The Effect of Ethanol Infusion on the Calcium-Phosphorus Balance in Man

In the normal organism the calcium concentration of the interstitial fluids is stable, and it is difficult to disturb this equilibrium. However, administration of ethanol to a healthy person is known to produce increased excretion of calcium in the urine[1-3]. ALHA[4] has observed changes in serum calcium homeostasis in connection with oral ethanol administration, but these changes were not considered to be significant. The authors have studied the effect of intravenously administered ethanol on the calcium concentration in serum. At the same time, the inorganic phosphorus content of the serum and the excretion of calcium and inorganic phosphorus in the urine during and after ethanol infusion were followed.

Material and methods. 50 ml of 94% ethyl alcohol were given intravenously in 500 ml of 0.9% sodium chloride solution, in a 3 h infusion, to 7 female and 2 male patients hospitalized for various internal complaints. None of these test subjects was an alcoholic. Blood specimens were drawn for electrolyte analysis just before and 1, 2 and 3 h after the start of the infusion, and 2, 5 and 17 h after its completion. In some cases urine specimens were taken when the patients voided their bladders at the beginning of the infusion; the urine excreted during the infusion (3 h) and within 3 h of the end of the infusion was collected.

Serum calcium was determined by ethylene diamine tetraacetic acid titration, using Calcon® indicator. The calcium in urine was determined by the same method after the phosphates had been precipitated by morpholine nitrate[5]. Inorganic phosphorus in the serum and urine was determined according to DRYER et al.[6]. The activity of alkaline phosphatase in serum was determined by the BESSEY et al.[7] method, and creatinine in urine according to OWEN et al.[8].

Results. The serum levels of calcium and inorganic phosphorus increased during ethanol infusion (Tables I and II). 1 h after the start of the infusion the increase of calcium over the pre-infusion level averaged 13.1%, and 2 h after the start 16.0%. The corresponding figures for inorganic phosphorus were 16.7 and 25.2%. Pre-infusion values were regained in some cases immediately after the infusion, while in many cases both the calcium and the phosphorus levels were still elevated 5 h after the infusion. After 20 h, calcium and inorganic phosphorus in serum had regained the pre-infusion level in most cases.

Table I. Serum calcium values (mg/100 ml) before (0), during (1–3 h), and after (5–20 h) the ethanol infusion. The increase after 1, 2 and 3 h is statistically significant ($p < 0.01$)

Test subject No.	Hours after the start of infusion 0	1	2	3	5	8	20
1.	13.2	14.2	15.3	15.8	15.8	–	–
2.	10.9	11.7	12.7	12.0	–	11.7	11.7
3.	8.4	9.8	10.4	10.7	9.9	9.4	8.4
4.	9.3	10.3	10.2	9.8	9.3	8.9	8.8
5.	8.0	–	10.0	8.8	8.5	9.0	8.2
6.	8.1	9.4	8.8	8.8	8.2	–	8.1
7.	7.8	8.7	9.1	8.7	8.0	–	7.7
8.	7.4	8.9	9.1	8.7	8.0	–	7.7
9.	10.2	10.7	11.0	10.5	10.3	–	–
Mean	9.3	10.5	10.7	10.4	9.8	9.8	8.7
S.D.	1.9	1.8	2.0	2.3	2.6	1.3	1.4

The excretion of calcium and inorganic phosphorus in urine, in correlation with creatinine excretion, definitely increased (Table III). In some cases the activity of alkaline phosphatase in serum increased during ethanol infusion.

Discussion. Chronic alcoholics are known to show changes in the electrolyte pattern of serum[9,10]. MARTIN et al.[10] also analysed the calcium content of the serum, which, in 20% of their cases, was below the normal level.

Table II. Serum inorganic phosphorus (mg/100 ml). Same test subjects as in Table I. The increase after 1, 2 and 3 h is statistically significant ($p < 0.001$)

Test subject No.	Hours after the start of infusion 0	1	2	3	5	8	20
1.	2.5	2.8	3.0	3.1	3.3	–	–
2.	3.7	4.0	4.5	3.9	–	3.7	3.7
3.	3.4	4.5	5.0	5.4	4.9	4.6	3.8
4.	3.9	4.4	4.2	3.8	3.5	–	3.5
5.	2.5	3.2	3.5	2.8	2.7	2.5	2.5
6.	3.7	4.1	4.3	4.7	4.7	4.0	3.7
7.	3.3	3.5	3.7	4.0	5.5	4.0	3.7
8.	3.6	3.7	4.1	4.7	4.0	3.5	3.1
9.	2.4	4.0	4.4	2.8	2.6	–	–
Mean	3.2	3.8	4.1	3.9	3.9	3.7	3.4
S.D.	0.6	0.6	0.7	0.9	1.1	0.6	0.5

Table III. Excretion of calcium and inorganic phosphorus in urine (mg/g of excreted creatinine) in some of the test subjects before, during and after ethanol infusion. The same test subjects as in Table I and Table II

Test subject No.	Before infusion Ca	P	During infusion Ca	P	After infusion Ca	P
3.	94	140	113	2590	165	4970
5.	121	1120	154	4000	144	4960
6.	110	1250	140	2730	170	3730
7.	130	1990	145	1640	158	2060
8.	115	1020	165	2480	160	2400

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As far as the authors can establish, no report other than that of ALHA[4] has been published on the effect of acute ethanol administration on the calcium level in human serum, but the excretion of calcium in urine has been found to increase[1-3]. According to the latter observations, ethanol produces no major change in the excretion of inorganic phosphorus in urine. In the present study the increase in the excretion of inorganic phosphorus was considerably more marked than that in the excretion of calcium. On the basis of the present observations, it is difficult to explain the mechanism that produces the simultaneous increase in the serum levels of calcium and inorganic phosphorus. The total dose of ethanol given was small, in all cases less than 1 mg/g body weight. The increased activity of alkaline serum-phosphatase, which was noted in some cases, suggests a mobilization of calcium and phosphorus from the bones, although not all test subjects showed increased phosphatase activity.

The increase in calcium and phosphorus content of the serum was particularly marked in two patients: No. 3, a young girl aged 15, who suffered from thyrotoxicosis, and No. 1, a man aged 40, who suffered from hyperparathyroidism (Tables I and II).

Further studies which may elucidate the mechanism by which ethanol mobilizes calcium and inorganic phosphorus, as well as studies on the kinetics of radioactive calcium and strontium in connection with ethanol administration, are in progress.

Zusammenfassung. Äthanol wurde 9 Versuchspersonen i.v. verabreicht (50 ml 94% Äthanol in 500 ml physiologischer Kochsalzlösung). Unter der Infusion stieg der Kalzium- und Phosphorgehalt des Blutserums an. Eine gleichzeitige Calciurie und starke Phosphaturie wurde beobachtet. Der Mechanismus dieser Phänomene ist noch ungeklärt.

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Presynaptic Inhibition of Trigeminal Afferent Fibres during the Rapid Eye Movements of Desynchronized Sleep

It has recently been reported that, synchronously with the rapid eye movements (REM) of desynchronized sleep, the excitability of primary afferents to the spinal cord[1-5] and cuneate nucleus[6] increases, suggesting a presynaptic inhibitory process[7] phasically acting on these terminals during the above-mentioned phase of sleep.

The aim of the present investigation has been to study, by means of WALL's technique[8], the excitability of primary trigeminal afferents to the brain stem at pontine level during the various phases of sleep and wakefulness, and particularly during the REM episodes of desynchronized sleep[9].

Methods. The experiments were performed on unanaesthetized unrestrained cats with chronic implanted electrodes. The electroencephalogram (EEG), the electromyogram of the cervical muscles (EMG) and the electrooculogram (EOG) were recorded by an ink-writer electroencephalograph. The stimulation of the trigeminal afferents was achieved monopolarly through a stainless steel microelectrode (50,000–100,000 Ω) stereotaxically introduced into the rostral part of the spinal tract of the trigeminal nerve at about 6–8 mm rostrally to the obex. The antidromic response evoked by stimulation of the trigeminal fibres was bipolarly recorded, with a type of electrode already described[10], from the ipsilateral infraorbital nerve after the eye was enucleated. In the same animal, chronic stimulating electrodes were also inserted underneath the skin of the nose in order to stimulate cutaneous afferents of the trigeminal territory able to depolarize the infraorbital nerve afferents[11]. Through this technique the possibility that the trigeminal afferents could be depolarized by conditioning volleys in different experimental conditions was tested.

Results. (1) Single shock stimulation (2–3/sec, 0.01–0.05 msec, 30–40 V) of the trigeminal spinal tract 6–8 mm rostrally to the obex evoked in the ipsilateral infraorbital nerve an antidromic response with 0.6–0.7 msec latency. Conditioning electrical stimuli (4 impulses at 300/sec, 0.1 msec) applied to the nose during wakefulness constantly increased the amplitude of the antidromic test response recorded from the infraorbital nerve. The conditioning curve showed a time course similar to that reported in acute animals[11] with maximal facilitation (up to 30–100% of the control values) at 35–40 msec stimulus interval.

(2) The amplitude of the infraorbital antidromic spike remained stable throughout the entire periods of relaxed wakefulness and synchronous sleep. No tonic modifications of the response were ever observed as the animal passed from synchronized to desynchronized sleep. During the latter phase the amplitude of the antidromic response did not change when the REM were absent (Figure). Synchronously with the most intense periods of REM, a phasic increase of the infraorbital antidromic spike amplitude occurred (Figure). The amplitude variations were

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