

XLIX. THE DIURETIC ACTION OF VITAMIN C

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DURING past work on the excretion of vitamin C by human subjects I have repeatedly observed that the volume of urine excreted was significantly increased after the administration of a test dose of ascorbic acid. I have refrained from drawing attention to this finding in earlier publications, because of the fact that in these experiments the fluid intake, as well as the other factors which are known to influence diuresis, were not specially controlled. In the experiment described in the present paper the effect of administration of large doses of vitamin C (as ascorbic acid) on the volume of urinary excretion in human beings in different states of vitamin C nutrition has been determined under strictly controlled conditions.

EXPERIMENTAL

The following groups of children were examined: 10 active rheumatics, 10 convalescent rheumatics and 10 controls. The latter were nearly all cases of congenital deformity.

The urine of each patient was examined for its vitamin C content for a total period of 5 consecutive days. In the first 2 days the resting levels of excretion of vitamin C and of the "normal" volume of urine were determined. During the remaining 3 days a test dose (700 mg. of ascorbic acid per 10 stone of body weight) was administered daily, and the excretion of the vitamin in the urine, as well as the volume of urine, were again recorded.

The specimens of urine were examined for their vitamin C content by the method of Harris & Ray [1935], the titrations being carried out as previously described [Abbasy *et al.*, 1935]. The samples of urine were collected, with addition of acetic acid, in dark-coloured glass bottles, the night urine being analysed early in the morning and the day's urine in the evening.

Experimental conditions

Throughout the experiment the children were kept on the normal institutional diet. This was a liberal one and contained an ample supply of fruit, sufficient to bring the daily intake of vitamin C well above the reputed "minimum optimum" standard (25 mg. per day per 10 stone body weight). The solid and fluid intakes of the children were kept carefully controlled and strictly constant for about 5 days before the titrations were started, as well as during the time they were being carried out.

RESULTS

The results are shown in Fig. 1. As collection of urine started and ended for each day at 5 p.m., the test doses were administered to the children immediately after the last specimen of urine had been passed at 5 p.m. Thus the arrow,

indicating the commencement of the 3 days' test dosing, coincides with the reading of the second day's resting level.

From these curves it is evident that there occurs a marked rise in the volume of the urine whenever a response to the test dose is obtained. This result is

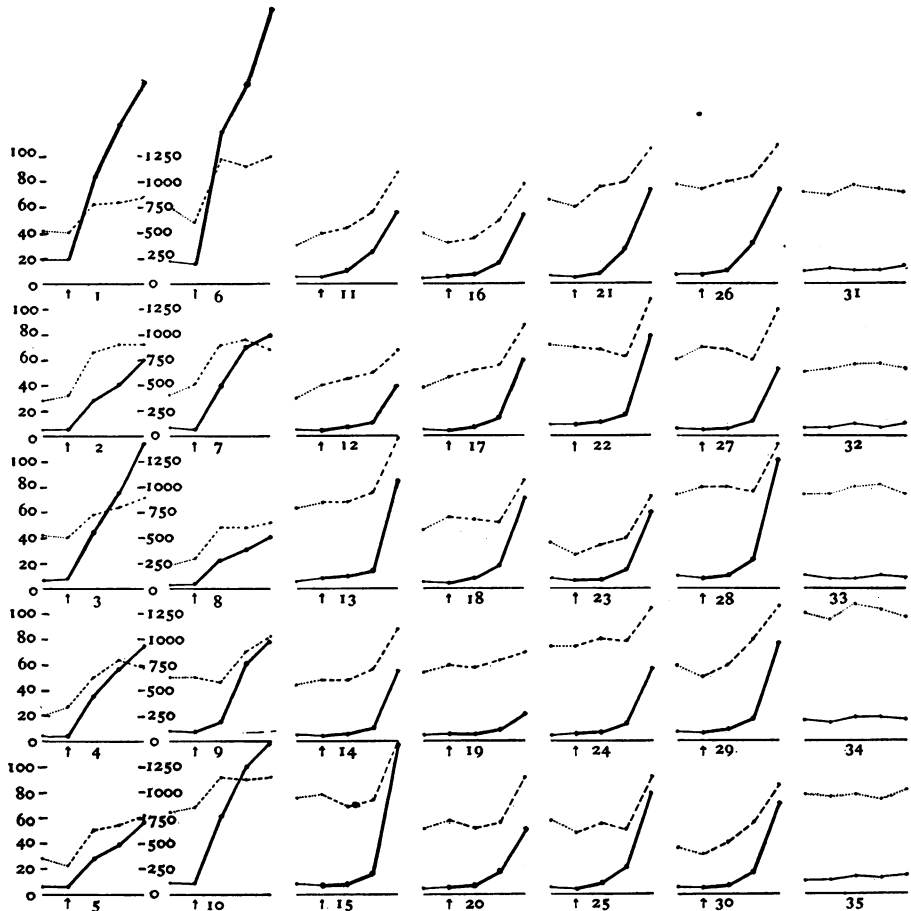


Fig. 1. Cases nos. 1-10 are positive controls; Nos. 11-20 are convalescent rheumatics; Nos. 21-30 are active rheumatics; Nos. 31-35 are negative controls. The dotted and broken lines indicate the volume of urine per 24 hours before and after test dosing, respectively. The thin and thick lines indicate the excretion of vitamin C in urine per 24 hours before and after test dosing, respectively. The arrow indicates when test dosing was started (for 3 consecutive days). Scales for ordinates = mg. of ascorbic acid (left), ml. of urine (right) excreted per 24 hours.

observed in all the subjects, rheumatics (both active and convalescent), as well as positive controls. (For the sake of comparison results with a group of negative control subjects, given no test doses of vitamin C, are also shown.)

DISCUSSION

As the solid and fluid intakes of each of these children are virtually constant during the long period of his stay in the hospital, and as they were kept strictly constant for at least 5 days before the test, it must be assumed that the consistent

rise in the volume of urine observed is due solely to the effect of administration of the test doses of ascorbic acid.

This diuretic effect of ascorbic acid may be satisfactorily explained by the work of Fliederbaum & Tislowitz [1935] who found that in dogs ascorbic acid exerts "a polyphasic effect on the affinity of the blood for water". These authors state that a single dose led to dilution of the blood, and repeated doses usually acted in the same way, but that there was no additive effect. In experimental adrenal insufficiency, they also found that a lowering of the osmotic pressure of the blood was prevented by the administration of ascorbic acid.

In the controls (who were in a normal state of vitamin C nutrition, judging by the figures of their "resting levels" and by their response to test doses) the volume of urine, as well as the excretion of vitamin C in the urine, showed definite rises from the day on which the first test dose was given, and the rise in the volume of urine persisted during the whole of the 3 days while the test doses were continued, with little or no significant variation.¹ It is repeatedly observed in these controls that the volume of urine on the third day of the test dosing is nearly the same as that on the previous day, or even slightly lower—perhaps owing to the fact that the children are using up their body fluids.

In the case of the rheumatics (active and convalescent), the reserves of vitamin C are deficient. This is shown by their low resting levels and the fact that none of them responded to test doses before the third dose. In such cases it is observed that the volume of urine does not rise until the third day, when it rises sharply as soon as the response to the test dose is obtained.

From this it seems that if the organism is furnished with large doses of vitamin C, the latter does not begin to show its diuretic effect until the body reserves of vitamin C are in a normal degree of saturation. This result is in complete accordance with the findings of Tislowitz [1936, 1], that in dogs some diuretic effect was generally observed on the first or second day and a marked effect on the third day: it must be borne in mind in this connexion that dogs do not need any external supply of vitamin C, being able to manufacture their own requirement inside their bodies.

Therapeutic considerations

Although the amount of diuresis recorded in these results may seem small at first sight, the following facts must be remembered:

(1) The body fluids of the children were in a normal condition during the experiment, and there was no oedema to be rectified.

(2) The diuresis in the case of the controls persisted for the 3 days while the test doses were being administered, and if the extra volumes of urine during these 3 days are added together, it will be realized that the total effect is quite considerable. No doubt the same would have been true of the rheumatic children (active and convalescent) if the test dosing had been continued for more than the 3 days, i.e. after a state of relative saturation of vitamin C had been attained.

Thus had any degree of oedema existed, there seems little doubt that the response would have been greater.

Although it is not claimed that vitamin C can replace the well-known powerful diuretics, nevertheless its diuretic property may be of some use in

¹ Although every factor affecting the volume of urine excreted which could be readily controlled was so controlled, such influences as variations in the temperature of the atmosphere, in the humidity, the amount of sweating etc., which vary from day to day, were in operation, and moreover all the cases were not examined at one time.

cases where a slow and progressive dehydration of the body is desired. Especially it should be remembered that ascorbic acid is a very safe substance to administer, and so far as is known does not cause any damage to the kidneys, as many other diuretics may. Hypervitaminosis C is unknown, possibly because of the prompt excretion of excess of the vitamin by the kidneys.

The possible antibactericidal or antitoxic properties of vitamin C [for references see Abbasy *et al.*, 1936] may be an additional indication for its use in certain types of cases.

If any ill effects due to the acid reaction of the ascorbic acid be feared, especially when large doses are given and when its administration is to be continued over a long period, a suitable alkali (e.g. sodium bicarbonate) could be given simultaneously. It should be added however that so far from ascorbic acid having any power to produce acidosis, it has been proved by Tislowitz [1936, 2] that the administration of the vitamin to dogs causes a definite and persistent increase in the alkaline reserve.

SUMMARY

A specific diuretic effect of vitamin C for human beings is reported. Its possible clinical application is considered and it is suggested that it may be of use where a mild diuretic, or a slow and progressive dehydration of the body, is to be desired. It may possess double value when infection is present in such cases.

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