Relative Renal Accumulation of Tc-99m Penicillamine as an Index of Differential Renal Function: Concise Communication

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The relative renal accumulation of technetium-99m penicillamine (TPEN) was evaluated as an index of differential renal function. Using a scintillation camera interfaced to a computer, renal uptake of TPEN was determined for each kidney by subtracting the renal activity at 10 min from that at 25 min. This percentage of TPEN activity in the left kidney was compared with the percentage of total creatinine clearance contributed by the left kidney in six patients with ureteral obstruction and nephrostomy drainage. The two measurements agreed extremely well, with a correlation coefficient of 0.98. The relative renal uptake of TPEN and similar cortex imaging agents such as Tc-99m dimercaptosuccinic acid can probably be used to assess differential renal function.

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A number of radionuclide procedures have been suggested to evaluate differential renal function (*1–5*). In general, these techniques require sophisticated programming and computer processing or involve the use of inferior radiopharmaceuticals such as Hg-203 or Hg-197 chlormerodrin. Furthermore, many of these techniques lack direct validation in patients. Recent unpublished studies in dogs have shown that the differential renal accumulation of Tc-99m Penicillamine (TPEN) correlates well with the differential inulin clearance. Unilateral postobstructive atrophy in one dog kidney was produced by ureteral ligation followed 2–4 wk later by a transureteroureterostomy drainage procedure. Based on the dog studies and the fact that TPEN has been shown clinically to be a superior cortex labeling agent (*6–7*), we decided to evaluate the relative renal uptake of TPEN as an index of differential renal function by correlating the relative TPEN uptake with the differential creatinine clearances in patients with nephrostomy drainage.

MATERIAL AND METHODS

Six patients with either unilateral or bilateral nephrostomies were positioned under a scintillation camera interfaced to a computer, and data were recorded at 1-min intervals for 25 min following the i.v. injection of 5–10 mCi of Tc-99m penicillamine. All patients had either unilateral or bilateral obstruction secondary to carcinoma of the prostate, renal tuberculosis, nephrolithiasis, or a postsurgical complication following pyeloplasty or ureteral implantation. The TPEN was originally prepared in our laboratory by the addition of 2 cc of pertechnetate solution (10 mCi) to 60 mg of D-Penicillamine, adjusting the pH to 8.6 and autoclaving for 15 min at 100°C. We now have an inhouse kit that is tested for sterility and pyrogenicity before injection in patients.

Regions of interest were selected on the computer to outline each kidney and the counts in each kidney were determined at 1 min intervals. Since previous studies had shown liver accumulation to be relatively constant during the first 25 min, renal uptake of TPEN was corrected for background activity simply

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by subtracting the renal uptake at 10 min from that at 25 min. The relative distribution of TPEN to the left kidney was calculated, for example, by dividing the net activity in the left kidney (25–10 min) by the net activity in both kidneys (25–10 min).

With the exception of one patient, 24-hr creatinine clearances were determined from the kidney with nephrostomy drainage and from the bladder to represent the second kidney within a few days of the TPEN studies. In all cases, the ureter from the kidney with the nephrostomy was obstructed so that nephrostomy urine represented total urine output from that kidney. The fraction of renal function for the left kidney was calculated by measuring the 24-hr creatinine clearance from the left kidney and dividing it by the total creatinine clearance.

RESULTS

Total creatinine clearance in the six patients ranged from 48 to 114 ml/min, whereas the total renal uptake of TPEN (25–10 min) ranged from 5,400 to 54,400 counts.

In Fig. 1 the fraction of TPEN uptake in the left kidney is plotted against the left kidney's fraction of the total creatinine clearance. The correlation coefficient is 0.98 and the line of identity is drawn for comparison.

DISCUSSION

In these six patients, the relative unilateral uptake of TPEN (25 min–10 min) has been shown to correlate extremely well with ipsilateral renal function as determined by creatinine clearance. Previous studies have shown that the relative uptake of TPEN correlated quite well with the relative distribution of effective renal plasma flow. In these studies, individual renal plasma flow was determined using the sophisticated computer modeling technique of DeGrazia et al. to measure I-131 hippurate clearances (*3*). Furthermore, our preliminary data suggest there may be a correlation between the patient's renal function and the total accumulation of TPEN by the kidneys similar to that shown for $^{197}HgCl_2$ (1).

TPEN is a cortex labeling agent that is not yet commercially available but can be prepared easily in kit form. Studies in rats comparing the uptake of TPEN and Tc-99m dimercaptosuccinic acid (DMSA) at 0.5, 1, and 2 hours after injection show similar cortex labeling properties (*8*). Furthermore, recent presentations suggest that DMSA can be used to provide an accurate assessment of the relative renal blood flow, and creatinine clearance (*9*). In view of these data and our results using TPEN, it is likely that the method we describe could be applied to DMSA to provide a satisfactory index of differential renal function.

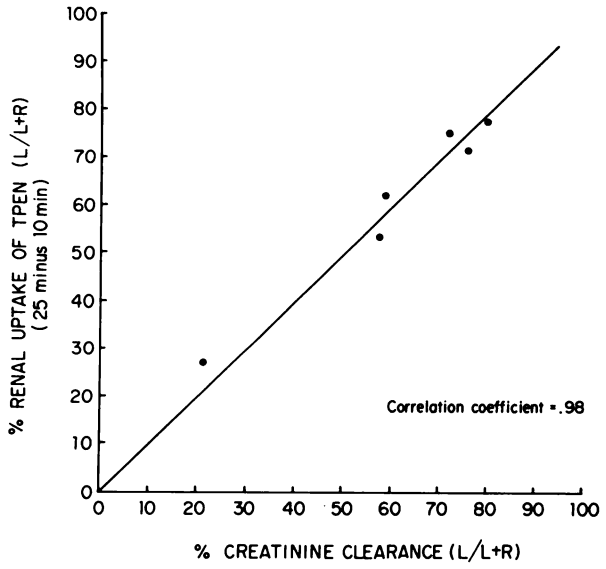

FIG. 1. Relative distribution of TPEN to left kidney (L/L + R) is correlated with percentage of creatinine clearance from left kidney as determined by nephrostomy drainage. TPEN uptake in each kidney was determined by subtracting the activity over kidney at 10 min from that at 25 min. (L — left kidney; R — right kidney.)

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