

COMPENSATORY HYPERTROPHY OF THE KIDNEY  
IN RATS AND RABBITS AFTER UNILATERAL  
NEPHRECTOMY IN EARLY STAGES  
OF POSTNATAL ONTOGENESIS

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In rats and rabbits during early postnatal ontogenesis (age 3-20 days) no direct connection could be established between the age of the animal at operation and the degree of hypertrophy. However, in adult animals the degree of compensatory hypertrophy is appreciably reduced.

\* \* \*

Very few experimental studies have been made of compensatory hypertrophy of the kidney after unilateral nephrectomy in early postnatal ontogenesis [1-4]. Most investigators consider that an inverse relationship exists between the age of animals and the degree of compensatory hypertrophy observed. However, except in individual cases [2, 3], the single kidney never reaches the combined weight of both kidneys of control animals, as has been clearly observed in the later periods of observation. The response of the renal corpuscles to unilateral nephrectomy at different ages has received little study.

The object of the present investigation was to study compensatory hypertrophy of the kidney after unilateral nephrectomy in rats and rabbits in the early stages of their postnatal development and to study whether a relationship exists between the age of the animal at operation and the degree of compensatory hypertrophy of the kidney observed.

## EXPERIMENTAL METHOD

The left kidney was removed from noninbred albino rats aged 3, 7, 11, 14, 20, and 85 days and rabbits aged 3, 7, and 14 days. The operation was performed under ether anesthesia. The animals were sacrificed between 9 and 10 A. M. on the 4th, 8th, 12th, 15th, 21st, and 41st days after unilateral nephrectomy. Between 8 and 14 experimental and 6 and 12 control animals, mainly from the same litter, were sacrificed at each time. The body weight and weight of the kidneys were determined. The kidneys were fixed in Carnoy's fluid. Paraffin sections, 7  $\mu$  in thickness, were stained with hematoxylin and eosin.

TABLE 1. Weight of Compensatorily Hypertrophied Kidney (in % of weight of two control kidneys) at Different Times of Observation

Age of animals at operation (in days)	Time of observations (in days)					
	4th	8th	12th	15th	21st	41st
3	68,2	71,4	84,9	80,5	66,0	72,4
7	56,3	63,0	100,9	90,8	75,2	80,9
11	58,8	73,0	85,6	78,0	75,0	84,7
14	73,5	62,0	108,9	82,8	87,7	88,9
20	83,1	74,9	88,2	77,0	82,9	89,3
85				63,9		68,2

To determine the character of structural changes in the kidney during compensatory hypertrophy and normal growth of the organ, the area of 80-90 renal corpuscles was determined in 6-8 cases at each time of investigation. The area of the renal corpuscles was determined by the formula

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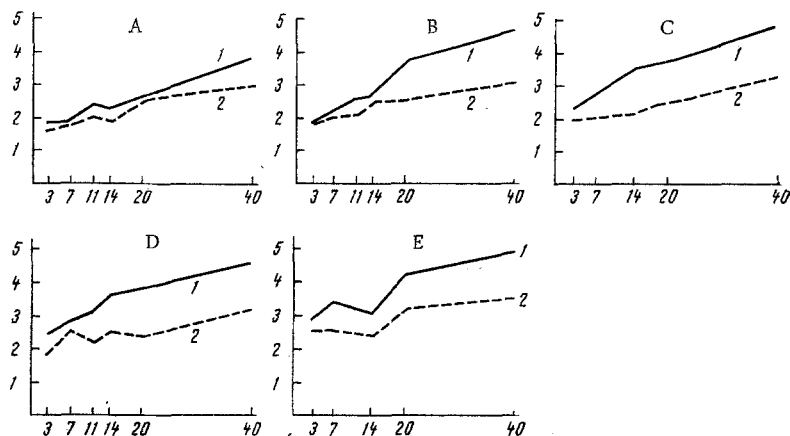


Fig. 1. Changes in size of renal corpuscles in rats of different ages at various times of observation. A) Unilateral nephrectomy performed at age of 3 days; B) at age of 7 days; C) 11 days; D) 14 days; E) 20 days. 1) experiment; 2) control. Abscissa, times of observation (in days); ordinate, area of renal corpuscles (in  $\mu^2 \cdot 10^3$ ).

for the area of an ellipse. In addition, the width of the cortex and medulla of the kidney was determined under a magnifying glass. Statistical analysis of the results was carried out by the Fisher – Student method.

#### EXPERIMENTAL RESULTS

The weight of the right kidney remaining after removal of the contralateral kidney was always increased, but never reached the combined weight of two kidneys in the control regardless of the age of the animals when the operation was performed. The only exception to this rule was the 12th day of observation, when the absolute weight of the residual kidney in rats undergoing operation at the ages of 7 and 14 days reached 100–108.9% of the combined weight of 2 control kidneys (Table 1).

In rats undergoing operation at the age of 3 days, hypertrophy of the kidney was unique in character: after reaching its optimal level 11 and 14 days after operation, subsequently the degree of hypertrophy of the organ diminished, and by the 41st day after operation the weight of the kidney in these animals was only 72% of the combined weight of 2 control kidneys.

Comparison of the completeness of regeneration of the kidney in young rats aged 3–20 days and in sexually mature animals gave the following result. With age, the rate of compensatory hypertrophy diminished slightly. For example, on the 15th day after operation on adult animals the residual kidney had reached only 63.9% of the weight of the 2 control kidneys, compared with 68.2% on the 41st day.

In young rats at this time the corresponding figures were 80.9 and 89%. However, within the limits of early postnatal ontogenesis, when the kidney was still growing rapidly, no connection could be found between the animals' age and the degree of hypertrophy (Table 1).

In rabbits undergoing nephrectomy at the age of 3, 7, and 14 days no substantial differences were found in the degree of compensatory hypertrophy between the various age groups. On the 8th day of observation the weight of the hypertrophied kidney was 67–80%, and on the 41st day 84–93% of the weight of both control kidneys.

Determination of the increase in weight of the right kidney compared with its initial weight after unilateral nephrectomy and during normal growth showed that with age the increase in weight of the kidney tissue was reduced, both during normal growth of the kidneys and during compensatory hypertrophy, although in the first case the effect was always less marked than in the second. For example, in rats aged 3 days at operation, on the 15th day thereafter the increase in mass of the hypertrophied kidney was 517% of its initial mass, compared with 328% for normal growth. In rats undergoing operation at the age of 20 days, the increase in mass was 230% of its initial value, compared with 154%. The same pattern was observed in rabbits.

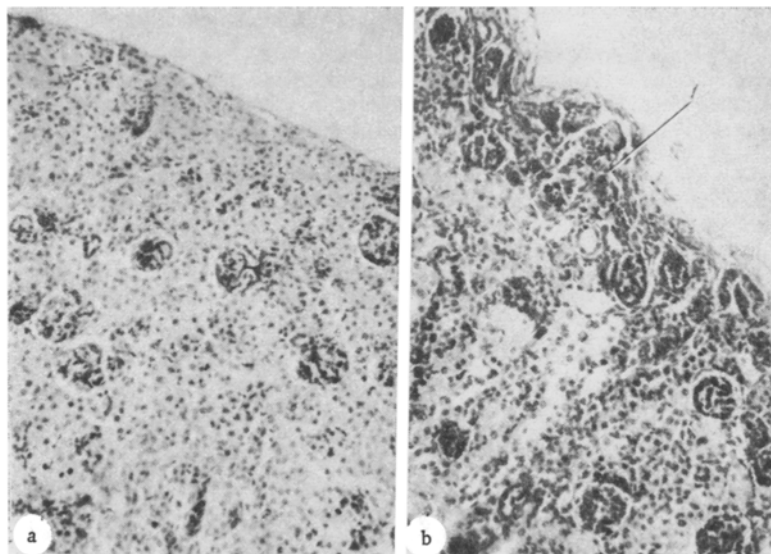


Fig. 2. Structure of renal cortex in nephrectomized and intact rats. a) Kidney of 3-day old rat on 8th day after unilateral nephrectomy (nephrogenic zone not found); b) kidney of 11-day old rat, nephrogenic zone (1) clearly marked, containing renal corpuscles at various stages of differentiation.

During growth and hypertrophy of the kidneys the renal corpuscles increased in size, but in the latter case this effect was more marked.

In rats aged 3 and 7 days, during the first 8 days after operation hypertrophy of the renal corpuscles was less marked than at later periods of observation. The increase in area of the renal corpuscles in the experimental group compared with the control at these times was not statistically significant ( $P = 0.252$  and  $P = 0.09$ ). Significant growth of the corpuscles began after the 14th day ( $P = 0.000$ ; Fig. 1A, B).

In rats aged 11, 14, and 20 days, appreciable hypertrophy of the corpuscles began on the 8th day after operation ( $P = 0.004$ ; Fig. 1C, D, E).

Investigation of the kidney structure during normal and compensatory growth of the organ gives the following results. The increase in width of the cortex and medulla and also of the pelvis of the kidney was characteristic of both normal growth and a state of hypertrophy, although in the latter case these processes were expressed to a greater degree. Moreover, after unilateral nephrectomy on rats at the age of 3-7 days the more rapid disappearance of the nephrogenic zone was observed than during normal growth of the kidney in intact rats of the same age (Fig. 2a, b). The impression is created that compensatory growth of the kidney takes place along similar lines to its growth in intact animals, but the process itself is much more rapid. These findings confirm the earlier hypothesis that the two phenomena are similar in principle [1].

It can thus be concluded from all these observations that definite age differences are found in the character of compensatory hypertrophy of the kidney.

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