cardiac arrhythmias.

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