

A note on kidney size in chronic hypovitaminosis C

By R. E. HUGHES

Welsh College of Advanced Technology, Cardiff

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This note records changes in kidney size associated with a state of chronic hypovitaminosis C in growing male guinea-pigs.

EXPERIMENTAL

Male albino guinea-pigs of initial body-weight 250 g were used throughout. The experimental conditions, diet and dosing technique were those previously described (Evans & Hughes, 1963). Paired feeding between the normal and the 'scorbutic' groups was not practised, as the levels of ascorbic acid given daily (8 and 0.4 mg, respectively) have been shown to have no marked effect on food intake (Evans & Hughes, 1963).

Three experiments were done.

Expt 1. The mean kidney weights were compared in groups of five guinea-pigs that had received 8 mg or 0.4 mg ascorbic acid daily for 35 days.

Expt 2. The mean kidney weights, adrenal weights and adrenal ascorbic acid concentrations were compared in groups of five guinea-pigs that had received 8 mg or 0.4 mg ascorbic acid daily for 28 days.

Expt 3. The mean kidney weights were compared in groups of five guinea-pigs that had received 8 or 0.4 mg ascorbic acid daily for 28 days. A third group of five guinea-pigs was included. These were kept under strictly comparable conditions and were placed on experiment 3 weeks after the first two groups. They received 8 mg ascorbic acid daily and were killed when the body-weights corresponded to the final body-weights of the guinea-pigs receiving 0.4 mg ascorbic acid daily.

All the guinea-pigs were killed by beheading. The kidneys were dissected out and, after removal of the renal capsule, dried between filter paper and weighed. The adrenal ascorbic acid was determined as previously described (Evans & Hughes, 1963).

RESULTS AND DISCUSSION

The results of the three experiments are recorded in Tables 1, 2 and 3. For purposes of comparison the kidney weights are expressed as percentages of final body-weights.

All the chronically scorbutic guinea-pigs (i.e. those receiving 0.4 mg ascorbic acid daily) had enlarged kidneys.

It is generally accepted that an increase in the weight of the adrenal gland is a prominent feature of acute scurvy in the guinea-pig (Randoin & Michaux, 1926). In hypovitaminosis C (chronic scurvy) adrenal enlargement is less marked and appears to

be associated with an increased water content of the gland (Howard & Cater, 1959). Little attention, however, has been paid to changes in the weight of other organs. Bessensen (1922) reported weight changes in organs of several scorbutic guinea-pigs. His results, however, were based on few animals in the final stages of acute scurvy. The rapid premortal fall in body-weight in such animals invalidates to a great extent any comparison of organ weights expressed as a fraction of body-weight.

Table 1. *Expt 1. Effect of ascorbic acid intake on kidney weight in male guinea-pigs (five animals/group) in an experiment of 35 days duration*

(Mean values with standard deviations)

Group no.	Ascorbic acid intake (mg/day)	Final body-weight* (g)	Kidney weight* (g)	Kidney weight as % of body-weight*
1	0.4	263 ± 25	2.89 ± 0.23	1.09 ± 0.05
2	8.0	532 ± 12	4.12 ± 0.29	0.77 ± 0.06

* Difference significant at $P = 0.01$.

Table 2. *Expt 2. Effect of ascorbic acid intake on weight of adrenals and kidney and on ascorbic acid content of adrenals of male guinea-pigs (five animals/group) in an experiment of 28 days duration*

(Mean values with standard deviations)

Group no.	Ascorbic acid intake (mg/day)	Final body-weight* (g)	Kidney weight (g)	Kidney weight as % of body-weight*	Adrenal weight (g)	Adrenal weight as % of body-weight*	Adrenal ascorbic acid* (mg/100 g)
3	0.4	331 ± 54	3.39 ± 0.42	1.03 ± 0.08	0.254 ± 0.034	0.079 ± 0.014	9.2 ± 1.78
4	8.0	449 ± 33	3.41 ± 0.23	0.76 ± 0.07	0.242 ± 0.021	0.054 ± 0.006	74.8 ± 12.0

* Difference significant at $P = 0.01$.

Table 3. *Expt 3. Kidney weight in male guinea-pigs (five animals/group) receiving 8 mg ascorbic acid (groups 6 and 7) or 0.4 mg ascorbic acid (group 5) daily. Groups 5 and 6 were killed after 28 days; group 7 was killed when the mean body-weight corresponded to the mean final body-weight of group 5*

(Mean values with standard deviations)

Group no.	Ascorbic acid intake (mg/day)	Final body-weight* (g)	Kidney weight*† (g)	Kidney weight as % of body-weight*†
5	0.4	345 ± 52	3.65 ± 0.20	1.03 ± 0.08
6	8.0	426 ± 144	3.18 ± 0.31	0.78 ± 0.06
7	8.0	347 ± 51	2.78 ± 0.22	0.80 ± 0.05

* Difference of means for groups 5 and 6 significant at $P = 0.01$.

† Difference of means for groups 5 and 7 significant at $P = 0.01$.

In the experiments described here, the condition produced was one of chronic hypovitaminosis C; consequently there were no sudden changes in body-weight. The mean kidney weights (as percentages of body-weights) for the three normal groups

were 0.77, 0.76 and 0.78. For the animals on a restricted vitamin C intake the corresponding values were 1.09, 1.03 and 1.03, the differences between the groups being all highly significant ($P < 0.01$).

In Expt 2 a comparison was made with the increase in adrenal weight (also expressed as a fraction of final body-weight). The percentage increase in adrenal weight was 46; that in the kidney weight was 36. Also in Expt 2 the ascorbic acid content of the adrenal gland was determined, as an index to the vitamin C status of the animal.

Both Expts 1 and 2 showed the expected divergence between the mean final body-weights of the two groups. The comparison of kidney weights was therefore between animals with widely different body-weights. By the inclusion in Expt 3 of a third group whose members were killed when the body-weights were approximately equal to the final body-weights of the chronically scorbutic animals, a comparison was possible between animals of similar body-weight. In this experiment too, the animals on a restricted vitamin C intake had enlarged kidneys.

It is not possible to say whether this enlargement of the kidneys is a direct effect of avitaminosis C or a secondary effect associated with the 'stress' of scurvy. It is known that hypertrophy of both the adrenals and kidneys of rats and guinea-pigs follows exposure to low temperatures, and that this cold-induced enlargement of the adrenals can be prevented in both species by ascorbic acid (Dugal & Thérien, 1949; Campbell, Green, Schönbaum & Socol, 1960). Also of possible relevance is the report by Eales & Turner (1956) of defective renal function in scurvy; this they attributed to the anaemia of scurvy.

SUMMARY

1. Groups of five young male guinea-pigs received a diet containing 8 or 0.4 mg ascorbic acid daily. The mean kidney weights of the groups were compared after 28 or 35 days.
2. The animals receiving the diet low in ascorbic acid had enlarged kidneys.

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