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CT EVALUATION OF COMPENSATORY RENAL GROWTH IN RELATION TO POSTNEPHRECTOMY TIME

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Abstract

In 27 patients nephrectomized for renal carcinoma, the compensatory hypertrophy of the remaining kidney was assessed by 72 CT examinations performed one month before and during 32 months after nephrectomy. Kidney size was estimated on CT by multiple measurements of the renal parenchymal thickness. Kidney growth was evaluated by comparing the amount of renal parenchyma before and after contralateral nephrectomy. Renal compensatory hypertrophy varied with postnephrectomy time. Kidney enlargement was 15% in the first 3 months, reached maximum 30% about a year later, and was reduced to 5%, 2 1/2 years postoperatively.

Key words: Kidney, hypertrophy; —, size; —, CT.

Several studies have revealed that after nephrectomy the remaining kidney undergoes compensatory hypertrophy both in man (1-5, 8, 11, 13) and in animals (7, 9, 10, 14). Renal enlargement in humans has been estimated by comparing the size of the remaining kidney on pre- and postnephrectomy urograms.

In this study we employed CT because it provides a reliable means of measuring renal parenchymal thickness (6). The aim was to assess the hypertrophy of the remaining kidney in relation to postnephrectomy time in patients with renal cancer.

Material and Methods

Our study consisted of 72 abdominal CT examinations performed on 27 patients (16 men and 11 women) with renal carcinoma. All patients had one examination in the month before nephrectomy. Twelve patients had one, 12 had two, and 3 had three postoperative examinations during the 32 months after nephrectomy (Table). The patients were between 42 and 74 years old, 11 were younger and 16 older

than 60 years at the time of nephrectomy. Patients with a history of renal disease in the remaining kidney or lesion that may alter kidney morphology were not included in this study.

Kidney size was estimated by measuring renal parenchymal thickness in three sections: one through the level of the renal pelvis and two sections through the upper and lower calyceal levels (Fig. 1). Measurements at the level of the renal pelvis were performed by means of two perpendicular axes, one of which was drawn along the renal vessels. Parallel sets of perpendicular axes were also employed for measurements at the two other levels. Renal parenchymal measurements were made of the anterior (A), posterior (B), medial (C), and lateral (D) parts of the kidney at each level, a total of 11 measurements for each kidney. The amount of renal parenchyma was assessed by adding together those measurements at the three levels. Similar measurements have been made for the estimation of the normal renal parenchyma by CT (6).

The compensatory hypertrophy of the remaining kidney was estimated by comparing the amount of renal parenchyma before and after contralateral nephrectomy by the relation:

$$\text{percentage change in kidney size} = \frac{R_2 - R_1}{R_1} \times 100$$

where R_1 and R_2 are the pre- and postoperative amount of renal parenchyma of the remaining kidney respectively. Student's t-test was employed to compare renal compensatory hypertrophy between males and females and patients older and younger than 60 years of age.

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Table
Time distribution of 45 postnephrectomy CT examinations

Postnephrectomy time periods (months)	1-3	4-9	10-15	16-21	22-27	28-32	Total
Postnephrectomy CT examinations							
Patients over 60 years of age	3	7	5	4	1	4	24
Patients under 60 years of age	5	4	4	2	4	2	21
Total number of examinations	8	11	9	6	5	6	45

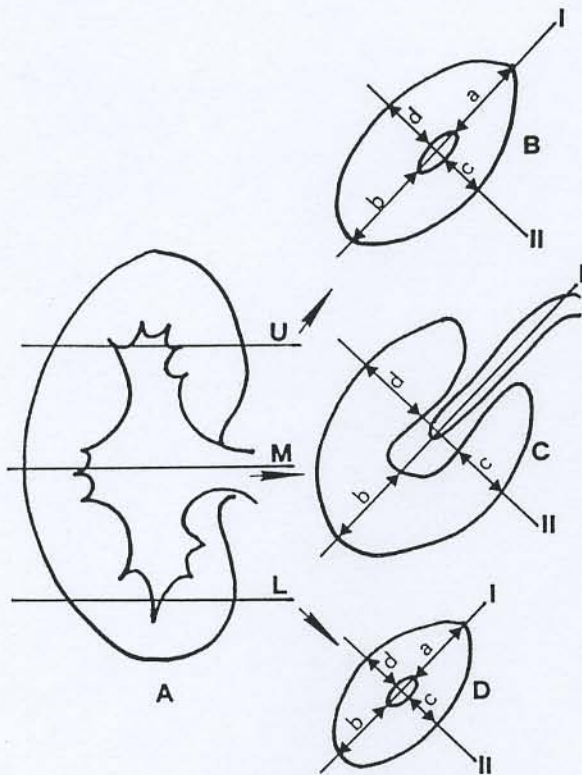


Fig. 1. Schematic diagrams of CT scans through the levels of renal pelvis (M), upper (U), and lower (L) poles of the right kidney. Two perpendicular axes I and II are drawn for measuring renal parenchymal thickness in anterior (A), posterior (B), medial (C), and lateral (D) parts of the kidney.

Results

Renal compensatory hypertrophy differed during the postnephrectomy time periods (Fig. 2). Renal enlargement was 15% in the first 3 months, 21%, 30%, 25%, and 17% in the following 6-month periods, and 5% in the last 5-month period.

The highest rate of compensatory hypertrophy was observed during the first 3 months while maximum increase in kidney size (30%) was achieved between the 10th and 15th month after nephrectomy. The hypertrophic kidney lost most of its compensatory growth after the 22nd postoperative month.

The percentage increase in kidney size did not differ

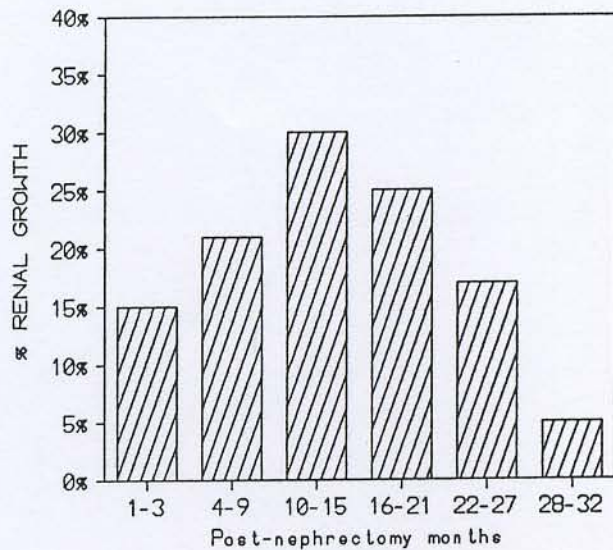


Fig. 2. Compensatory renal growth in relation to postnephrectomy time.

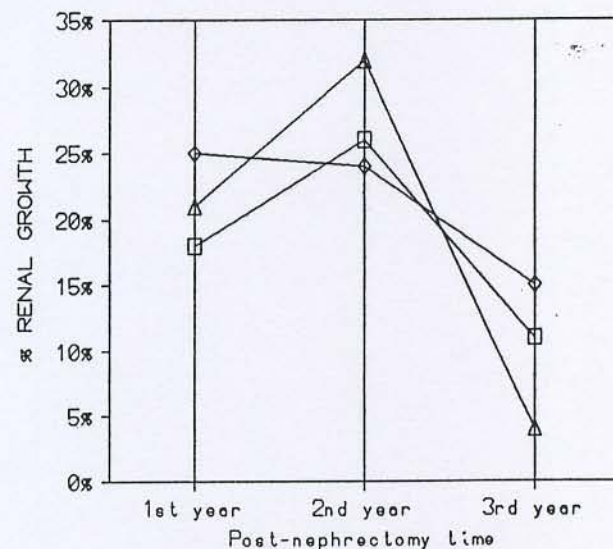


Fig. 3. Change in renal hypertrophy of 3 individual kidneys in the 1st, 2nd, and 3rd postoperative years.

significantly between males and females ($p > 0.10$) or between patients older and younger than 60 years ($p > 0.10$).

Fig. 3 demonstrates the compensatory hypertrophy of individual kidneys in patients with three postoperative CT examinations.

Discussion

Several studies have shown that nephrectomy induces compensatory hypertrophy in the remaining kidney and an increase in renal plasma flow and glomerular filtration rate (5, 9, 14). No reports, however, have been published on renal hypertrophy by CT in relation to postnephrectomy time.

Previous studies (1-4, 8, 11, 13) have assessed compensatory growth by measurements of kidney length, length and width, or by planimetry of the renal area obtained from pre- and postnephrectomy urograms. Kidney growth differs among studies (3%-22%) and in one report (8) there was no renal enlargement.

In this study, multiple measurements of the renal parenchymal thickness were performed by CT to achieve reliable estimation of the renal size. Additionally, the compensatory hypertrophy was expressed as the percentage change in the size of the remaining kidney before and after nephrectomy, because kidney size depends on age and body habitus (6). The compensatory growth was examined in relation to postnephrectomy time since it is known (12, 14) that the compensatory reaction of the kidney in animals is different during the early and later stages after nephrectomy.

Our results showed that the remaining kidney was 15% larger than preoperatively in the first 3 postnephrectomy months. Studies in animals (7, 9, 12) have revealed that creatinine clearance increased by 43% to 50% and kidney weight by 38% during the same time period. This difference may in some patients be due to pre-nephrectomy growth of the healthy kidney that parallels the progressive functional deterioration of the affected kidney. Therefore, the difference in kidney size before and after nephrectomy in patients with renal neoplasm may be smaller than in animals.

Maximal growth (30%) was observed between the 10th and 15th postoperative month and, thereafter, the hypertrophic kidney decreased in size. One study on renal function of the remaining kidney (11) has suggested that maximal hypertrophy requires about 18 months in humans.

According to our findings, the size of the remaining kidney was enlarged by only 5%, 2 1/2 years after nephrectomy. This result is in accordance with the findings of DOSSETOR (2); in 14 of his patients operated for kidney neoplasm, the compensatory hypertrophy was about 3%, 2 to 8 years after nephrectomy.

Previous studies (2-4, 8) have made an overall estimation of the kidney enlargement between one month and 10 years after nephrectomy. Our findings, however, indicated that the compensatory growth varied with postnephrectomy time. Thus, a representative mean value of renal enlargement for the postnephrectomy period may not be useful.

Our results also indicated that the compensatory enlargement of the remaining kidney did not depend on patient age in adults over 40 years of age. This is in agreement with the findings of EKELUND & GÖTHLIN (4), who have similarly

based their results on patients over 40 years of age nephrectomized for renal cancer, and also with the study of BONER et al. (1). EDGREN et al. (3) found the greatest changes in renal size to occur in donors under 40 years of age. However, TAPSON et al. (13) found only a weakly significant negative correlation between the change in kidney length and age in donors 23 to 57 years old.

In conclusion, the remaining kidney undergoes significant enlargement during the first year after nephrectomy and, thereafter, loses most of the compensatory growth.

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