Vitamin E Content in the Cortical and Medullary Layers of the Mammalian Kidney

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Earlier [3] we showed that the cortical and medullary layers of human kidneys differ in their content of vitamin E; specifically, the vitamin content in the cortical layer was 1.6 times as high as in the medullary layer (the difference is statistically reliable). These results were obtained for the first time, and it seemed worthwhile to examine whether the revealed difference is also inherent in kidneys of other mammalian species.

In this work we studied the content of vitamin E in the cortical and medullary layers of rat, dog, and rabbit kidneys. Such investigations are all the more justified as there are indications [7, 9] of an unequal activity of lipid peroxidation (LPO) processes in the cortical versus the medullary substance of the kidneys of laboratory mice and rats, which may be related to different levels of antioxidants, including the most important one, namely vitamin E.

MATERIALS AND METHODS

Kidneys were obtained from 19 Wistar rats weighing 240-350 g, 9 rabbits of the California breed weighing 2.3-2.6 kg, and 3 nonpedigree dogs weighing 16-24 kg. The kidneys were taken under hexenal anesthesia. The organs were perfused with cool saline, after which, following the removal of the capsule, the cortical and medullary substance (with the exception of the renal papillae) were isolated. The vitamin E concentration was determined in homogenates of the corresponding substances by spectrofluorimetry [8] on a 650-10S spectrofluorimeter (Hitachi). The preparation of the homogenates and measurement of vitamin E content were described in detail elsewhere [3]. The results were expressed in μg of vitamin per gram of wet tissue and in ng per mg of tissue protein. The protein content in the homogenates was determined by the biuretic method [2]. Statistical calculations were performed using the Student t test and the Wilcoxson paired T test. For a direct comparison of the results obtained in different experiments, Table 1 also includes the data of our earlier study [3] concerning the content of vitamin E measured separately in each layer of 10 human kidneys obtained during nephrectomy in connection with renal carcinoma. The assays were performed using intact regions of kidney tissue distant from the tumor.

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RESULTS

As can be seen in Table 1, the content of vitamin E in the medullary substance of the examined human and animal kidneys significantly exceeded that in the cortical layer (by 1.4-2.2 times). This difference was especially pronounced in the rats. The same tendency was also noted when the vitamin content was calcu-

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TABLE 1. Vitamin E Content in Cortical and Medullary Layers of Mammalian Kidneys ($M \pm m$)

Type of kidney	Vitamine E content			
	μg per gram wet tissue		ng per mg protein	
	cortex	medulla	cortex	medulla
Human (10)	10.6±0.66	16.2±1.1	130±10	250±20
Rat (19)	8.42±0.79	19.4±1.8	66±4	185±20
Dog (3)	12.5±1.2	21.1±0.43	95±8	220±40
Rabbit (9)	4.4±0.3	6.33±0.56	30±2	57±5

Note: the number of animals or humans examined is indicated in parentheses; significance of differences in vitamin E content in cortical and medullary layers: *: $p<0.01$; **: $p<0.001$.

lated per mg protein of kidney tissue. The minimal level of vitamin E was found in the rabbit kidneys, being 2-3 times lower than in the corresponding kidney layers of other animals and humans. This may be related to the herbivorous diet of this animal. For instance, low levels of vitamin E (4.2 μg per gram of wet tissue) were found in the renal cortex of another herbivorous animal, namely, sheep [5]; the medullary content of vitamin E was not tested.

As for man and experimental animals whose ration includes animal products, the vitamin E concentration in their kidneys was higher and manifested less striking interspecific variations, although some significant differences were recorded, such as those between the cortical level in rats and dogs ($p<0.01$) and rats and humans ($p<0.05$), and between the medullary level in dogs and humans ($p<0.01$).

In the literature there are only isolated reports about the content of vitamin E in the kidneys of rats [8] and humans [4] (7.3 μg and 7.0 μg per gram of wet tissue, respectively), without any reference to the layer tested. Assuming that the estimations were conducted at the cortical level, these results seem to be similar to ours, especially regarding the analysis of rat kidneys, where the authors, as in our study, used the precise spectrofluorimetric method.

The increased medullary concentration of the antioxidant vitamin E revealed by us explains the reduced LPO activity in this layer that is observed in rat [7] and mouse [9] kidneys. The higher level of vitamin E may be related in this case to an extremely active metabolism of membrane phospholipids in the medullary tissue. Their consumption in the course of prostaglandin synthesis in this layer exceeds by one order of magnitude the analogous process in the cortical layer [1]. Arachidonic acid, produced from the phospholipids by the action of phospholipase A_2 and serving as the substrate for prostaglandin synthesis, is polyunsaturated and therefore may easily undergo peroxidation. It is quite possible that the increased level of vitamin E in the medulla as compared to the cortex is required for the prevention of an undesirable expenditure of arachidonic acid in the course of LPO reactions.

The decreased supply of the cortical layer with vitamin E and the increased liability of its lipids to peroxidation imply an increased susceptibility of the cortical layer to damage in pathological states whose development is considered to be largely associated with LPO activation, e.g., renal ischemia, graft rejection, action of nephrotoxic agents, etc. [6].

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